

Cato Institute Policy Analysis No. 123: The Promise of High-Definition Television: The Hype and the Reality

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Executive Summary

High-definition television (HDTV) has been described as a technology driver that will determine the future of the computer industry and the semiconductor industry as well as the technological state of our society. However, like many aspects of our political life, this description may be more hype than reality. HDTV has the potential to improve electronic visual displays, but at a cost.

High-definition television is a broad term for a range of technologies that will produce a TV picture with the clarity of a 35-mm motion picture, on a wider-than-normal TV screen. The current TV technology was developed by the National Television System Committee (NTSC) in 1940, before commercial broadcasting was launched. The NTSC system, originally developed for black-and-white transmission and subsequently enhanced to include color and stereo sound, uses 525 lines per frame and has a 4:3 ratio of width to height. The NTSC signals are transmitted through 6-MHz (megaHertz) channels. This transmission bandwidth, currently used by both broadcasters and cable TV systems, is the basis for the TV channel allocation scheme established by the Federal Communications Commission (FCC) in the early 1950s.

Advanced TV refers to a number of TV systems that will provide better, sharper pictures than the NTSC system. Proposals to improve on the current system range from simply enhancing it to completely replacing it. The most advanced system considered for development, HDTV, is now at the prototype stage. HDTV is generally thought of as any TV system with over 1,000 lines per frame and at least a 5:3 ratio of width to height. The best-known HDTV system, the NHK system, developed by the Japanese Broadcasting Corporation, uses 1,125 lines per frame and has a 16:9 ratio. As a result, HDTV pictures are equivalent in sharpness, clarity, and color to a 35-mm motion picture shown in movie theaters, while NTSC transmissions are roughly equivalent to 16-mm film. The NHK system, however, requires more bandwidth--approximately 8.1 MHz--than is currently allocated for TV channels and is not compatible with existing TV receivers.

The NTSC system is constantly being improved. Several TV set manufacturers are experimenting with or offering various forms of "enhanced television." These systems employ computer technology to extract more information from the current TV system. Some interpolate a line between every two lines in the current system, thus providing a simulated 1,050-line system. While this technology does provide a better picture, it fails to increase the amount of information that the home receiver will receive. Moreover, it does not provide any additional signal information to allow for a wider screen.

One difficulty with the current system is that motion pictures usually are made using a much wider aspect ratio than the 4:3 provided by the NTSC system. When a motion picture is broadcast, the TV editor must decide what part of the original picture--a bit from each side or all from one side--will be cut. When a motion picture is made for the theater, TV viewers often will notice that the ends of the titles or credits are cut off as a result of the reduced ratio.

Drawbacks to HDTV

HDTV will offer a medium that is clearly superior to the current TV system. However, several significant drawbacks will limit its penetration in the marketplace: the cost of HDTV sets will be much higher than the cost of NTSC receivers; large sets will be required to realize the full advantages of HDTV; and programming that will exploit the strengths of HDTV will be relatively scarce.

HDTV sets will cost considerably more than current sets for two reasons. First, to achieve the high definition, the sets must exploit computer technology and include a significant memory component. According to some estimates, the necessary conversion from analog to digital will require a memory system with associated semiconductors that are some 30 times more powerful than those found in popular personal computers selling for around \$2,000. The great amount of computing power means that HDTV sets by necessity will cost much more than current sets. Some observers have argued that mass production and the continued fall in the cost of computing power will lower the cost of HDTV. However, even the Japanese have admitted that the new sets will continue to cost considerably more than current equipment. Current estimates are that, after prices drop, an HDTV set will cost from \$4,000 to \$7,000.[1] Experimental sets produced in Japan cost about \$100,000.

A second reason for the high cost of HDTV is that, to appeal to consumers, the sets must be considerably larger than the most popular sets on today's markets. Sets that are 19 inches or smaller, representing about half of all new sets sold in recent years, provide a good picture that appears free of graininess or lines, at least from a normal viewing distance. However, bigger NTSC sets reveal the limitations inherent in the current technology. Larger conventional sets are expensive--a 30-inch set sells for approximately \$2,000, compared with around \$500 for a 20-inch set. A 30-inch HDTV set will cost much more than \$2,000--perhaps, after prices decline, \$4,000--because it will include so much computer hardware. Larger HDTV sets will be comparably higher.

The size of the picture tube will add to the cost of HDTV. The tubes are expensive, especially the larger ones. If flat-screen technology becomes practical and economical, the cost of the tubes may come down. However, at the moment large, flat screens that can produce high-definition displays have not been developed, even in the laboratory.

The market for HDTV is limited, not only because the large size of the set adds to the cost, but also because most households do not have a room that can accommodate such a large piece of equipment. Most living rooms are too small to comfortably contain a very large TV set. Few homes have media rooms that could suitably house a very large set. Sets larger than 26 inches now represent less than 5 percent of the market.[2] Robert R. Nathan Associates, in a report for the Electronic Industries Association on TV manufacturing in the United States, forecast that "HDTV technology would be first commercialized as a high end product in screen sizes of 30 inches and larger, absorbing the 26- to 29-inch screen segment of the market." [3] Eventually they expect HDTV sets to be offered in the 20- to 25-inch market.

Moreover, the current technology for HDTV is being continually improved. The Japanese are planning to broadcast an "enhanced" NTSC signal later this year. Some manufacturers already are selling Improved Definition Television sets that use electronics to enhance the signal of current broadcasts. Thus, by the time HDTV becomes widely available, the relative improvement in picture quality may not be substantial.

For much of what is broadcast today on TV, an HDTV set will provide only marginal improvement. Sitcoms, "talking heads" shows, most news programs, and soap operas or dramas will benefit little from improved picture quality. Sporting events, epic motion pictures, operas and ballets, and shows with exotic settings will benefit the most. However, these kinds of shows make up only a fraction of the programs currently being broadcast, which again limits the attractiveness of HDTV.

Nevertheless, HDTV probably will become an important medium. Since the FCC has tentatively concluded that

broadcasts from earth transmitters must be compatible with existing TV sets, a market for NTSC receivers is likely to continue. Large-screen HDTV probably will grow to dominate the high end of the market, while many households, if not most, will have one or more small NTSC sets.

Introductory Problems

There are two standards that the industry must address. The "production" standard refers to technical quality in recording and filming material for subsequent viewing. This standard would govern the studio equipment, such as cameras and taping equipment, used to produce programming. The "transmission" standard refers to the quality of the signal that is broadcast and received. At a minimum, this standard would include over-the-air broadcasting, cable TV systems, direct-broadcast satellites, and probably videocassette recorders. Clearly, the most efficient arrangement is for the transmission and production standards to be identical. This would allow a program to be recorded and, without technical transformation, broadcast to the public.

The Japanese have developed an HDTV production standard and are marketing equipment based on it. For several years, the U.S. Department of State has urged that this standard be adopted worldwide. The U.S. film and TV industry has strongly supported a universal standard. U.S. programs and films are an important export and earn a significant proportion of their royalties abroad. A universal standard would facilitate the distribution and sale of our motion pictures and television shows.

In Japan, government and industry reportedly have spent around \$1 billion on developing HDTV over the last 20 years. The prime mover has been the Japanese semigovernmental TV network, NHK. This year, NHK began experimenting with satellite-to-home transmission.

However, the Europeans have been opposed to adopting the Japanese standard, partly because they fear that Europe is falling behind in many high-tech industries, including communications. Instead, the Europeans in 1986 adopted a pan-European approach to HDTV, with a coordinated program called EUREKA-95. The purpose of this program is to establish the technological base and know-how needed to compete in the HDTV market. About \$100 million has been allocated for this project, with approximately 60 percent coming from private firms and the rest from governments.

The Europeans have developed an alternative technology based on 50 cycles per second (the frequency used in European electric power production and transmission) and 1,050 lines on a screen. This standard is incompatible with both the NTSC system and the proposed Japanese HDTV standard.

In the United States, the decision on a production standard has been and will be made in the marketplace. Several producers of TV commercials already have used the Japanese system. However, even for producers the equipment is expensive. A high-definition VCR for use in a studio currently sells for nearly \$400,000, but this price should decline with increased sales and production.[4] As studios buy more HDTV equipment, they will necessarily establish a de facto standard.

Again, identical transmission and production standards would ensure the efficiency of HDTV. Unfortunately, a single standard for both is not likely to be developed or accepted worldwide. The Europeans have precluded that possibility by adopting a standard that is incompatible with the Japanese standard and that has been unanimously rejected by the U.S. industry.

The Advanced Television Systems Committee--a group of 51 firms representing the U.S. TV industry, the major U.S. motion picture producers, the Electronic Industries Association, the Institute of Electrical and Electronic Engineers, the National Association of Broadcasters, the National Cable Television Association, and the Society of Motion Picture and Television Engineers--voted unanimously to delay a decision on whether to accept a world standard for HDTV. The committee issued a statement citing the European Community's unwillingness to "accept a standard based on a picture repetition rate of 60 Hertz, while the United States cannot accept a rate of less than 59.94 Hertz (the rate currently used in USA television receivers)."[5]

Unless Europe agrees to the United States and Japan's picture repetition rate or the United States and Japan agree to Europe's, there will be no worldwide standard. Given the strong position of the Europeans, they are unlikely to back

down. By insisting on a separate standard, they will protect two important industries. First, the manufacturers of broadcast and television receivers in Europe will face less competition from the Japanese, who will concentrate, at least initially, on the U.S. and Japanese markets, assuming that the standards in the United States and Japan are the same. Moreover, since there will be some degradation in signal in translating from a system based on 60 Hertz to one based on 50, there will be some additional protection provided to their motion picture and television producers, albeit not a large amount.

The U.S. industry is insisting on staying with 60 Hertz because that is compatible with current equipment. The FCC tentatively has ruled that terrestrial broadcasting must be compatible with existing receivers. Thus, there is little prospect that the United States would be willing to shift to 50 Hertz. Nor is there much prospect that Japan would do so if the United States did not. It seems safe to conclude that there will be at least two HDTV production and broadcast standards in the world; there could be three if the United States adopted a standard that differed from both Europe's and Japan's.

While the production standard largely will be determined in the marketplace, the transmission standard for terrestrial broadcasting or direct satellite telecasting necessarily will be controlled by the government, principally the FCC. Again, the FCC has already made a tentative decision that any terrestrial broadcasting must be compatible with the existing NTSC sets.

It may be preferable to allow the marketplace to determine the transmission standard. The marketplace would allow experimentation with various systems until consumers make a clear choice. A government-imposed standard may easily be wrong, but there is no way even after the fact to be certain of whether the right decision was made. On the other hand, allowing the marketplace to determine the standard would be messy and slow because firms would be reluctant to try a system without assurance that it would become dominant. Most firms in the industry would prefer that the government set the standard and remove the risk. Consequently, the FCC no doubt would use its authority to set the standard.

No matter who sets the standard, no system is likely to be introduced unless it is compatible with the existing system. This compatibility is essential because to pioneer broadcasting of HDTV will be extremely expensive. Without compatible broadcasting, few HDTV sets will be sold; nor will many sets be sold without an official or uniform standard. A pioneer in terrestrial broadcasting will have to acquire the necessary frequencies--that is, two TV channels--and install expensive HDTV broadcast equipment before the public begins purchasing HDTV receivers. The pioneer then must start broadcasting and offering programming that is so novel and attractive that enough of the public will purchase the expensive receivers. Only then will it be profitable for advertisers to utilize the medium. Much of the public already will have access to more than 20 different channels of free entertainment on broadcast and cable systems for which no additional purchases are necessary.

The FCC has a difficult issue to decide. If true HDTV is to be provided and not simply an enhanced picture, current bandwidth compression techniques imply that more than 6 MHz of spectrum must be provided. Proposals have been made to use 9 MHz and 12 MHz. The FCC Advisory Committee on Advanced Television has concluded that

sufficient spectrum capacity in the current TV allocations might be available to allow all existing stations to provide ATV (Advanced Television Service) through either an augmentation or a simulcast approach. However, this view is predicated on two assumptions: an elimination of the present UHF channel separation requirements . . . and the establishment of power and cochannel and adjacent channel interference protection requirements that are substantially less than those demanded in the current NTSC system.[6]

Another problem in developing HDTV is the difficulty of finding attractive programming. NHK, the Japanese company that is actively promoting HDTV, has been "shopping around Hollywood for someone to make a \$45 million HDTV science fiction film." [7] Talk shows, a major staple of TV, will not be effective. It will take action, exotic scenery, and panoramic views for HDTV programming to be worthwhile.

Thus, a pioneer no doubt would prefer to offer programming that could be received initially by existing sets but that would provide a distinct improvement to those wishing to make the additional investment. The relatively slow growth

in sales of Super-VHS, a format that provides a markedly superior picture if the monitor has the capabilities to show it, indicates that the public is reluctant to invest heavily in better reception unless more "software" is included. As of December 1988, only one movie of the last 10 years, *On Golden Pond*, had been released in that format.[8] Since then, more movies have been released in Super-VHS, but until there is a large base of such tapes, the attractiveness of that format will be limited. Video stores will be reluctant to stock these tapes without a large market of potential renters. Furthermore, few people will wish to purchase the more expensive Super-VHS machines until more movies are released in a compatible format. A pioneer who tries to develop or market an incompatible HDTV broadcasting system will face similar problems.

Even without FCC approval, would-be pioneers in HDTV can offer cable programming or video recorders and tapes that show HDTV productions. As the example of Super-VHS indicates, this task is not simple or cheap. The case of video recorders is exactly parallel. Households would have to purchase expensive video recorders and new HDTV sets to see the pictures. Few would wish to invest until sufficient "software" was available. The problem for videocassette producers and dealers is exactly the problem that Super-VHS has been facing.

Cable distribution of HDTV also is possible. However, for true HDTV productions, the cable company must devote at least one and one-half regular broadcast channels for every HDTV channel. Thus, to make it pay, the cable company must expect that the HDTV channels will provide at least 50 percent more viewers or subscribers than the marginal ordinary channel. Again, until a broad base of the public owns HDTV sets, few cable companies will be willing to allocate the channels unless they have surplus capacity. Efforts to interest cable companies in offering HDTV so far have failed.[9]

Thus, the introduction of HDTV is likely to be evolutionary rather than revolutionary. Whatever system is introduced almost surely will be compatible with the NTSC system, just as color TV is compatible with black and white. Systems are being developed, in U.S. labs as well as abroad, that would provide compatibility. For example, the David Sarnoff Center, with support from U.S. private firms, has pioneered a system, ACTV I & II, featuring an enhanced wide-screen picture that appears on existing sets in the standard NTSC width-to-height ratio, 4:3, but would acquire true high definition on HDTV sets because a second channel would be added. This system would require the use of two existing channels for every HDTV channel, a substantial spectrum allocation.

Before true HDTV is introduced, innovations or improvements in the current NTSC system are likely to continue. As mentioned above, several TV manufacturers have already introduced or are in the process of introducing such receivers.

The Japanese Threat

Although HDTV probably will not be introduced into the U.S. market in the next year or so, many commentators and politicians are concerned that this market will become another one dominated by the Japanese. As they have pointed out, Zenith is the only U.S.-owned television manufacturer. All video recorders are imported from either Japan or Korea. However, Zenith makes TVs in Asia, while Hitachi, Matsushita, Mitsubishi, Sanyo, Sony, and Toshiba, among others, make color TV receivers in the United States. Twenty companies manufacture color sets in the United States, with about 40 percent of the value added being domestic. Nearly all sets larger than 20 inches sold in the United States are made in the United States, albeit mostly by Japanese companies.[10]

The fear is that the Japanese, who have a head start on HDTV, soon will dominate this market as well. As Richard J. Elkus, Jr., chairman of the Prometrix Corporation, put it, "All markets are linked. Lose one market and you lose others. Lose others and pretty soon you lose your entire technological base." [11] This statement is nonsense. No country has all markets, nor can a country have most markets. The United States does not dominate the coffee market, the banana market, the watch market, the calculator market, the high-speed train market, or the chromium, manganese, and cobalt markets. It does dominate the personal computer, the mainframe and super-computer, the commercial aircraft manufacturing, and the biotechnology markets, among others. A country's dominance of one market implies nothing about its potential to dominate others.

It is true that Japanese firms dominate the video recorder industry and play a major role in TV manufacturing. They

also produce a substantial portion of the world's semiconductors, although the most advanced and specialized chips are produced mainly in the United States. Notwithstanding their lead in these areas, the Japanese have failed to make significant inroads in the computer industry (with the exception of laptops), even though they have targeted that area for over a decade. For example, Cray Research has sold four times as many supercomputers in Japan as Japanese companies have sold in the United States.[12] Ironically, Cray buys many of its semiconductors from Japan.

World trade is based on specialization. Many semiconductors are designed in Silicon Valley, produced in Thailand, assembled on circuit boards in Hong Kong or Mexico, and shipped back to the United States to be assembled into TVs or personal computers. In 1987, almost 70 percent of all color TV sets sold in the United States were made in the United States,[13] as are virtually all large-screen TVs.[14] It is too expensive with too much chance for damage to ship large TV sets long distances. Because HDTV sets will be large, they almost certainly will be assembled in the United States.

While a U.S.-based company may obtain more of its parts from domestic sources than a Japanese firm, the U.S. company undoubtedly will buy from the best source, taking into account price and quality. The Japanese, on the other hand, have a reputation of buying, if possible, only from other Japanese firms. It follows that the Japanese in many cases must be either paying more for their components or buying lower-quality ones. Accordingly, the Japanese product may be either more expensive or of lower quality and hence less competitive.

What is probably more important than where the HDTV sets are made is who did the engineering. The creative end is the design end. Assembly, after the process is well understood and developed, is often relegated to areas with cheap unskilled labor. As indicated above, several U.S.-owned companies are actively working on research and development in this field.

A number of observers claim that only U.S. companies will purchase U.S. semiconductors. Thus, they say, a viable HDTV industry is necessary if the federal investment in Sematech, the government-sponsored consortium to reestablish a leading role in semiconductors, is to pay off.

Actually, a U.S. HDTV industry will utilize U.S. chips only if they are cheaper than and as good as foreign-made ones. A Japanese-owned plant assembling HDTV sets in the United States is more likely to use Japanese semiconductors, assuming that they are of comparable quality and price. In recent years, however, Japanese semiconductors often have been cheaper than U.S. semiconductors, of better quality, or both. Thus, Sematech must bring about a marked improvement in semiconductor production if U.S. companies are to gain a major portion of the HDTV market.

Most of the current U.S. semiconductor production goes into electronic goods that are not used by private consumers, computer companies being major purchasers. Thus, it is false to assume that without an HDTV industry, the U.S. semiconductor industry is lost. More than half of the semiconductors used in the United States are made in the United States, and if the U.S. computer market remains strong, so will the semiconductor industry. However, many standard semiconductors may be manufactured in countries where labor costs are lower. Semiconductor production in Thailand does not threaten U.S. technological leadership.

Policy Proposals

A consortium sponsored by the American Electronics Association recently proposed that Congress provide \$1.35 billion in grants, low-interest loans, and loan guarantees for high-definition TV development. The chairman of Zenith Electronics, the one U.S.-owned company still building TVs, has proposed that Congress impose a \$5 per set sales tax on TV sets to raise \$100 million per year to subsidize the development of HDTV.[15]

Several bills have been introduced into Congress to help foster HDTV. Two of the bills would have the government allocate \$100 million per year for five years to this project.[16] Secretary of Commerce Robert Mosbacher has proposed that antitrust objections to joint production ventures be waived. He also has publicly opposed large government subsidies. The Department of Defense, on the other hand, in the guise of the Defense Advanced Research Project Agency (DARPA), has already announced a plan to put \$30 million into HDTV over the next two or three years.

DARPA claims that improving the resolution of large screens would have important military applications. In large battle-control systems, sharp, large video displays are essential. If the department's objective is purely military, DARPA should be willing to award R&D contracts to U.S.-based, foreign-owned firms, several of which have submitted proposals. However, DARPA so far has been reluctant to do so. The hidden agenda is to foster a domestically owned HDTV production base.

Proponents of government subsidies or sponsorship claim that U.S. industry has too short a time horizon, or faces too high a cost of capital, to invest in what may become a major industry. Industry responds that at present, even in Japan, it costs \$100,000 to produce an HDTV receiver.[17] Although the cost will come down, the profit margins in consumer electronics are very narrow, and the competition, especially with the Japanese, is fierce. Many of the arguments made for government intervention were made in the 1970s in favor of a government program to develop synthetic fuels. As a result, the Carter administration created the Synthetic Fuels Corporation, which wasted billions of taxpayers' dollars and was finally eliminated in 1986.

This experience and others like it show that the government is singularly bad at picking winners and losers. Government officials have little knowledge or appreciation of the marketplace. They lack sufficient information to judge costs or demand. In contrast, private firms must carefully evaluate the likelihood of success or else risk losing money. Private firms do make mistakes, but the private investor, not the taxpayer, bears the cost. Because the individual must bear the cost, decisions are made with great care; if mistakes are made, they are rectified more quickly than they would be by the government.

Governments often base investment and spending decisions on political considerations. Investments are made to preserve or create jobs, not because they are profitable; governments tend to invest in losing firms. Thus, the best policy is for the government to stay out of the private sector. Its incentives are wrong, its information is inadequate, and its biases are all wrong.

While the HDTV industry looks like a winner, it could be the turkey of all time. Another technology could replace it, or it could remain so costly that few sets are sold and the industry never becomes established. The latter is likely even if, as seems possible, technology keeps improving the existing NTSC system to the point that HDTV offers little additional benefit.

A major drawback to fostering HDTV artificially is that the resources used in the development of HDTV would have to be diverted from elsewhere because engineering talent is scarce and valuable. Much of the relevant technical expertise needed to develop an HDTV industry probably would come from the computer industry. This diversion of talent then would handicap the information-processing industries, in which the United States is dominant. Ironically, one argument for developing HDTV is that the resulting innovations and technical knowledge will be applicable to the computer industry. Actually, if the objective is to promote the computer industry, it would be better to keep the resources in that industry and not set up a subsidized rival for the skilled personnel.

Moreover, the potential market for HDTV has been grossly exaggerated, with estimates for total sales as high as \$100 billion. In fact, the total sales of color TV sets in the United States last year amounted to less than \$10 billion. Again, even under the most optimistic assumptions, HDTV will not capture the entire market. Although HDTV sets will cost more than the ones that they supplant, the assumption that sales would be much larger than \$10 billion (in 1989 dollars) for any year in the foreseeable future seems to be more hype than reality.

Secretary Mosbacher has suggested that modifying the antitrust laws to permit joint manufacturing ventures might be helpful. Behind this suggestion is the idea that only large entities will command the resources to compete in the HDTV market. This proposition, however, is far from obvious, since many of the developers and manufacturers of large-screen projection sets were small start-up firms. Initially, HDTV sets will sell only to a few wealthy enthusiasts, and small firms may be able to compete.

However, it might be worthwhile to examine the antitrust laws to ensure that economically efficient activities, including joint manufacturing, are not discouraged. At least the threat of triple damages should be removed when any such activity is approved by the Antitrust Division of the Justice Department. If this change in the law is made, it

should be made for all such activity and not simply to foster HDTV, and the approval should preclude any future trade protection.

Simply making joint production agreements legal probably would do little to foster a U.S. HDTV industry. If consumer electronics is unprofitable for GE or IBM, it would probably be unprofitable for GE plus IBM plus other firms. No change in the antitrust laws is likely to change this proposition.

The appropriate policy for the government, then, is to treat the advent of HDTV with benign indifference. If HDTV can succeed in the marketplace, the result will be a greatly improved audiovisual experience. But only the marketplace can determine if that experience is worth the cost.

One policy that could help HDTV or other promising technologies, however, would be to permit a market in the spectrum to develop.[18] While the FCC now allocates frequencies to various uses, no mechanism exists to ensure that the spectrum is used in the most efficient manner. A market would allow firms or individuals to purchase frequencies for broadcasting signals such as HDTV's.

Under FCC rules, TV stations can be purchased with approval from the commission. A first step toward a market in the spectrum would be for the FCC to permit TV channels to be bought and sold freely. That is, if a firm wants to buy two TV channels and combine them into one HDTV station, it should be free to offer that service even if the new combined signal is incompatible with the current system.

Conclusion

The government should avoid industrial policies. Bureaucrats are not good at picking winners and losers. While many observers point to the purported success of the Japanese government agency MITI in fostering industries, its actual record is spotty. The U.S. record is replete with failures.

Barring import restrictions, the U.S. government can do little to prevent the market from choosing the production standard. The FCC can and will approve whatever standard for terrestrial broadcasting is adopted. The process will be delayed because choosing among competitive systems will not be simple. No system should be ruled out or discriminated against simply because it has been developed primarily in another country. If the Japanese system is the best, it should be chosen. Much of the objection to the Japanese system can be labeled as simply old-fashioned protectionism.

In summary, HDTV has the potential to markedly improve audiovisual reception in the home. Its economics are tricky and best left to the marketplace. Government involvement will only waste taxpayers' money and misdirect technological progress.

Footnotes

[1] "Japanese Test Illustrates Big Lead in TV of Future," New York Times, March 21, 1989, p. D10.

[2] HDTV Information Center, 1722 Eye Street N.W., Suite 200, Washington, D.C. 20006, news release, November 30, 1988.

[3] Robert R. Nathan Associates, Television Manufacturing in the United States: Economic Contributions--Past Present, and Future (Washington: Nathan Associates, February 1989), p. 48.

[4] "Japanese Test."

[5] News from ATSC (Advanced Television Systems Committee, Washington), no. 89.

[6] "Interim Report of the FCC Advisory Committee on Advanced Television Service," June 16, 1988, p. 8.

[7] "Japanese Test."

- [8] "Orion's 'Super' Series," Washington Post, December 22, 1988, p. C7.
- [9] "VR Symposium," Video Review (January 1989): 60.
- [10] Nathan Associates, pp. 1, 9 (fig. II-2).
- [11] "The Fast Track to New Markets," New York Times, Sunday, May 28, 1989, sec. 3, p. 2.
- [12] "Long a U.S. Province, Supercomputer Market Feels a Japanese Threat," Wall Street Journal, May 24, 1989, p. 1.
- [13] Nathan Associates, p. 1.
- [14] HDTV Information Center, p. 3.
- [15] "Zenith Electronics Chief Seeks U.S. Tax for HDTV Research," Wall Street Journal, May 17, 1989.
- [16] H.R. 1267 and H.R. 1516.
- [17] Irwin M. Stelzer, "Corporatism Ousts Reaganomics," American Spectator, May 1989, p. 31.
- [18] See Milton Mueller, "Privatization of the Airwaves" (Santa Monica, Calif.: Reason Foundation, April 4, 1988); Federal Communications Commission, Office of Plans and Policy, "A Framework for Decentralization of Radio Service," FCC Working Paper, October 1983; and "Spectrum Management Policy in the United States: A Historical Account," FCC Working Paper, April 1985.