

News & Comment

HDTV: The Technology *du Jour*

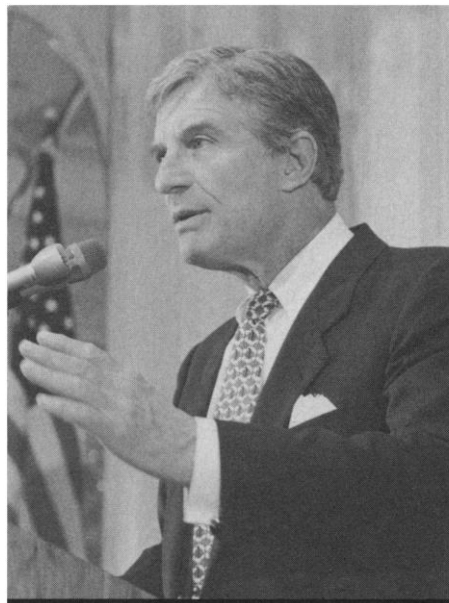
Proposals are flying around Washington to boost development of a high-definition TV capability in the United States. Can a depleted industry take on the Japanese?

TO HEAR SOME PEOPLE tell it, the industrial future of the United States will be determined by which manufacturers' names will be on the high-tech television sets that are expected to become a hot consumer item in the late 1990s. If none of them are American, the United States risks "missing out on the 21st century," says Representative Don Ritter (R-PA).

High-Definition Television, or HDTV, has consequently become what one observer describes as the "technology *du jour*" in Washington. Congressional hearings on the topic play to standing-room-only audiences. The Bush Administration is thinking of relaxing antitrust rules and giving tax breaks to U.S. companies developing HDTV. The American Electronics Association (AEA) last week called for \$300 million in federal R&D funds to push the technology along, and it proposed the formation of a novel government-industry partnership, backed by \$1 billion from Uncle Sam, to guide the development and production of HDTV systems. It is an astonishing leap to prominence for an issue that barely raised a flicker of public interest a year ago.

The outcome of all this political churning could have implications that extend well beyond television manufacturing, for what emerges in terms of federal support for HDTV may pave the way for broader changes to antitrust laws and provide a model for government funding for R&D in other critical areas such as machine tools and x-ray lithography. Indeed, this is one reason why HDTV is attracting so much attention. Says Brookings Institution economist Kenneth Flamm: "They see this as the shock troops landing on a beach that has to be invaded."

Why HDTV? The short answer is that billions of dollars and thousands of jobs may rest on whether or not U.S. companies can compete with Japanese and European manufacturers in producing HDTV equipment. A study done for the Commerce Department last year forecast that the U.S. market for HDTV receivers—which will have film-like picture quality, big screens, and the sound reproduction of compact disc players—will amount to \$140 billion over the next 20 years. In November, the AEA



©1989, Ken Heinen

"If the private sector doesn't want to pursue this without massive infusions from government, there is nothing we can do."

—Robert Mosbacher

upped the bidding: a \$500-billion market could develop by 2010 for all HDTV-related equipment, including VCRs and video cameras, it predicted.

But what's new? Similar dire predictions were made about U.S. failure to compete in the market for stereos and VCRs. But HDTV may be different because it will be on the technological cutting edge. HDTV receivers will be stuffed with more memory chips and microprocessors than today's personal computers. This means that, if the AEA's market projections are even remotely accurate, the manufacture of HDTV receivers could drive innovation in semiconductors, the effects of which would ripple through the electronics industry. And the advanced display technologies being developed for HDTV could have applications ranging from medical diagnostics to com-

puter-aided design. "The issue is not a prettier picture in the living room. The issue is the industrial future of the United States," says David Staelin, an economist at Massachusetts Institute of Technology who recently completed a study of the U.S. consumer electronics industry as part of a huge MIT report on American competitiveness.

It will be an uphill fight to develop a domestic capability in HDTV though. Japanese and European companies have been working on HDTV systems for years, while U.S. efforts have been slow in getting off the ground. "The facts are very stark," says Solomon Buchsbaum, executive vice president of AT&T Bell Labs. "Right now, Japan and Europe are ahead of us in HDTV development."

Why? By now it is a familiar story: Both the Japanese and European efforts have benefited from substantial infusions of government funds, and they have involved cooperative ventures linking several electronics companies in the development of complete HDTV systems. Standardized formats, such as the number of lines per TV picture, were also established early on, to encourage cooperative development of studio production equipment, broadcasting systems, and receivers.

The core of Japan's HDTV effort is an R&D program begun in 1970 by the giant National Broadcasting Company (NHK). It is estimated to have been bankrolled by the federal government to the tune of \$500 million. Private companies, including Sony, Toshiba, Hitachi, and Matsushita, joined the program in 1983 and, according to a Japanese government estimate, they have put about \$400 million into the venture.

The Japanese decided early in their program that they would broadcast HDTV signals via satellite directly to individual antennas linked to each receiver (see box). Test broadcasts began earlier this year, and the plan is to begin marketing HDTV receivers and VCRs in 1991.

In response to the Japanese developments, the Europeans started a \$200-million coordinated HDTV program in 1986. Called Eureka-95, it was the first substantial effort launched by the Eureka program, Europe's major multinational effort to pro-

Without Standards, U.S. HDTV Lacks Definition

This fall, a handful of research and engineering teams will begin a shoot-out in a small studio in the Washington, D.C., suburb of Alexandria. Their weapons will be the esoteric armamentarium of signals processing, and the winner will be the team that can demonstrate the best and most practical system for broadcasting high-definition television (HDTV) signals to viewers in the United States.

The shoot-out is part of a two-track process to establish the formats, or standards, that will shape the development of HDTV in the United States. Billions of dollars will ride on the outcome, for the choice of standards will strongly influence international competition between Japanese, European, and American companies to market HDTV equipment in the United States.

Two interrelated sets of standards are at issue: production standards, which govern the formats in which HDTV images will be produced; and broadcast standards—the focus of the Alexandria tests—which govern how the images will be transmitted to viewers' television sets.

A fervent hope in the television production business is that a universal, worldwide production standard can be negotiated so that HDTV programs produced in one country can be shown in any other country without requiring complex and costly translation into another format. That is not the case at present, of course. European TV currently has 625 lines and displays 50 images per second; in contrast, most other countries—including the United States and Japan—use 525 lines and a so-called field rate of 59.94 images per second.

The leading candidate for a worldwide HDTV production standard has been one developed by Japan's broadcasting giant, NHK. The chief reason this standard has gathered support is that, until recently, it has had no competitors. Japan has been developing an HDTV system based on the NHK format since 1970, and Japanese companies have already produced a range of cameras, video recorders, and production equipment compatible with it. The NHK system has 1125 lines—more than double the resolution of conventional TV—and a field rate of 60 images per second.

In 1985, the United States, Japan, Canada, Mexico, and several other countries urged the International Radio Consultative Committee, the body that sets international broadcasting rules, to adopt the NHK format as a world standard. Later that year, however, the Europeans served notice that they would not go along. They subsequently proposed a different format—1152 lines and a field rate of 50—and set about building their own HDTV system around it.

European officials justified the move on the grounds that their proposed standard would be more compatible with Europe's conventional TV system, which would ease the transition to HDTV. But while it played well at home, Europe's decision dashed hopes elsewhere for a worldwide HDTV production standard, and it rendered Japanese HDTV equipment incompatible with Europe's planned system.

The U.S. government is still officially clinging to its support for the NHK format, but it is under mounting pressure from large segments of the electronics and broadcast

industries to back off and adopt yet a third, U.S. standard. Last October, the National Broadcasting Corporation, backed by nine organizations developing HDTV systems, formally proposed a format of 1050 lines—exactly double the existing standard—and a field rate of 59.94, the same as the current standard.

Although technical arguments are invoked against the Japanese standard, the real issue appears to be economic: if the NHK format were adopted, Japanese companies would have a head start in marketing their HDTV products in the United States. "I am convinced that the principal motive behind pushing the NHK system is to advance Japanese economic interests to the detriment of our own," says William Schreiber, head of the Advanced Television Research Program at the Massachusetts Institute of Technology. "There is no reason whatsoever for the United States to be a party to inflicting this damage on itself."

By now, most leading experts expect that Europe, Japan, and the United States will each end up with a different format for its HDTV system. This will require different production hardware, and programs will have to be translated from one format to another before they can be shown on another system.

That would not be a major technical challenge; rather, the burden on national television systems will be essentially economic. The technological challenge comes in the development of broadcast standards. The difficulty is that the massive amount of information required for sharper resolution and digital sound must be squeezed into a



Sharp image. Conventional picture (left) is enhanced by information sent in an associated signal to produce a high-definition image (right) in an HDTV receiver. North American Philips and the David Sarnoff Lab are



taking this general approach. (These images were produced by William Glenn at the New York Institute of Technology.) Zenith favors broadcasting a complete, entirely separate, HDTV signal.

©Davis/Phototake

relatively narrow signal that can be handled by the various broadcast media.

The fiercest constraints are in terrestrial, over-the-air broadcasting, in which TV channels are limited to 6 megahertz. The airwaves are already jammed, and a host of new users such as cellular telephones are clamoring for space on the spectrum. In most major cities, in fact, all the broadcasting slots are already allocated.

Last September, the Federal Communications Commission (FCC), which regulates terrestrial broadcasting in the United States, issued broad ground rules for HDTV: no additional bandwidth will be allocated, and the 160 million conventional TV sets currently in U.S. homes must not be rendered obsolete by a switch to HDTV. A single broadcasting standard will be chosen from contenders that meet those rules.

Some 20 groups have developed proposals, but there are generally acknowledged to be about half a dozen serious contenders. These are the groups that will be battling it out at the Alexandria test facility.

The proposals fall into two general categories: those that intend to broadcast HDTV signals that can be shown on conventional TV sets, and those that would simultaneously broadcast a conventional signal and an incompatible HDTV signal on different channels.

Among those in the first camp are Yves Faroudja, a French engineer and entrepreneur who runs his own research labs in Sunnyvale, California; North American Philips, a subsidiary of the Dutch electronics company, which has spent \$15 million at its labs in Briarcliff, New York, developing an HDTV system for the United States; and the David Sarnoff Laboratory in Princeton, New Jersey, the old RCA lab that is now owned by SRI International and which, on this project, is working with the National Broadcasting Corporation and the French company Thomson.

Faroudja and Sarnoff are proposing an initial step in which additional information would be added to a conventional TV signal. Existing TV sets would not notice much difference, but new, "enhanced definition" receivers would display sharper images. In a second stage, Sarnoff has proposed transmitting an additional signal in one of the so-called taboo channels, the dead space between existing channels that is now left vacant to prevent interference. The second signal would be combined with the conventional signal in a high-definition receiver to

produce very sharp images and digital sound. Philips is proposing to skip the first stage and go straight to a high-definition system, which, like the proposed Sarnoff system, would add a second signal in a taboo channel. Philips, in fact, already has such a system under test.

Among the groups advocating an alternative approach is Zenith, which has developed a system for transmitting an entire HDTV signal within a single taboo channel. Because today's receivers would not be able to tune into the HDTV signal, conventional signals and HDTV signals would have to be broadcast simultaneously while HDTV is phased in. Eventually, conventional broadcasting would cease and bandwidth could be freed up for competing users.

Japan's NHK is expected to plant a foot in both camps by offering two alternatives. One is expected to be compatible with existing receivers and another, like the Zenith signal, would require simulcasting.

The tests of the competing systems are expected to run through 1990, and the results will feed into the FCC's decision. The system eventually chosen will be the standard only for terrestrial broadcasting—it will not apply to cable TV or to direct satellite-to-home broadcasting, which are not regulated by the FCC.

Therein lies a possible nightmare for terrestrial broadcasters. Because cable transmission and satellite broadcasting are not so constrained in bandwidth or so vulnerable to interference, they may be better mediums than over-the-air broadcasting for transmitting HDTV signals—indeed, that is one reason why both Japan and Europe have chosen direct satellite broadcasting for their systems. An even better medium, eventually, would be high-speed fiber optic networks carrying HDTV signals in digital form. Thus, if the alternative media develop their own broadcast standards, they may be able to snag more viewers. However, a variety of broadcast standards would then emerge, and receivers would not be compatible with all the broadcasting mediums.

Schreiber of MIT has an answer to this problem: build supersmart receivers that can be programmed like personal computers to decode a range of incoming signals. "Open architecture" receivers of this type could also be upgraded by plugging in new cards. Schreiber's group has already tested prototypes of his smart receiver, but so far the broadcast industry has shown little enthusiasm. ■ C.N.

mote high-technology cooperation among European companies.

Like the Japanese, the Europeans are developing a system based on a set of agreed-upon European formats (different from NHK's) and have also chosen to broadcast HDTV directly from satellite to homes. Test transmissions are planned for 1990 and the system is scheduled to begin operation in Europe in 1995.

In contrast, U.S. efforts in HDTV are fragmented, as usual. They have not benefited from direct federal assistance, and there are as yet no agreed formats for the way HDTV programs will be produced and broadcast. As a result, different companies are taking very different—and generally incompatible—approaches.

Moreover, the technological and manufacturing base is severely limited because U.S. companies have steadily been dropping out of the consumer electronics business over the past few decades in the face of fierce competition from foreign (mostly Japanese) manufacturers. Zenith, in fact, is the only U.S.-owned company still making television sets, and there is not one U.S. company manufacturing VCRs.

Given this gloomy environment, it may seem like an impossible task to launch a viable U.S. HDTV effort. But those prodding the federal government to take some action emphasize the bright spots. For one: the Japanese and Europeans have tailored their systems around their own formats and designed them for direct satellite broadcasting; some of their technology may not be directly applicable if the United States opts for a different system. For another: the market for HDTV is expected to develop slowly because the early-model receivers will be expensive and massive. Perhaps the United States could build a better receiver.

Enter the Pentagon. Last fall, the Defense Advanced Research Projects Agency (DARPA) announced that it would launch a \$30-million research and development program to develop high-resolution displays. This could be crucial for HDTV if it leads to low-cost flat panels or projection systems that would replace conventional cathode-ray tubes, which may be too bulky for big-screen HDTV receivers. Says James Carnes, vice president for consumer electronics at the David Sarnoff Research Center, which is developing an HDTV system: "HDTV will really take off when consumers can have bright, high-resolution displays that will fit through the door."

But more than a \$30-million defense program may be needed. The AEA, the trade group that represents the interests of U.S. companies, is thinking big. Last week, it unveiled a proposal that calls for some hefty

federal outlays and a novel arrangement to guide government and private efforts.

For starters, the plan calls for DARPA's modest effort to be expanded to \$100 million a year over 3 years. It would focus on key technologies, such as signals processing and the development of manufacturing systems, in addition to high-resolution displays.

Next, the plan calls for the creation of a board dominated by industry but with membership from government and academia, to coordinate and guide government and private HDTV efforts. The board's clout would come from \$1-billion worth of low-cost federal loans and loan guarantees that it would use to back projects in individual firms or consortia.

As for the tricky issue of participation by U.S. subsidiaries of foreign-owned companies, the plan says they should be included if they perform most of the relevant R&D, design, and manufacturing in the United States and if they buy their semiconductors from U.S.-based firms. This could provide an entree for European companies, such as North American Philips, but would probably exclude many Japanese firms.

The plan also calls for a waiver of the antitrust laws to make such cooperation legal, and asks for tax breaks for some HDTV activities. And it suggests that the government should move as quickly as possible to adopt a format for broadcasting HDTV signals so that developments by individual companies can proceed in a common direction.

A novel aspect of the plan is that the proposed board, which would be known as the ATV Corporation, would hold title to technology underlying whatever broadcasting standards are eventually adopted in the United States. This would give it considerable authority to determine who could participate in the venture.

The Bush Administration may buy some elements of this plan. Commerce Secretary Robert Mosbacher, who testified before the Senate Commerce Committee last week shortly before the AEA unveiled its wish list, said that he personally favors relaxing antitrust restrictions and providing tax incentives to stimulate the industry. Mosbacher has promised to submit Administration proposals to Congress for HDTV by 1 July.

Mosbacher made it plain, however, that the Administration is unlikely to come through with a major cash outlay. "If the private sector doesn't want to pursue this without massive infusions from government, there is nothing we can do," he said. "I think they are hoping that Uncle Sugar will fund it and I don't think they should."

This drew a sharp response from commit-

tee chairman Ernest Hollings (D-SC), who noted that last year Congress established a variety of programs in the Commerce Department that would be the focus for supporting critical technologies such as HDTV, but the Administration has not funded any of them. Moreover, many key jobs in the department have still not been filled (*Science*, 14 April, p. 137). "I'm embarrassed for you," Hollings said, adding that he would work through the appropriations process to try to break some funds loose.

A half-dozen bills are in fact already in the congressional hopper to channel funds to HDTV, including a broad bill proposed by Representative Ritter that would provide \$100 million a year in R&D funds and provide waivers from the antitrust laws for firms cooperating on HDTV.

Underlying the Administration's caution in getting involved in ventures like HDTV

is a reluctance to establish industrial policy—in essence, to put the government in the position of picking potential commercial winners. The hesitation is understandable: many earlier attempts have been dismal failures. The Synthetic Fuels Corporation—a body similar in some respects to the proposed ATV Corporation—is a case in point.

But to some observers, such as National Academy of Engineering president Robert White, the debate over how to support HDTV points up once again the poor environment for fostering civilian technologies in the United States, and the lack of a mechanism in the federal government outside the Pentagon to fund industrial research. "We seem to career from problem to problem. What we have is a much broader issue facing the economy, and we haven't puzzled that out yet," says White.

■ COLIN NORMAN

A Fast Track for High-Risk Science

When the National Science Foundation (NSF) asked its 1985 grant recipients how well they liked the agency's peer-review system, 38% said they were dissatisfied. A larger number—about two-thirds of the 9500 who responded—agreed with the statement that NSF is unlikely to fund high-risk, innovative research projects because its review process is too conservative. These results, cited in a report published last year, came



Erich Bloch

as something of a shock, amounting to "a serious accusation, if true," says NSF director Erich Bloch. The agency last week came up with a response, revealed by Bloch at the monthly meeting of the National Science Board on 12 May.

This fall NSF intends to launch an experiment of its own, a program of innovative grants that will bypass the peer-review system and make up to \$50,000 available to principal investigators who can convince NSF program officers that their ideas deserve support. "We are now drawing up the rules and regulations," said Bloch, "and we're trying to keep them as unobtrusive as possible." The goal will be to attract new ideas and adventurous scientists, giving them the resources to explore topics that might not meet with approval in a more formal setting.

NSF already has had some experience with this approach in its engineering direc-

torate. James McCullough, director of NSF's program evaluation staff and an advocate of the experiment, says it was first tried by Nam Suh, NSF's former engineering chief, who has since returned to the faculty of the Massachusetts Institute of Technology (MIT). "When Nam Suh came here from MIT he brought an agenda," McCullough says, "and I think this was high on his list." Under Suh, the engineering directorate in 1986 launched a pilot program called "Expedited Awards for Novel Research." As of February 1989, it had made 239 one-time awards of no more than \$30,000 each.

Bloch empaneled a group to look into the results, chaired by John Kemper of the mechanical engineering department at the University of California at Davis. The Kemper committee gave a favorable report in March, adding several recommendations. It said NSF should not only continue, but expand the experiment to include every division in the foundation. It recommended that the ceiling be raised from \$30,000 to \$50,000; that no external review be required for proposals submitted; that an expenditure limit for this type of research be imposed amounting to 5% of each program's budget; and that the awards be made on a one-time basis, so that researchers will be able to renew grants only by submitting to formal peer review. All the recommendations were accepted.

NSF is working out the details of its new award system and McCullough expects the agency to get promotional literature out to universities this summer.

■ ELIOT MARSHALL