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CABLE TELEVISION:
ITS URBAN CONTEXT AND PROGRAMMING

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FOREWARD

I have been interacting with Forrest Warthman for almost two years as he was exploring the potential of cable television. One of his objectives was to discover what could happen to cities in America when they became wired up once again, this time enabling many more kinds of information to flow freely into households and commercial establishments.

The technological information I could pick up was transmitted to Forrest. It was accompanied by the policy issues raised in the committees of which I was either a member or an observer. Forrest collected far more on his own initiative by very diligently covering current literature, interviewing industry representatives, and engaging in the selling of cable television services. As a result, I read this report to establish what the state of the art is as of early 1973, because a huge amount of sifting and knowledgeable analysis has gone into its assessments.

The conclusion I reach regarding community-based television is that the easy ideas and proposals have been generated simultaneously in many parts of the country. All those on the table for consideration now do not appear to be potent enough to change the culture of cities or the civic order significantly. We can generate innovating ideas (Forrest discusses some in Section III on Programming) but they appear to require hard work, the investment of quite sizable resources, and a relatively long time to implement. Therefore, the organization

of cable television is likely to remain pretty much as described here for the rest of the decade. Although the level of disillusion is likely to increase, the remarkable potentials of the cable remain with us.

Berkeley, California
May 21, 1973

Richard L. Meier
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I. INTRODUCTION

Television has become the principal leisure and mass communication medium in America. We have more television sets than automobiles. More U.S. households have television sets than have telephones.* In the average home, a television set is on almost seven hours a day. Television news is more credible than newspaper news to most Americans (8).** By the time children finish elementary school they have spent more time watching television than attending classes. In a country where 80% of all homes bought television sets within the first decade of their introduction (1950-60), and where television ranks in industrial growth alongside computers, jet aircraft, and xerography, it should come as no surprise to find both public interest and private investment gravitating toward an expanded television medium.

Cable television provides one avenue for this expansion, an avenue that is being linked with broadcast television, microwave, and videotape media to bring local audiences more programming choices. In the not too distant future, with more video cassettes, microwave, and satellites, the prospect of large amounts of program choices will emerge. It will be the next-best thing to on-demand television programming.

*96% compared to 92% in 1970.

**Parenthesized numbers in the text refer to citations in Section VI.

Cable systems have an ancestor in master antenna television (MATV), a simpler closed-circuit coaxial cable system still used for the internal wiring of motels, hotels, apartment and office buildings, hospitals, and schools. The antenna for MATV systems is located on the roof of the building where it picks up broadcast signals and transmits them to television sets in various rooms throughout the building. Cable television (CATV) is an extrapolation of MATV to community-wide dimensions. In CATV, amplifiers are added to the coaxial cable at regular intervals to carry signals up to 10 miles in radius from a central headend antenna site. Most of the 3000 cable systems in the U.S. carry 12 television channels or fewer. In large urban areas the newest systems have capacities reaching 50 channels, though almost none have more than 25 channels activated.

The growth of cable television has been vitally linked to commercial television programming as we know it today. Small towns and suburban areas receive neither the abundance of stations nor the quality of signal reception that urban dwellers enjoy, yet they account for better than half the residential TV-viewing population. Where any of the three major networks is not available, or where other independent stations can be picked up with the cable system's special antennas, the closed-circuit method of importing those signals and supporting costs on a subscription basis has an excellent chance of success.

Cable systems are serving better than 10% of the U.S. population, with the biggest concentration of subscribership around the North Atlantic and California coastal megalopolises. By 1980, subscribership may reach 15 to 20 million homes. Twenty-five percent of Canada's population subscribes to cable television service,

in large part because American network-affiliated stations are picked up from across the border.

Many "blue sky" proposals have grown up around cable television systems. They are seen as an avenue for facsimile or teletype mail into homes, for on-demand access to video or print media libraries, and for two-way video communications from one residence to another. All of these applications are technologically possible on modified cable television systems, but none of them has an immediate mass market due to high costs. They have only small, specialized markets, which some diversified cable television companies are serving.

In March 1972 the Federal Communications Commission adopted rules for cable systems in the top 100 television market areas, to be implemented by 1977 (7). They require minimum capacity of 20 television channels; two-way data transmission potential for communications between home subscribers and the central headend of the cable system; separate channels for local schools, local government, and public access; and extra channels that can be leased to private users. The rules also constrain importation of broadcast television signals and the duplication of program material on those stations which are imported. Technical standards of signal quality are also covered.

These FCC rules simplify the work of local governments, which franchise cable systems. They also establish a working relationship with broadcast stations on the question of program copyright while the Senate Judiciary Committee rewrites the 1913 copyright law. The rules do this at the expense of some free development and negotiation, and they tend to raise not only the

service level of cable systems, but also the costs of providing that service. Recognizing this, the FCC has retained some flexibility in its rules.

I have chosen to discuss the emerging cable television industry in the context of alternative media that are capable of serving similar markets with similar programming. It is not the only context worth considering. There are legal contexts of franchising, copyright, and federal regulation. There are resource allocation contexts of the electromagnetic frequency spectrum and its efficient and equitable use. There are industry contexts of state-of-the-art knowledge in electronics and production capability. And there are broad communication contexts of television's relationship to print media, radio, or face-to-face human interaction.

In the final analysis, the reason for choosing the context I did is simply that it interested me more. We are expanding into an age of environmental television in which television's eyes to the outside world will shape the environment inside our homes and inside our minds more each year. While television has this power, it is also a benign medium in the sense that we can turn it off at will, an art some people have difficulty learning. Environmental television will be more malleable and more personally controllable than the physical environment which surrounds us. All we have to do is sense how to use it.

II. TRANSMISSION NETWORKS

Large communication networks are not built in a vacuum. They depend upon pre-existing networks--either electromagnetic transmission or physical transportation--during construction phases and often throughout their entire productive life. Broadcast television, for example, depends on the telephone network for interstate signal transmissions; the telephone network depends on the postal system to bill customers; and the postal system depends on the highway network to deliver mail.

Present cable television systems are no different. They depend on broadcast television for access to programming and on the postal system for billing. Future cable systems could develop somewhat more independence from these networks, particularly if original programming and two-way cable communications become common. But it will be a gradual evolution at best. The following sections review some of the important features of those networks.

A. The Postal Network

One of the major difficulties with the postal system today is the congestion of physical objects requiring physical transportation. Success is spoiling this network by overloading it. The efficiency, structure or pricing policy of the system must be changed if it is to survive. Private parcel carriers are competing very successfully with the Postal Service; they already carry more parcel

post units than the Postal Service. Regional shopping centers avoid some of the problems of mail-order home delivery by accepting mass merchandise deliveries and having each customer perform his own local delivery by picking up items at the regional center. Among second class mails, mass newspapers and magazines have been seriously affected by postal delivery costs and inefficiencies; some of the largest publications have succumbed in part because of these problems.

Certain types of information carried by the mail can be sent electronically. About 40% of all first class mail consists of business documents and financial transactions that could be transmitted by a national switched teleprinter network (28). The cost of sending messages this way would be about the same as by mail, but both speed and reliability would be greatly increased. Some of this evolutionary development is already under way with teletype and facsimile interconnection over the telegraph and telephone networks, though costs are still high and delivery usually requires the receiver to have a compatible terminal.

Distribution of videotape through the Postal Service or private carriers, including air freight carriers, is growing. These methods facilitate low-cost television program distribution when delayed-time playback is acceptable and when the program users are geographically dispersed throughout a large region. Cable television systems, pay television systems, private industries, educational institutions, and individuals are beginning to use this method of television program distribution along with film distributors.

There are two basic methods of postal distribution for television software. One is analogous to the broadcast model of

telecommunications, where one source distributes several prints of the same program to several receivers. The other method--called bicycling--is analogous to a multipoint distribution model, where one source sends the program material to a second user, who sends it on to a third user, and so forth.

B. The Telegraph Network

Western Union is seeking to evolve from a low point in its activity as a communication network. Three times as many messages were handled in 1945 as are handled today. To cope with this situation, the company is closing outmoded local offices and automating message handling. It was the first communications company to be granted rights by the FCC to launch a domestic satellite. The company has also initiated new message-switched data transmission services for general business and the securities industry.

A new telegraph service, Mailgram, was recently introduced by Western Union in cooperation with the Postal Service. Messages delivered in person or by phone to the local Western Union office are transmitted to the destination city where a teleprinter in the post office records the message for delivery as regular first class mail on the following day. The 1973 rate for this service is \$1.60 per 100 words.

A form of electronic postal delivery competitive with both teleprinters and the Mailgram service utilizes individual facsimile terminals interconnected through the telephone network. This system is faster and more convenient than Mailgram, but it is only operable when the receiver has a similar terminal: it is slower than teleprinter links but more versatile, since it can carry pictures and graphs as well as print.

C. The Telephone Network

The average person now receives more telephone calls than pieces of mail in a day, with an increasing proportion of those calls coming from more distant points (24). A.T.&T. has reinforced this trend recently with its Wide Area Telephone Service (WATS), that enables users to pay a fixed monthly rate for regional toll calls. The fastest growing segment of telephone line traffic has been in data transmission; the longer the distance, the faster the growth. Data, together with network television signals, now occupy better than half the long-lines capacity of the Bell System. This rapid growth has prompted Bell's experimental development of advanced high frequency transmission techniques such as millimeter waves and waveguides, light beams, and glass fiber optics (13). In the meantime, this growth in data traffic has brought competition on major intercity trunk routes from new microwave companies who want to serve the growing market of users dissatisfied with telephone company service and tariffs. A.T.&T. recently announced tariff reductions on long distance lines to meet this competition. In addition, the company is continuing its installation of digital-mode trunk lines for faster, more accurate transmission.

The Touchtone telephone, now becoming available in many areas of the country, is able to accept data entries as well as voice. Each of the push-buttons on the Touchtone unit emits a separate set of frequencies that can be read by a computer acoustically coupled to the telephone line. By dialing the computer's telephone number a dialogue can be opened, often with the computer responding in synthetically constructed voice from its linguistic memory (13).

Full video/keyboard terminals for computer input/output operate regularly on standard telephone lines. Small home units for obtaining stock prices on simple digit-displays operate acoustically over standard telephone lines; they lease for under \$500 per year. Another device for acoustical coupling can display computer information on standard television receivers. One system of pay television, carried over cable television systems, uses a small push-button device acoustically coupled over WATS lines to request specific television programs and automatically identify the caller for billing purposes.

Access to computers by Touchtone telephone can accomplish all of the interactive services mentioned in the context of two-way cable television systems. Stock market quotations, home shopping, theater ticket ordering, interactive games, computer assisted education, calculation services, and television-displayed newspapers can all be done over the telephone network using computerized voice-answerback strip-printing terminals, or television screen display terminals. More importantly, these services can be offered from regional or national centers; the telephone company is not confined to small geographic areas as cable television systems presently are. Two-way cable television systems, however, would have the advantages of automatic subscriber identity for purposes of billing (the identity of telephone users is known only to the local telephone exchange) and of greater bandwidth for more speed and more services on a single line connection. Use of the telephone for dialogues with computers will prevent incoming voice calls from reaching the user. If these special services were accessed frequently, telephone subscribers would need additional telephone lines for them.

In a few large urban centers, notably New York City, local telephone switching centers are experiencing overloads not unlike the overloads on postal system switching (mail-sorting) operations. This is due to the relatively slow speed of electromechanical circuit switching equipment. New electronic switching systems that close circuits with special-purpose computers are being installed at increasing numbers of local exchanges, but the changeover is not unduly rapid; A.T.&T. uses a 40-year amortization period on switching gear.

The electronic switching systems being installed have continuous polling features similar to the polling features of two-way cable television systems. The telephone switchers poll every subscriber's line at 100 microsecond intervals to detect when a telephone receiver is taken off its hook. The same polling sequence could be used to continuously monitor security and fire alarms, just as cable systems do, though again it would require a separate telephone line for each service.

Bell's Picturephone is the video analog to the switched voice network. The Picturephone receiver uses 1/6 the bandwidth of conventional television so as to minimize demands on transmission lines and switching centers. The screen size is quite small, making document display difficult and relying on closeup shots for personal appearance. Original estimates of its marketability have fallen somewhat short of expectations. It has, however, the capability of bringing broad bandwidth capacity to home or office subscribers, a bandwidth that can be used equally well for high-speed data transmission.

The telephone company carries national network television transmissions on its long lines. Major cities are equipped with television operating centers for switching signals to local television stations. During off-peak hours, these channels and operating centers are used by the telephone companies for their own internal video conferencing and training classes. If the television networks take some of their long distance transmission business to the lower-priced private microwave networks, A.T.&T. will have lost a good customer, but it may gain a marketable television conferencing network between major cities in the U.S., where hotels could add it to their growing array of business services.

D. Broadcast Radio

Radio was the first real-time mass broadcast medium. It has survived the competition of television by refining its programming formats for specialized audience, by developing portable receivers for automobiles and individuals, and by automating production operations to the point where many stations play only prerecorded material obtained from national distributors. Radio has become a vital marketing link for the music recording industry.

Radio is not always carried over the air. In Britain, radio is carried through certain parts of the country on separate wire systems. In Japan and Spain, the telephone networks accommodate radio, with either the telephone headset or an attached speaker serving as the radio terminal in homes. In the U.S., the Muzak subscription radio system is carried monaurally over the telephone lines (though stereo or quadrasonic is possible). Other methods of

subscription radio utilize sidebands of radio station frequencies or separate coded frequencies. These subscription methods all require special receivers.

It is possible that future cable television systems will carry subscription radio. If consumption of radio programming continues to grow, cable systems may find it economically feasible to provide the electronic multiplexing and tuning equipment necessary for cablecasting a wide variety of radio channels.

E. Broadcast Television

Broadcast television, like radio, is a system of program distribution in which the audience pay for their own terminals (the television set), advertisers pay for the program production and distribution, and the audience pay the advertisers by purchasing the advertised products. It is a system in which both program producers and advertising sponsors try to maximize the audience they reach.

VHF and UHF are the two categories of commercial broadcasting designated by the FCC. VHF, operating at lower frequencies, is the decisively preferred category owing to better signal propagation characteristics and easy click-stop tuning provisions on standard television receivers. Only a handful of UHFs show a profit. As VHF channels became fully allocated in dense urban areas, the FCC attempted to expand the television broadcasting medium by allocating new space on the frequency spectrum for UHF and by requiring television receiver manufacturers to install additional UHF tuning devices in each set. The effort has been, at best, a modest success. The

inconvenience of using UHF's non-click-stop tuner and the poorer signal quality have worked consistently against mass viewership. The most pervasive use of UHF channels has been by educational authorities, as educational television (ETV) stations.

Cable television systems are required by current FCC rules to carry local UHFs along with VHF's. This will make UHF broadcasting price-competitive with cable television channel leasing when program distribution needs involve several cable systems.

Broadcast television is regional in scope, with signals typically reaching a 50-mile radius, depending on power output and topography. Intercity and interstate networking is accomplished largely over A.T.&T. cable and microwave trunk routes. Television translators are sometimes used to extend the range of VHF and UHF stations. These are large antennas located at the fringe of a station's reception area, receiving the weak signal, amplifying it, and rebroadcasting it at another frequency so as not to interfere with the original incoming frequency. Translators are difficult to support financially; originating stations must try to attract higher advertising rates for the additional audiences reached by their translators, or small towns must raise public or private money to finance the translator. Unlike cable television systems, translator reception cannot be a function of subscribership since the signal is available to anyone.

The FCC has established rules for cable television carriage of broadcast signals. These rules generally require the carriage of all broadcast signals that originate within 35 miles of the cable system's franchise area, all education (ETV) station signals that

reach the cable headend with specified signal quality, translator stations within the cable community, and any other independent stations that attract at least 2% of the viewing hours in a cable system's television market area (7).

The Rand Corporation recently studied the future impact that cable systems would have on broadcast station audiences through importation of distant broadcast signals (22). The study projects a general reallocation of broadcast station audiences in which the local audience of small-market VHF stations is increased. UHF stations, because their signal is received and tuned better, generally benefit from cable system carriage.

F. Microwave Networks

The early technology of microwave was developed to a large extent by A.T.&T. for its interstate trunk lines. Today, microwave is used by many common and private carriers, including the cable television industry. In these higher frequencies, well above the UHF television band, it becomes easier to transmit narrow point-to-point beams that do not interfere with other nearby transmissions, and the availability of electromagnetic spectrum resources in this range allows greater capacity for transmission. This is especially important in dense urban areas where broadcast frequencies are filling up the VHF and UHF bands.

While point-to-point transmission is possible at microwave frequencies, omnidirectional broadcasting is also still possible, depending on the design of the transmission gear. Educational institutions have been using this form of microwave under the name

Instructional Television Fixed Service (ITFS). The FCC has also recently designated a similar Multipoint Distribution Service (MDS) band for commercial common carrier applications, reaching about 20 miles in radius.

Large private microwave companies are building national point-to-point trunk routes between cities, using a variety of equipment and signal transmission formats, new and old. They carry primarily data and television traffic for computer-oriented businesses, commercial television networks, and cable television systems that import distant broadcast stations. Most of the trunking will eventually serve central business districts where clients are clustered. The local distribution and collection of messages will be handled by a large variety of means, including low-power microwave, laser beams, coaxial cable, standard telephone lines, and land-mobile radio.

The entrepreneurial moves in microwave have been fostered in part by A.T.&T.'s average pricing policy, which tends to subsidize the proliferation of infrequently used local lines at the expense of more heavily used long distance trunk traffic. A.T.&T. has recently announced some revision in this pricing policy, but there are other incentives for private competitors, including the growing demand amongst computer people for long distance digital-mode lines which can accommodate a wider range of terminal devices and allow the user's own access arrangements to the trunking network.

The extent to which future cable television systems might act as local distribution networks for microwave data services depends on the switching capability of cable headend computers, and on the

signal mode and error rates of channels; no cable systems yet provide facilities to interconnect with these microwave networks. The penetration of cable systems to relevant market areas is a factor of equal importance. Much of the demand for these microwave networks is in central urban areas, where cable systems have generally low penetration due to high construction costs and lower demand for entertainment television programming, the cable industry's basic service.

Microwave is being used to reach hotels and cable system headends with pay television programming. An intercity network of this kind would have great flexibility. Microwave antennas and amplifiers can be added or moved easily, since they require only a small permanent installation, and they require no franchise action on the part of local authorities as cable television systems do. When consumer demand rises for any data or television services, individual points including MATV-wired apartment buildings, office buildings, hospitals, motion picture theaters, and industrial centers can be reached easily by point-to-point or broadcast microwave.

G. Domestic Satellites

Domestic satellites will make national program distribution relatively cheaper and more pervasive. A satellite can act as a single repeater station carrying programming from one origination center to a multitude of receivers. While national program distribution by cable and terrestrial microwave must interlace a multitude of receiving stations with a multitude of trunk lines and amplifiers, broadcast satellites require only a single transmitting station at one end and single receiving stations at each point in the national distribution network. Neither topography nor distance is a major consideration for satellites. Their signals reach valleys as easily as mountain tops. With wide-beam coverage of the continent, the cost of sending signals from San Francisco to New York will be the same as sending them from San Francisco to Denver.

Time zone differences will constrain the most efficient utilization of satellite broadcasting. It is not acceptable to watch Walter Cronkite at 6 p.m. in New York and 3 p.m. in San Francisco; residential living patterns and television program scheduling are closely wedded in this respect. Programs must either be broadcast at separate times on separate satellite channels corresponding to time zones, or they must be recorded on videotape for later replay in those time zones where the live broadcast would fall too early.

There are presently seven companies seeking FCC approval to launch domestic satellites. The smallest proposed satellite has a transmission capacity of 12 television channels, the largest one, a capacity of 120 television channels (15). Narrowband communications for two-way switched voice and data will probably constitute the

largest proportion of traffic on these satellites, but they will not enjoy the economies of one-way broadcast transmission.

The size and cost of earth station antennas is interrelated with their receive/transmit capability, channel capacity, and reception quality, and with the retransmission power of the satellite, the frequency bands used, and the scale of production of antennas. Earth stations presently being discussed for use by cable television systems would cost about \$100,000 for 12-channel receive-only capability. The utility of these antennas must be maximized by conventional cable or microwave interconnection to adjacent program clients. Future antennas utilizing higher frequency bands and more satellite power may come down to \$10,000 or even much less. Very large scale production (more than one million units) of receive-only antennas for about 12 television channels could bring costs down to a few hundred dollars (27). If this happens, the overall efficiency of national-level broadcast distribution systems will increase, since the necessity for terrestrial interconnection between one large earth station and neighboring program markets will decrease, and individual users will more readily carry the capital costs of earth stations. Experiments with satellite broadcasting to rural areas are being conducted in Canada and the Rocky Mountain region of the U.S. They will also begin soon in India.

H. Recording Media

The most pervasively used recording medium in television is videotape, part of the larger group of magnetic tapes used in audio recording and computer systems. Broadcast television videotape is two inches wide, while cable television systems generally use one

inch and three-quarter inch formats. Portable television equipment uses primarily one-half inch tape for small closed circuit applications; cable television is just beginning to use this width also. Computer tape uses digital signal encoding rather than the analog signal encoding common to videotape (23).

A major advantage of the videotape medium is that it can be played back instantly; it does not require intermediate processing as do visible light, x-ray or electron beam recordings on photographic film. It can also be demagnetized and reused. Editing is done electronically rather than mechanically as in motion picture film, and advanced systems for broadcast television record digital codes on the tape alongside visual information so that specific sequences can be automatically located, a technique of information retrieval developed in the computer industry. Videotape decks can also be remotely controlled to record or play back at predetermined times, though this capability is still confined to the more expensive studio equipment.

The emergence of tape cassettes adds a new dimension of convenience to playback machine loading. Linked with the emergence of playback units in the under-\$1000 range, postal distribution of cassettes to cable systems and many other users is growing. Various methods of "bicycling" videotape are used when the volume of program traffic does not warrant real-time interconnection.

Discs are undergoing prototype development using both magnetic encoding and tracking and also laser beam tracking on microgrooves. They require somewhat simpler playback terminal mechanisms; they have better manual access to internal information than videotape; and they

do not need to be rewound. But discs often cannot be reused as videotape can, they are not as convenient to load and store as cassettes are, and the cassette systems have a strong headstart in the acquisition of software and sale of playback machines. Disc systems will compete in the mass home market only if their cost is lower than cassette systems.

Photographic film has been in steady use on television systems because of its vast stock of software. It preceded videotape as a storage medium and the cost of dubbing film onto videotape inhibits this transfer. The cost of reproducing film prints is significantly higher than reproduction of videotapes, and it has been an important factor working against national distribution of films to motion picture theaters. The per-square-inch storage capability of photographic film is much higher than videotape, and for this reason film is being developed most rapidly for microfilm and microfiche, where 200-fold reductions in size are now possible. Both electron and laser beam exposure techniques are under development for microrecording applications. Development of playback machines has advanced far more rapidly in photographic micro-recording than in standard motion picture recording.

Facsimile recording can produce small quantities of hardcopy documents at substantially lower cost than commercial printing. High distribution costs in the newspaper and magazine industries have prompted speculation over electronic distribution of print and graphic information to facsimile terminals on cable television systems. Facsimile terminals are commercially available for use on the telephone network, but their cost (about \$1500) and maintenance requirements are still too high for mass home applications. The present

market for these terminals is in national business document networks. It is a form of electronic postal distribution analogous to Western Union's Mailgram; rather than depending on the postal network, it depends on the telephone network.

Cable television systems are being used by the Associated Press and Reuters news services, for electronic delivery of print information on television screens. The narrowband alphanumeric information reaches cable system headends over telephone lines, where it is stored and continuously read out onto a television channel, reaching cable subscribers as a normal television signal.

An alternative method of electronic print, graphic, and visual image delivery uses more decentralized storage at each subscriber's terminal and a greater bandwidth which is shared by many users. Silicon storage tubes are being developed to receive and store single video frames for minutes or hours. A charged target chip is scanned continuously by an electron beam onto the subscriber's television screen, giving the appearance of a still picture. The system allows joint use of a television channel by many subscribers when each subscriber has a unique code. Single video frames are requested by a subscriber on a push-button keyboard and sent out on the common channel by the computer. When the subscriber's unique address is recognized the frame is scanned into his storage tube, and the common channel is then free to carry other information.

Integrated circuit memory, now being mass produced in the computer industry by quasi-photographic methods, offers another means of storing video, audio and alphanumeric information in future cable television systems. Remote television/keyboard terminals in the under-\$2000 range are coming into production in the computer industry.

They are often linked to computers over standard telephone lines, using an interfacing "data-set" that converts their digital signals to the analog signals used on the telephone network. The great interest for the computer industry will continue to be in all-digital networks, since central processing units and peripheral devices all use this signal format.

In the cable television industry, where entertainment television has been the mainstay, these advanced storage media are, at best, future possibilities. Other forms of storage media, such as paper tape strip printers or neon digit display tubes, may be adapted to terminals for convenience and practicability in working with software or hardware. But among large scale program storage media, only video-tape has a guaranteed future.

III. PROGRAMMING

Building a transmission network is one thing: communicating something over it is another. In theory, the two activities ought to be interrelated: How can we know the best way to build a transmission or distribution network unless we know the geographic distribution of our target audience? And how can we know what audiences we want to reach unless we have in mind some messages or programming content with potential audience demand? In national network television, both the transmission network and the program content are designed to reach mass residential audiences. Radio broadcasts are intended for reception both in homes and in moving vehicles. Bulk data communications, in contrast, need only reach select locations in cities, not sprawling suburbs.

Present cable television systems have developed their market in areas that are generally removed from urban centers but are still residential in character. The programming these systems carry, which is almost exclusively retransmitted broadcast television, is geared to home viewing and allows for different program expectations during different times of the day. If future cable television programming is to reach more specialized audiences, at hours other than those prescribed by the commercial networks, or in locations other than the home, it will benefit from building on the foundations already successfully established in this residential market.

A. Broadcast Television

National network television brings us real-time coverage of men on the moon, the Senate Watergate hearings, evenings with Barbara Streisand, the presidential visits to Peking and Moscow, the Munich

Olympics and the Superbowl. It has shrunk the world in our perceptions by showing events and people that most of us would not otherwise see, and it has given individuals an unprecedented opportunity for exposure to mass audiences. In addition, television networks regularly produce entertaining, dramatic, and documentary programs that engage us with comedy, wide adventure, news, trivia, benign and tormented love, masked sex, greed, conspiracy, and violence. The programs appeal not only to needs for information and adventure, but more pervasively to common subjective needs for role identity and situational environments alternative to daily life in the home. They develop cultural heroes and anti-heroes of vast importance to the American public.

Using camera techniques, editing tempos, background music and canned laughter, television program producers sandwich these contents into formats geared to viewers' visual and auditory senses and attention spans. Many of the programs run serially, from day to day and week to week, in their attempts to attract and hold loyal audiences--something they have done very successfully. Together, the three major networks draw 80% to 90% of the viewing audience through their locally affiliated broadcast stations. Local stations without network ties do well to draw a few percent of the total audience, and even the best non-commercial stations affiliated with the Public Broadcasting Service do no better than these independents.

Local programming on broadcast stations is actually regional programming by cable television standards. Broadcast signals generally reach audiences within at least a 50-mile radius, unless topography intervenes. Local programming has seldom been as profitable as national

programming. It is usually subsidized from advertising revenues derived from network programs. Production costs appear high because the programming is not often shared with other broadcasters. Even then, local production standards, talent and material do not measure up to network material, and the audience is consequently smaller. The federal government's position has been that, since broadcasters use limited public frequency resources for private advantage, they ought to do something for the public in return. Local programming and equal time for controversial topics are two of the services the FCC has so far required. Broadcasters have in fact done much more public access programming than cable systems have, though it tends to be somewhat sterilized in form and content.

To maintain their positions of dominance, the national networks will no doubt continue to find or help create new super-stars, super-events, and super-techniques for programming at the national level. Unlike mass magazines, mass television is not likely to be plagued by rising distribution costs; cable television, microwave and satellites will hold these costs down. But they may be plagued by rising production costs.

B. Local Origination

Local programming on cable systems, like local broadcast programming, has been nurtured more by the federal government and local officials through their control of franchising than by private enterprise. An FCC rule requiring local origination on systems with more than 3500 subscribers, though suspended since 1971,* nonetheless stimulated early attempts at local programming in concert with local grass roots initiative. Sports, talk shows, local talent, and civic

* The rule was first overturned by an Appeals court, later declared valid by the Supreme Court, but never reinstated.

events are all being tried, with the support of local volunteers and some advertising sales.

In a few cases where cable systems have located a real market for particular kinds of programming, local origination has paid its way either through advertising sales or through new subscribership sales. Sports and movies are still among the prime choices. Successful suburban cable systems sometimes carry local origination purely as a public service, with no advertising. The success of this kind of programming depends in large part on management which is sensitive to community values, on an able and tactful program director, on the availability of community activities or personalities who volunteer their efforts, and on the absence of a broadcast station within the region that is already tapping community energies.

Networking at the regional level, by means of videotape exchanges, can alter the local character of program productions but improve the ability of cooperating systems to produce higher quality programming. This can lead into national networking, where either many studios produce shared material or one studio distributes productions to many users. A few independent agents are attempting national distribution of videotaped program material containing advertising and distributed free to cable systems. Industries, tourist bureaus and public service groups also supply topical material without advertising and at no rental cost, usually on 16 mm. film.

Networking is part of every growing communication system. It allows local people to be exposed to a greater variety of ideas and opportunities of particular interest to them, and it allows greater concentration of program production resources by widening

the base of consumption; it therefore allows productions of higher quality and more specialized subject matter. Imaginative and articulate local human resources can add greatly to cable television programming, but when they cannot be readily found in a community, they cannot be arbitrarily created.

C. Access Channels*

The intent of reserving television channels for use by the public and major social institutions is in the tradition of free speech and an open, well-informed society. Access channels have the potential of promoting public service information, creative expression, protest or rebuttal, and general knowledge. In being available to wider segments of society, these channels will broaden skills in the use of television and prepare future generations for part of their increasing dependence on media of all kinds.

As the availability of portable television equipment increases, the medium is becoming more widely used. Media centers and video collectives are organizing small production centers and distribution networks. Free tape exchanges are attempted, with the use of volunteered labor and equipment. People traveling across the country or across continents bring videotapes with them for mutual exchange. The video production work is supported occasionally by foundations or institutions, or by revenues from publications, videotheater admissions, training workshops, or commercial videotaping jobs. The skills and effort involved in producing a television program capable

*In March, 1972 the FCC required cable systems in the top 100 television markets to provide separate channels for local education, local government, and general public access within five years. They must also provide additional channels for leasing (7).

of holding audience attention are commonly underestimated by these and all other groups. But some of the new videotape work contains the seed of creative breaking with the traditions of broadcast television, as well as an expanded social awareness.

Public access can be used by special-interest groups who do not find their programming needs adequately fulfilled by commercial television. If these groups are able to increase their sophistication in program production, reaching out for wider audiences, then the success of public access will rest with the general television viewer's willingness to watch it, and to experience the world through others' eyes rather than seeking simple entertainment.

In educational programming for cable television, educators still greatly overestimate their capabilities for producing programming. They commonly make large requests for channel time, but the number of school districts presently running programs over local cable systems is still relatively small. To fill whole channels with programming requires considerable time and talent, as well as substantive financial resources on the part of school districts or any other educational institution that proposes to use the medium.

Educational programs, both instructional and cultural, are already being produced at the regional level by educational television (ETV) stations in the UHF and VHF broadcast range, and by Instructional Television Fixed Service (ITFS) stations in the microwave broadcast range. ETV stations, on average, do less than 30% of their own productions, the rest being obtained from regional or national networks. The great majority of these ETV's are carried on one or more cable television systems. ITFS stations, which transmit signals to somewhat

smaller geographic areas than UHF and VHF, tend to be used internally by school districts and instructional institutions. In many cases these ETV and ITFS stations will represent an available source of production equipment and personnel for educators who wish to program local cable system channels. But many organizational and financing questions will need to be resolved before meaningful cable production can begin. A reliance on the creative programming instincts of students, in concert with the organizing skills of faculty, may bring new life to educational television. It is a formula that has been highly successful in Public Television shows such as "Sesame Street", "The Electric Company", and "Zoom".

Educators have a bewildering array of possible program types to choose from (19). To reach public audiences, districts can work cooperatively with government and educational television at all levels in cablecasting programs on driver education, the environment, job skills, consumer product information, public health, child care, the law and legal action, simple auto mechanics, and so on. In school, the act of production itself can become educational, not only in terms of production skills but also the subject matter itself. Learning of this kind simply becomes the act of organizing to teach others.

The local government channel on cable systems can likewise be programmed with public service information obtained locally, regionally, or nationally. Public meetings and civil service job training are other possibilities. National programming sources will be important where the content of public service information does not change from one locale to another. One difficulty with social

service information delivery by television lies in the fact that audiences will not tend to watch unless those social services constitute immediate needs. If these programs are to serve immediate needs, they should be available to small audiences at times corresponding to the pattern in which those needs arise. This can be achieved on one-way cable systems by cablecasting programs redundantly, at different times of the day from one week to the next, or by live ombudsman programs responding to telephone questions. The entire cablecasting and telephone service could be advertised in spot ads over broadcast television, or radio, in newspaper ads, or by direct mail.

D. Pay Television

Commercial television relies on advertising revenues to support production and distribution costs. It is called free television, but in fact the audience supports it indirectly through additional purchases of advertised products. The choice of programming on commercial TV is dependent on bringing mass audiences together with mass advertisers; it bears no particular relation to the dollar amount television viewers would be willing to pay for the program itself.

Pay television, on the other hand, will derive its revenues from per-program or per-channel charges. National pay television systems, leasing channels on local cable or broadcasting over the air, will support program acquisition and distribution costs without advertising when their subscriber market is large enough. By running programs redundantly, several times during a week, they will add a new convenience to the choice of viewing time; by charging a fixed rate, several people can watch a program for the same cost of one person watching.

Motion pictures will be the first programming offered over pay television. The home market for this product is strong both in suburban areas where cable systems have high penetration rates, and in urban areas where UHF broadcasting can serve as a distribution medium. Since the age of motion picture theater audiences has declined to an average of 20 years, television is the favored medium for reaching less mobile families and older age groups. New motion picture theaters are following the population movement to the suburbs by locating in shopping centers and drive-ins, but home television offers a more direct route to their market.

Other types of entertainment and informational programs may be offered over pay television as well, including sports*, rock or symphony concerts, and legitimate theater, with stereophonic sound. Like movies, these programs stand to increase their base of financial support on pay television. As cable system subscribership develops potential audiences large enough to support more specialized programming, pay television may carry public affairs, medical, legal, engineering, and business management programming, plus general adult education courses such as cooking, golf, and humanities.

Access to pay television programming is generally restricted by coding devices that scramble the outgoing television signal. Special decoding devices are activated by pre-purchased cards, a WATS telephone call, a push-button signaling device on two-way cable systems, or by permanent installation of the decoding device on a monthly payment basis. Along with the software packages, most pay

*Major sports events carried regularly on commercial television cannot be carried on pay TV systems by present FCC rules (7). Similarly, motion pictures between two and ten years old may not be carried.

television systems supply this electronic hardware to one-way cable systems and their subscribers.

Hotels are a separate market for pay television. Since the population turnover is higher in hotels than in suburban neighborhoods, fewer programs can be run redundantly for longer periods of time. Videotape cassettes can be a low-cost distribution medium for redundant programming systems, though real-time distribution by microwave and leased telephone lines improves reliability of operations. Once the programs reach the hotel, they are distributed to individual rooms over the building's master antenna television (MATV) system, with special electronic terminals or room-call procedures for ordering and billing. This same method of program distribution can be adapted to any special-purpose building or territory equipped with a closed-circuit MATV system.* Medical programming can be distributed to hospital complexes or clinics with MATV; banking, securities, legal or other professional programming can be distributed to downtown office buildings equipped with MATV. Besides MATV systems, broadcast television in the UHF or MDS bands can be used in a closed-circuit fashion by coding outgoing signals and supplying subscribers with decoding equipment.

The future of pay television as a choice-maximizing concept lies in the provision of many channels carrying a wide variety of general and special-interest programming on one television system. It is the next best thing to on-demand television programming, a service which many people wish to have but virtually none can afford as an individual. In a system with many subscription channels, unified two-way cable television home terminals for selecting all

channels and activating central, automatic billing will add convenience and simplicity for everyone.

E. Home Shopping

Television spot advertisements which display telephone numbers or postal addresses for home ordering have both inertia and imprecision in reaching potential markets. Advertising of this kind is used mainly for impulse buying items. Telephone numbers and mailing addresses are not easily remembered, and viewers who are suddenly exposed to a piece of merchandise they are not consciously prepared to buy must often be motivated with "hard sell" techniques. These are home shopping systems designed more for sellers than for buyers.

In broadcast television there is no simple way for viewers to see the items they may want to buy. Good on-request video systems are extremely high in cost, and the best that can be hoped for is a better compromise between a seller's system and a buyer's system.

A more humanized form of television advertising may use lengthier merchandising shows in a more relaxed style. Some of this is already being done on UHF stations. Future merchandising shows may style themselves after local auctions or convention exhibits. They may be "window shopping" tours through simulated or real shopping centers led by well-known personalities, including short sequences on interior decoration, consumer product information, or general entertainment. The shows would be produced as regular television programs rather than spot advertising, and they would compete with soap operas and quiz shows for daytime mass female audience.

Television can be a strong inducement to buying, one which merchandisers will continue to use in conjunction with direct mail

advertising, catalogue distribution, and other media if they can reduce the inertia between product promotion and the actual collection of money from product sales. One special example of home shopping by television is pay television: since the product to be delivered is already in video form, its advertising and delivery can utilize the same medium. But even pay television would be unmarketable without convenient systems for ordering and billing.

Ordering and billing systems have three hurdles to overcome: identifying the product, the seller, and the buyer. Product names are not easily remembered in quantity, and they are not easily entered into automated billing systems except with the assistance of human operators; numeric code identification lends itself to automation and is often more reliable. Sellers are identified by telephone numbers or postal addresses, but if there are many sellers it becomes difficult for buyers to keep track of them all; one seller's agent or an index book of sellers makes accessing simpler for buyers. Buyers can identify themselves to sellers by name, address, or other code, but these identifications are sometimes misrepresented; secret spoken codes, written signatures or electronic address identification devices add security to transactions involving money. All of these hurdles need to be overcome in a sophisticated system of home shopping which allows automatic credit transfers from banking or credit card accounts.

Touchtone telephones offer a convenient way of entering coded requests into a computer system accessed by WATS lines, but the caller is not identified to anyone other than the local telephone company exchange. It is conceivable that sellers could arrange to

purchase identity information from the telephone company when the buyer authorized it by a special code. Standard telephones can be equipped with acoustically coupled devices which not only uniquely identify the user but also provide push-buttons to enter product codes. The security in this system relies on the buyer's ability to keep the electronic device away from unwanted users, a problem no more difficult than holding on to standard credit cards. In two-way cable television systems, the subscriber's push-button home terminal would act very much like the acoustically coupled device for standard telephones. Telephones have the advantage of giving callers access to either human operators or to computer systems which can respond to data inputs with simulated human voice. Two-way cable television terminals could add strip printers or small audio speakers to accomplish similar purchase verification or information services. Telephone systems can operate nationally with their existing network; cable systems would require new national two-way interconnection to achieve a similar capability. While a unified cable system terminal would be most convenient in use, the advantages of A.T.&T.'s national two-way network cannot be overlooked.

It is possible to establish a national system of on-request television information transmission for catalogue shopping or general library access. This could be done by supplying each television set with storage tubes or buffers for holding video images while they are being displayed on the television screen. This system could be implemented completely on the existing telephone network; or on a one-way cable television system using telephone WATS lines for upstream requesting; or completely on two-way cable television

systems. The all-telephone system could handle print information, it would probably require the addition of a second telephone line to subscribers, and it could either use standard color television receivers or the computer industry's video-keyboard terminals for display. The second telephone/television system could handle visual pictures in addition to print, it may require additional telephone lines to each subscriber, and it would require downstream regional video interconnection to cable television headends. The third two-way cable television system would handle visual pictures, it would use the same push-button terminal for home shopping, pay television and library information, it would require downstream regional video interconnection to cable system headends, and it would use either telephone or microwave narrowband upstream interconnection between cable system headends.

F. Leased Channels

Cable systems can lease their extra channels to national pay television, home shopping, and video information libraries which deliver video signals to the cable system headend by videotape cassette, telephone lines, terrestrial microwave, or satellite. Banks, telephone, insurance, and securities companies are large urban employers with high employee turnover. When a sufficiently large number of their potential labor force can be reached by cable systems, these companies may find it advantageous to conduct staff training programs over cable television, reaching viewers in their homes at evening prime time. They may also seek to reach clients by this medium. Videotape programs are already being produced in national headquarters of these industries for playback

over closed circuit systems. The difficulty here lies in the fact that cable television is still in its infancy in the largest urban centers, where population and specialized activities and labor force are greatest. Suburban and exurban areas are rich in cable television subscribers, but generally poorer in specialized interests or labor force.

G. Narrowband Programming

Cable systems could lease narrowband channels for two-way data transmission in the larger cities where data communication by telegraph and telephone is pervasive. Cable systems could lease channels to data processing companies that provide their own computers for line control and automatic switching to outside telephone, microwave, or satellite links. Cable systems can also supply this line control and switching capability for more widely marketable services such as security alarm monitoring.

By adding electronic devices to divide the cable's frequency spectrum into many audio channels, and by supplying subscribers with tuning devices compatible with their stereo and quadraphonic sound equipment, cable television systems could offer non-commercial radio programming on a subscription basis. A national system of pay radio might carry 20 to 40 channels of music and information, each identified by musical style or information content.

If schools constructed upstream wire links from their building to the cable system's headend, they could cablecast their entire language lab programming simultaneously over several of these channels, reaching all schools in the cable system franchise area. City agencies or private business may use these channels in a similar way. The

upstream audio link can either be a fixed wire or a standard telephone call to the cable system's headend. Individual subscribers or groups could also do this, using the cable audio channel exactly as they would a broadcast radio program with telephone call-ins.

H. Automated Programming

From the cable system operator's point of view, almost all of the programming he carries is automated. It is received off the air from broadcast stations and transferred onto the cable by electronic equipment that, for the most part, is unmanned. The programming does not require local production.

Inanimate program formats such as time/weather dials, news and stock price information are also carried on several cable systems. They require only the installation of electromechanical equipment and telecommunication links to outside program sources.

There are some problems with print media adaptations to television. The news service information, received over national telephone lines and displayed in moving print on television screens, requires a new vision skill on the part of viewers. It requires restricted, sequential reading patterns, and it does not allow scanning forward and backward as books and newspapers do. In this respect it is far less efficient for skilled readers, though for unskilled readers this may not be a great problem, and one could even imagine it as a stimulus to literacy or reading speed.

Both the time/weather dial scanning and stock information formats will benefit from approaches which minimize the sequentiality and maximize the simultaneity of their information presentations. It is better to display several dials or digital arrays

simultaneously than to scan them sequentially. Similarly, stock quotations might be more effective if, instead of one line of quotes moving through the entire alphabetic index, five identical lines moved alphabetically out of cycle, allowing viewers to locate their particular piece of information more quickly. An increased specialization of information implies an increasing number of specialized channels. This differentiation of programming content by channels will improve the predictability of programming content: when viewers tune in to channel 37 they will be able to expect specific programming. This is a next-best alternative to interactive, on-demand program selections.

Cable operators have also been known to put animate, real-time subjects in front of unmanned television cameras: tropical fish, kittens, pedestrian street scenes, freeways, and coastal surf. These animate scenes can bring a new dimension of reality to cable television, and viewers may develop sentimental attachments to the animals they see on cable television. Someday we may be watching Frazier the Lion or the porpoise tank in Marineworld each day. In this age of Environmental TV, people tune in to television like they tune in to radio--just to have some company or atmosphere around the house.

I. Two-way Programming

Two-way cable television, as the U.S. industry and the FCC use the term, is really a marriage between the television broadcast model and the narrowband loop or polling model commonly used in data transmission networks and industrial control systems. Television signals are broadcast (or cablecast) downstream to all subscribers

where they are received and displayed on television screens; the data signals, on the other hand, make a loop from the central headend computer and back again, checking each subscriber terminal along the way to accept or deposit small amounts of coded information.

This two-way capability will enable future cable subscribers to order pay television programming. They may use small push-button terminals to play electronic games, where the responses are tallied and displayed on a gaming channel. They may order products displayed on their television screens during special merchandising shows or auctions. They may register their opinions during shows from city hall, or the school board. They may take job-qualification examinations or respond to questions posed on their television screens during educational programs. They may send teletype information to other subscribers within the system, and receive answers. They may operate interactive library, schedule, or catalogue systems showing still-picture and print displays, one frame at a time. All of this is possible, and some of it is being market tested now.

Programming on two-way systems is very much a function of the electronic terminal devices used. The simplest terminals do little more than monitor switches (television tuners or alarm switches) and identify the subscriber to the headend computer with a coded address. With these terminals, per-program pay television and security alarm services can be provided. The repeated polling of subscriber terminals by the cable system's computer can detect any changes in the television channel being viewed, any change in status of security alarms, or any tampering with security alarm circuits or communication lines.

By adding a small keyboard with 10 to 20 push-buttons, subscribers can use the terminal to make specific requests for software or merchandise and to register votes or game responses. The terminal would be similar to a Touchtone telephone, except that it may have more special function keys, and it would identify itself automatically to the cable system headend; the telephone terminal identifies itself only to the telephone company's local exchange office.

By adding strip printers to the home terminals, the headend computer can verify requests or give limited amounts of information from computer memory or outside telecommunication links. Cash transfers can be charged to subscribers' credit card accounts if there is enough security built into the system, and the headend computer can supply an immediate hard-copy verification. Simple computing services, individual electronic games, stock prices, or scheduling information can also be provided by strip printers.

By adding electronic storage tubes or buffers, still-picture and television print displays can be individually requested. Small libraries for computer-assisted education, games, and catalogues, can be programmed into the memory of individual computer systems. Where economies of scale favor use of regional or national memory banks, accessible by several cable systems, these can be accessed by headend computers over automatically dialed telephone lines or microwave links.

By adding neon digit readout arrays and additional push-buttons and circuitry, the tuning of large numbers of television, radio or data channels can be facilitated. FM radio tuners are already available with this digital tuning capability; it may be quite useful in

future cable systems with many channels, if the cost comes down.

By adding full alphanumeric keyboards, business or personal letters can be typed to selected subscribers on the cable system who are equipped with similar terminals. Telephone or microwave networks could eventually interconnect cable systems across the country.

By adding telephone circuits at the cable headend which feed directly into radio channels carried over the cable system, subscribers can create their own radio programming from their home telephones. By adding a new upstream wire to the cable headend from each site originating audio programming, the fidelity of sound can be improved.

By adding an upstream video channel from a specific neighborhood location (a school, business establishment, city hall, or community center), along with microphones, lights, and television cameras at that location, decentralized video origination for cablecasting throughout the system can take place.

By adding two video channels to the entire cable system for each subscriber (one upstream channel and one downstream channel per subscriber) plus microphones, lights and television cameras in each subscriber's home, plus channel-switching equipment at the cable system headend, interpersonal video communications within the confines of the cable system can take place. Cable systems could be interconnected with each other by using additional video switching equipment and outside telecommunications links.

Technology can provide all of this and quite a bit more. But it is unlikely that the more elaborate systems will find a market soon, even in America where expectations of technology run fancifully high.

A RAND Corporation report recently estimated the 1976 cost of a nationally switched two-way video system at well over \$1200 per subscriber per month, more than the entire income of most people (2). The expectations of personal access to television media and eventually personal two-way television, with on-demand services, are on the horizon. If cable television systems evolve in this likely direction, they will have brought the television medium a long way from its present form of ostensibly free entertainment. Interactive video will cost individual users money, and it will be used for quite serious purposes as well as for entertainment. By providing more extended and controllable eyes and ears on the world, interactive television will eventually reshape many social institutions and personal self-images. It will be a slow but profound evolution.

IV. CONCLUSION

Cable television in the small towns and suburbs of America is a healthy and growing industry. Subscribership in established systems is growing. Capital investment in expanded cable plant, already higher than fixed capital investment in the broadcast television industry, is growing and attracting favorable finance terms. And new programming options distributed by pay television systems over cable show early signs of success. Local programming, always a nebulous area for the television medium, is looking for a sustaining motive in more stable communities.

New hurdles face the industry as it moves into the major population centers. To some extent it will be moving in the opposite direction of suburb-bound populations. While the density of residential development in major cities is attractive to cable systems, wiring is more expensive with undergrounding and right-of-way complications. Franchising will be more deliberated as public officials obtain more information, hire more consultants, and hold more public hearings. Population turnover will require more installation servicing. Demands for public access and local programming will grow.

As new programming options appear on urban cable systems, these difficulties may be counterbalanced with new potential subscribers. Pay television, already in major urban hotels before the installation of cable television systems, will be one addition. New, commercially-sponsored and networked programming may be another. As subscribership reaches larger proportions, semi-institutional industries such as telephone companies, insurance companies, and banks may begin leasing channel time for programs directed at their labor force or clients. Cable systems will rely

on new revenue from these program sources, since basic subscription rates will be hard to increase.

Cable audiences, be they minority or majority, will continue to prefer nationally-distributed programs. Their expectations have been primed for this standard of production, and the costs of national distribution by new technologies will favor it. Land microwave networks are growing rapidly and dropping in cost, in concert with expanding data transmission traffic; domestic satellites will offer new economies of signal distribution in the national or time-zone broadcast mode; and pervasive distribution of recording media such as videotape cassettes, will expand the libraries of specialized programming. As the skills of television production become more widely understood, production standards will go up and a greater variety of talent will emerge.

Regional program distribution will also increase more than local programming. VHF and UHF broadcasting will improve as the signal reception and audience for these stations is improved by cable systems; yet they will still be available to non-cable audiences. Educational institutions using UHF and ITFS will be able to reach cable system headends and other specialized audiences. MDS broadcasting and point-to-point microwave links will likewise be used to distribute regional cable programming. While very dense urban areas may face broadcast spectrum crowding, these broadcast media will find new applications in less dense areas as their hardware costs come down. Automated or remote program control may improve efficiency.

The future of two-way cable television depends to some extent on the success of pay television. But pay television does not depend

on two-way cable systems for distribution and billing. Subscription programs, entertainment or educational, can be distributed over one-way cable systems or over a variety of broadcast frequencies direct to individual television receivers or master antenna systems.

The utility and convenience of unified push-button terminals on two-way cable systems will become apparent if several program distributors seek to reach cable subscribers with a variety of program formats. Two-way terminals will give individual subscribers an improved modicum of on-request control over their television sets, a form of home shopping in which pay television is the foremost product.

The telephone network will continue to be the best medium for home shopping services, computer-assisted instruction, and information library services, owing to its nationally-switched network. Decentralized computers can be accessed from ordinary telephones, and responses can be made in computer-simulated voice. With the addition of scan converters to telephone lines, print or graphic responses can be displayed on standard color television receivers. Business markets for this are evolving.

Two-way cable systems in large urban centers could install separate cables using digital signals to serve data transmission traffic. Switching capability to outside telephone or microwave lines could be supplied either by the cable system or by private data processing firms leasing channel space on the digital cable. But the market for this service will often be in a distinctly different geographic location within the city than the major market

for entertainment television, and cable operators may find it more advantageous to build two separate systems.

Both data and video transmissions in the central business district will find advantages in using roof-to-roof communication links by microwave or light beams, since these media have more flexible, less fixed hardware installations. They do not require city franchising procedures as cable installations do.

In broader perspective, large cities, new or old, can facilitate the development of more diverse, specialized and efficient cable communications by planning physical rights-of-way and easements with more foresight. If cities owned not only transportation rights-of-way but also the real estate rights-of-way used by private communication networks, they could build large, empty conduits in which all (or most) electric wires could lease physical space. Power, telegraph, telephone, cable television, industrial or small inter-office links could all gain access to these common utility tunnels at equitable lease rates. Communication networks could become more specialized and more flexible. Wire, optic fiber, and wave guide technologies could all share these facilities freeing the radiated frequency spectrum for more land-mobile services.

The FCC's rules relating to cable television should take a liberal and flexible route, aimed at preventing repetitious local court trials and maintaining commonly expressed standards of service. Likewise, the attitudes of the cable television industry toward new channel users should continue to remain open and experimental. There are enough present or possible alternatives

in distribution networks, feedback networks, and terminal configurations to argue against a rigid attitude toward an industry which, after all, is still primarily leisure-related.

In large urban areas, minorities already in positions of alienation by virtue of joblessness may find their appetites whetted still further by this new medium of consumption, with its related advertising and subscription programming. Serving these groups with programming they choose and identify with may help. Providing them with an opportunity to express their attitudes on television may help. And providing opportunities for them to create their own television programming may help, though it has an edge of deception when they discover that it seldom leads to television production jobs; the competition from schooled production staff is still too keen. Until watching television becomes a job, or leads to a job, they are not likely to escape their alienation with respect to this medium.

It is worth noting that the term "public access" is common to both communications and land development. Environmentalists have beaten paths across the shorelines of private developers just as surely as private individuals and local institutions of education and government are beating paths across the channels of private communication companies. In large part it stems from the premise that shorelines, airwaves and city rights-of-way are part of the public domain. But at the same time it raises a sensitive challenge to the concept of private property.

The cable television industry has accepted this challenge, in part, and they have raised a counter-challenge in the process: "Now that you have this resource, what good will you create with it?"

A pessimistic but sometimes realistic attitude will see the public for its well known ability to litter the shorelines and parks of America with cigarette butts and beer cans produced by our enterprising consumer economy. The public may also become well known for depositing similar debris from old television consumption habits on our television screens.

In the long run, however, access to television media by those of us who consume its programming may be the only way we will learn to use the medium, to practice with it, and to develop natural skills and talents which will shape future television programming. It may be a necessary step in implementing future two-way video communication networks. It will certainly broaden our values and our imagination in the process.

V. GLOSSARY

- ACOUSTIC COUPLING:** a method of sending data by telephone to an automatic device like a computer, teletype terminal or facsimile terminal. Audio pulses or frequency levels from telephones and other input devices are sensed and interpreted in code by the receiving machine.
- ADDRESS:** a coded representation of the destination of data, or of their originating terminal. Multiple terminals on two-way communication lines, for example, must have unique addresses. Two-way cable television messages carry the address of the subscriber.
- ANALOG SIGNAL:** a continuously variable signal as opposed to a discretely variable signal. Physical quantities such as telephone voice signals are continuously variable and so are described as "analog". Data characters, on the other hand, are coded in separate pulses or signal levels, and are referred to as "digital." The telephone network is converting some trunk lines to digital mode by interfacing equipment.
- BANDWIDTH:** the range of frequencies available for signaling. The difference in cycles per second (hertz) between the highest and lowest frequencies of a band. "Narrowband" generally means local telephone bandwidths of 3,000 Hertz or less. "Broadband" generally means anything larger, including television channels at 6,000,000 Hertz.
- BUFFER:** a storage device used to compensate for a difference in rate of data flow, or time of occurrence of events. Pushbutton home terminals on two-way transmission systems use buffers to correlate the subscriber's slow rate of data entry with the polling computers very fast rate. Buffers are also used to store single still-pictures or print frames for continuous scanning onto television tubes, since standard television receivers have no information storage capacity.
- CABLECASTING:** cable television programming originated by the cable system rather than retransmitted broadcast station programming.
- CONVERTER:** an electronic device used on cable television systems to convert the signal frequencies of the cable to the signal frequencies recognized by the television receiver. It takes the place of the standard television channel tuner, allowing more than 12 channels to be tuned.
- DIGITAL SIGNAL:** a discrete or discontinuous signal used in coded information (compare with analogue signal). The use of digital signaling allows direct connections to computer equipment which also use digital signals. It also allows longer, more accurate transmissions because digital repeaters (or signal regenerators) are more effective than amplifiers on an analog line. Pulse code modulation (PCM) is a principal method of digital encoding.

DOWNSTREAM: signaling which goes from a cable television headend to all the subscribers on the system.

FREQUENCY SPECTRUM: the range of frequencies for electromagnetic wave energy. Direct current is at one end of the spectrum, with infinite wave length and no frequency; cosmic rays are at the other, fuzziier end with huge frequency and wavelengths no bigger than an electron. Alternating current is at the low end (60 Hertz), radio and TV are about in the middle, microwave and visible light are higher up. It is one of the world's great natural resources, and it's all around us all the time.

GLASS FIBER OPTICS: a method of carrying signals on coherent (laser) or incoherent light beams through very pure fibers of glass. Since the frequency space of visible light is extremely large, the capacity for carrying voice, data, or television communications is equally large.

HEADEND: the source of signals on a cable television system. The headend brings together signals from the master antennas and signals from local studio production for distribution to subscribers throughout the system. On two-way cable systems, the headend is equipped with a small polling computer which continuously sends inquiries and accepts responses from subscribers' terminals.

INTERNAL RANDOM ACCESS: the ease and speed with which specific portions of information can be retrieved from a storage medium. Indexed filing systems, books and computer core memory have good internal access. Long-playing records have better access than reel-to-reel magnetic tapes. The telephone book's white and yellow pages, plus the switched telephone network, gives very good internal random access to the U.S. population, but it could be improved by adding message-switched answering services to local exchanges.

ITFS: instructional television fixed service; a broadcast microwave frequency band licensed to educational entities by the FCC. It requires special antennas and frequency converters for use with standard television sets. Up to four TV channels can be broadcast. Return audio is also possible.

MATV: master antenna television; a miniature cable television system for large buildings. Signals received from a rooftop antenna are distributed to all offices, apartments or other rooms in the building. The received signals may be from broadcast television and radio, land-mobile radio, microwave (broadcast or point-to-point), optical beams, or satellites.

MDS: multipoint distribution service; another broadcast microwave frequency band like ITFS, but licensed to private parties for operation as a common carrier.

- MESSAGE-SWITCHED:** the technique of receiving a message, storing it until an outgoing line or receiver is open, and then retransmitting it. No direct connection between the incoming and outgoing lines is necessary, unlike the circuit-switching used on the telephone network. The telephone network could be improved by adding message-switching to its local exchanges; it would function like a central answering service, for data or voice. Cable television polling computers use message-switching.
- MULTIPLEXING:** the division of a transmission facility (cable, wire, or over-the-air bandwidth allocations) into several channels, either by splitting the frequency band into narrower bands, each forming a new and distinct channel (frequency-division multiplex), or by allotting the whole frequency band sequentially to several different users, one at a time (time-division multiplex).
- NARROWBAND:** narrow bandwidth; usually taken to mean voice-grade (3,000 Hertz) bandwidth or less. It is used for slow-speed data transmission, which can accommodate a very fast typist's input, but not a computer. Narrowband can include monaural radio programming, but not stereo. Obviously there are many in-betweens from narrowband to broadband.
- SCAN CONVERTER:** a device that converts signals from a telecommunications line (telephone or television cable) to the scanning pattern of a television receiver tube. It usually incorporates a buffer, or storage tube.
- TELEVISION MARKET AREA:** a 35-mile radius drawn (by the FCC) around television stations' broadcast sites. The 35-mile radius is called the "specified zone", and where several television stations are located in a single urban area, their specialized zones are combined to shape the television market area. Columbia, South Carolina ranks 100 on the top-100 list; its television market area corresponds very roughly to an urbanized area population base of over 200,000.
- UPSTREAM:** on two-way cable television systems, signals sent from any subscriber terminal back to the cable headend are moving upstream.
- WATS:** wide area telephone service, offered by A.T.&T. companies. Subscribers can call a specified region or combination of regions outside their own state for a fixed monthly rate. They can also accept free calls from those regions for double the monthly rate. In-state calls are not included in the WATS service.

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