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INNOVATION IN AMERICA

The Challenge We Face • What Must Be Done

THE MOST INNOVATIVE COMPANIES:
HOW THEY DO IT
HOW THEY FINANCE IT

OUR NEW R&D SCOREBOARD
THE TOP SCIENTISTS
WHAT'S HOT IN PRODUCT DESIGN

THE SCIENCES

AN HDTV WITH LESS THAN MEETS THE EYE

WILLIAM GLENN'S SYSTEM LEAVES OUT SOME DETAILS WE CAN'T EVEN SEE

PEOPLE

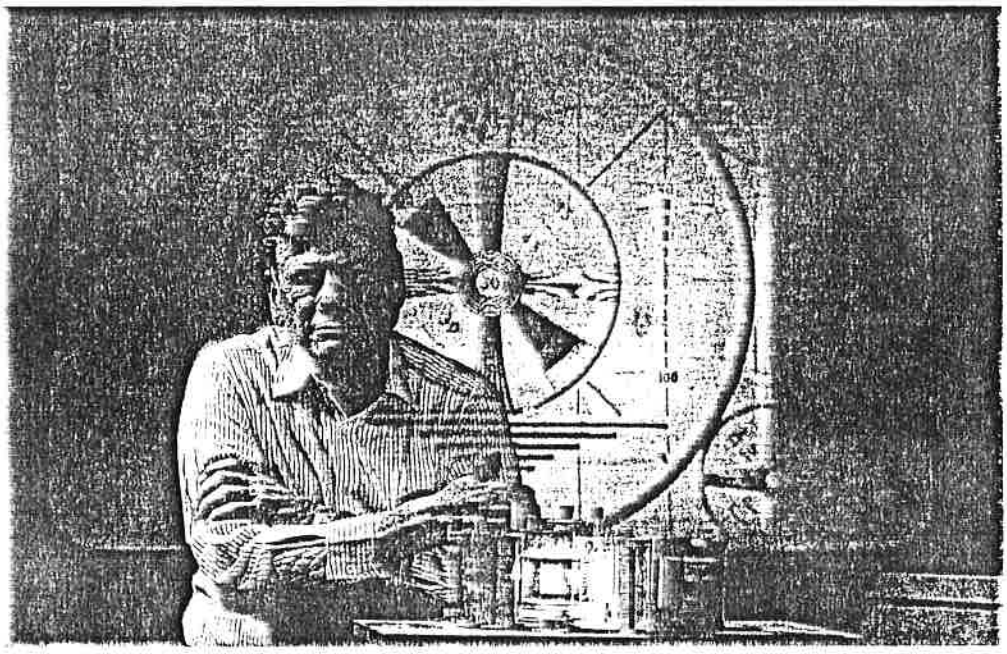
WILLIAM GLENN

ELECTRICAL ENGINEER

FLORIDA ATLANTIC UNIVERSITY

TO MANY TELEVISION ENGINEERS, WILLIAM Glenn is a rare example of old-fashioned American ingenuity. Working in his small laboratory in Florida, he is contending against some of the world's largest corporations in the race to develop a workable system of high-definition television (HDTV), a technology that promises to bring photo-clear pictures into the home in the mid-1990s. "Bill Glenn proves the American spirit of innovation is 100% alive," says Patricia Hill Hubbard, a vice-president at the American Electronics Assn.

Indeed, Glenn, 63, kept going as the U.S. television industry collapsed around him. He had been director of research at CBS Laboratories, but when the lab was scaled back in 1975, he left the company and joined the New York Institute of Technology. Glenn exchanged patent rights—including those on future work—for funding and a lab that NYIT set up for him in Dania, Fla. There he continued working on advanced television projects. In 1981, he began working on a broadcast transmission system for HDTV.



"Bill Glenn proves the American spirit of innovation is 100% alive"

One of the biggest hurdles facing HDTV is that the signals needed to produce such high-resolution pictures require more spectrum than the Federal Communications Commission allocates for a single conventional TV broadcast channel. As a result, engineers are trying to compress the signal as much as possible.

Glenn found a way to limit the signal by leaving out information that the human eye can't see anyway. He got his inspiration from research on human vision conducted by his wife, Karen, who is an experimental psychologist. Her studies focused on the eye's inability to transmit certain details—particularly of motion—to the brain.

The idea has been widely copied by other engineers designing HDTV systems. "Bill Glenn's contribution is teaching us a way to play tricks on the eye," says Jack S. Fuhrer, director of television research at the David Sarnoff Research Center in Princeton, N.J. That former RCA Corp. lab, now owned by SRI International, is developing advanced television systems with NBC Inc. and Thomson CSF.

Glenn's effort is outgunned by Sarnoff and many other competitors, including North American Philips, Zenith Electronics, and Bell Laboratories. They are all vying for a piece of the estimated $20 billion HDTV market. On Apr. 20 Sarnoff demonstrated the first phase of its $60 million advanced television project. By contrast, Glenn estimates that he's spent less than $3 million on his so-called VISTA HDTV system.

Citing disagreements over how to commercialize VISTA, Glenn left NYIT in April, accepting a post at Florida Atlantic University. NYIT says it will market VISTA, paying Glenn a share of the royalties.

Glenn, who is an avid sailor and musician, plans to continue his HDTV work, focusing on flat-panel HDTV screens that can hang on the wall like a painting. Another project is a fiber-optic HDTV system for NASA's proposed space station. And he's working on a compact video projector he says will take up only a quarter of the space of a big-screen TV, while providing movie-house-quality HDTV pictures.

If the U.S. wants to compete against the Japanese in HDTV, Glenn says, it will have to leapfrog ahead with radically new display technologies. But Glenn has come up empty-handed in his search for financial backing from a U.S. company. "U.S. investors are not interested in long-term projects," he says. Now, he is talking to a British company. What's next if that fails? Well, there's always Japan.

By Antonio Fins in Miami

Exploring TV's next frontier

By Mark Lawrence

ON CUTTING EDGE: Professor William Glenn works on a way to broadcast sharper TV images.

COVER STORY

USA still blurry on new technology

Japanese are in the lead on sharper-image broadcasting

By Mark Lewyn
USA TODAY

Professor William E. Glenn speeds his boat to the office each morning to work on what may be the biggest advance in television since color pictures.

At the New York Institute of Technology's waterfront research laboratory in Dania, Fla., Glenn is working on a method for broadcasting super-sharp TV images that could mean the best picture that TV buffs have ever seen.

Glenn and others have been working on a high-definition TV — HDTV — system for years, but a move is finally afoot to get TV's next generation out of the lab and into USA homes.

USA TODAY
Money
WEDNESDAY, NOVEMBER 18, 1987

Tuesday, CBS Inc. Chief Executive Officer Laurence Tisch, Capital Cities-ABC Inc. Chairman Thomas Murphy and about 30 other broadcasting luminaries gathered in Washington, D.C., to consider how to do that. By May, they are hoping to have a plan to implement HDTV, but it won't be an easy task. Some of the nagging problems:

■ There's no consensus on how to best capture the HDTV signal for home viewers. At least a half-dozen different re-

Please see COVER STORY next page ▶

WASHINGTON POST
OP-ED PAGE
9/24/87

Hobart Rowen

High-Density TV

Another Japanese marketing success in the making.

Another multibillion-dollar Japanese marketing success in television is in the making, and major American manufacturers aren't raising a finger to bid for the business. Later, they will be crying a lot if and when the Japanese dominate in the latest technological breakthrough: high-density television.

HDTV is such a qualitative leap forward that it has to be seen to be believed. I was fortunate enough to see a demonstration of the Japanese system at the Tsukuba City science fair in 1985. For the first time, a picture of the same quality shown in large-screen movie theaters can be brought into the home.

The question of how to cope with HDTV is a hot topic in broadcasting and TV circles, but it has almost totally escaped the attention of the general public. It is reminiscent of what happened to videocassette recorders. The first VCR production models were built by RCA in the United States and by Phillips in Europe back in the 1960s.

But they cost well over $1,000, out of the reach of most consumers. RCA and Phillips blew it: unwilling to invest enough money to make VCRs attractive to consumers, they decided the VCR business would be a flop. But Japan's Sony and Matsushita took those first cumbersome machines, redesigned them to fit the living room or den, slashed prices—and grabbed one of the all-time great consumer markets.

There could be a reprise of the VCR story with HDTV. The new technology has evolved more generally, here and in Japan, over the past 15 years. But while Japan ran with the ball, committing an estimated $500 million to development, American electronics companies have put almost no effort into a competing system.

Japan's state-owned television broadcasting system, NHK, has already demonstrated HDTV here in Europe and in the Soviet Union. It plans to start commercial transmission by satellite in Japan in 1990, along with the sale of HDTV receivers in both Japanese and American

The only American entry is a prototype developed by a distinguished American inventor, Dr. William Glenn. Glenn isn't as far along as NHK—but he's got one big advantage going for him. The system, which he demonstrated last spring to the National Association of Broadcasters in Dallas on a closed-circuit basis, is compatible with, and therefore would not make obsolete, present color-TV receivers.

Glenn is a former vice president and director of research of CBS Laboratories. He has 96 high-tech patents, many of them major, to his credit and has a top-notch reputation among scientists and in industry.

He has invented an HDTV system that—same as NHK's—transmits a picture with 1,125 lines, or more than twice the 525 lines received by today's standard TV receiver-sets. It has other technical advantages over current transmission. But the fact that it is "friendly," or compatible with present sets, is of major economic significance.

"This is not a small or inconsequential public-policy issue," says Assistant Secretary of Commerce for Communications Alfred C. Sikes. "If you start adding up the total TV-equipment investment in this country . . . you find that this is potentially a $100 billion problem."

Glenn tells me that American industrial moguls seem paralyzed. He observes that the big manufacturers are abandoning their interest in practically all consumer electronics. In recent weeks, General Electric sold its consumer electronics division to Thomson S.A., a French company. By default, Glenn feels, the Japanese will soon enjoy commercial dominance of what he estimates to be a $25 billion to $50 billion HDTV market in another 10 years.

Glenn told me that, given the short-term investment approach in American industry, HDTV technology will cost too much over too long a time for any single company to undertake. Thus, he is trying to get the government to sponsor a consortium formed with industry, government and university participation—based, to be sure, on his HDTV system.

After CBS went out of the manufacturing business in 1975 and shrank its research lab staff from 700 to 30 people, Glenn says he talked CBS into donating its commercial projects to the New York Institute of Technology, as a tax write-off. Among the institute's affiliates is a research facility that Glenn now operates in Dania, Fla., where he carries on his work. It has a tiny $750,000 annual budget provided by the National Association of Broadcasters and the Electronics Industry Association.

Commerce Department officials are sympathetic to Glenn, but find industry apathetic. Sikes recently asked: "Why can't U.S. industry see this as an opportunity to regain an important position in one of this country's most important and influential industries?"

It's a good question. As Sikes told broadcasters in Washington yesterday, there is a need for government to get involved, perhaps by getting "new players" outside of the TV industry into the act. Unless someone soon shows some of the old Yankee trader spirit, NHK may become a better known acronym than ABC, CBS or NBC.

The New York Times
Business
Sunday, March 6, 1988
Section 3

HIGH DEFINITION TELEVISION

Let's Not Lose Another Market to Japan

By WILLIAM E. GLENN
and KAREN G. GLENN

THE United States must not miss out on taking the lead in another new technology — high definition television. HD TV is video with the clarity and sharpness of film. The advance that HD TV represents over standard television is comparable to the improvement in picture quality that came with advances in color television. When HD TV sets become available in the United States within the next five years, they will usher in an era in which TV screens will be measured in feet and in which videotape will increasingly displace 35-millimeter film in making and showing motion pictures.

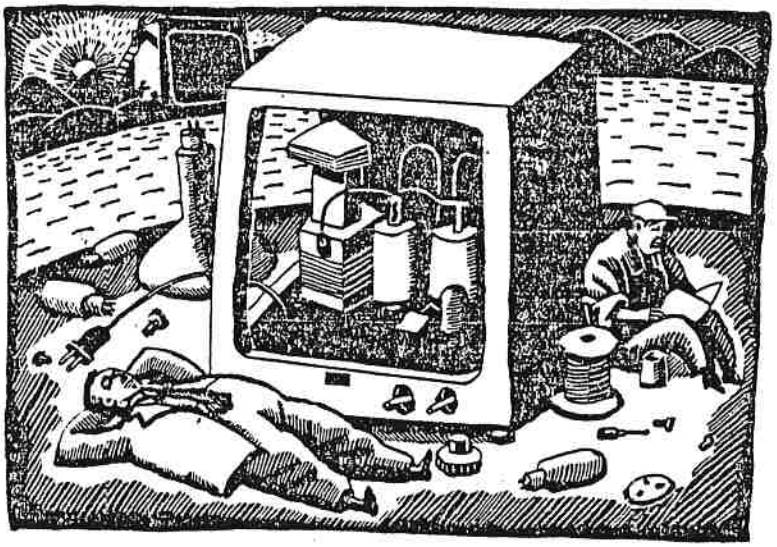
The American market for HD TV sets is estimated to be as big as $20 billion a year by 1997. The big question is where will those sets be made.

The current prospect is that foreign manufacturers will dominate this new market, as they now dominate all markets for consumer electronics in the United States. But this need not happen if government and industry take advantage of advances in HD TV technology achieved here through American university research. With prompt initiatives, the disappointing history — for American manufactures — of the video casette recorder will not be repeated. The VCR was conceived in the 1960's by the Ampex Corporation and the RCA Corporation; yet today, with annual sales in the United States at $6 billion a year, not a single VCR is made in this country. Similarly, HD TV is an American invention, first produced in the 1950's. Except for a few specialized applications, the technology has been abandoned by American companies. The few remaining American corporations that manufacture television sets show little interest in HD TV.

In contrast, in the laboratories of Japan's government-sponsored television network, NHK, an intensive 17-year research program has resulted in the development of HD TV for consumer use. NHK and several Japanese manufacturers have been demonstrating HD TV cameras and receivers at American trade shows since 1982. NHK plans to inaugurate high-definition broadcasting by satellite in Japan in 1990. At that time it will introduce its version of an HD TV receiver, using a transmission and recording system called Muse, into the Japanese and American markets.

This is worrisome from the point of view of trade deficits, but it also poses a threat to much of the American broadcast industry — and ultimately to the viewing habits of the public. The Muse system, for all the brilliance of its images, is incompatible with current broadcasting standards in the United States. In other words, in the Muse system, programs broadcast in high definition could not be seen on standard television sets.

Fortunately, there are alternatives. The one with which we are most familiar was developed at our laboratory at the New York Institute of Technology and demonstrated at the 1986 and 1987 conventions of the National Association of Broadcasters. This HD TV transmission system is not only equal in resolution to Muse but compatible with current broadcast standards. Thus, regular TV sets would be able to receive programs broadcast in HD TV, just as black-and-white sets can receive programs broadcast in color.



Drawings by John Howard

By 1997, the annual market for HDTV will be as big as $20 billion.

Because a compatible HD TV system has such great advantages for both broadcasters and the viewing public, it is to be hoped that the Federal Communications Commission encourages its development. One important question in this regard is whether a portion of the frequency spectrum now allocated for television will be re-allocated for land-mobile phones. It is vital that these channels be retained for television, since they will be needed to carry the augmentation signal for HD TV.

Even if a compatible system prevails over Muse, however, the question remains as to where HD TV sets will be manufactured. Given the substantial Japanese lead in research and development, the future for American development of high definition technology would appear bleak. More careful analysis of the situation, though, reveals a business opportunity that has yet to be seized.

This opportunity stems from the fact that HD TV images are best displayed on very large screens of four to five feet or more. Conventional television sets employ cathode ray tubes to project images on their screens, and the Japanese are using this cathode-ray technology. The problem is that cathode-ray-tube technology does not lend itself to large-screen projection at an economical cost, with Japanese home-sized receivers are expected to sell for about $3,500.

This technology gap creates a great business opportunity for producing inexpensive displays that would vastly expand the market for HD TV. While most American corporations have been inactive in this field, research has proceeded independently at universities. One result has been a television projector with a solid-state light valve. This type of projector could be manufactured commercially within three or four years and could reduce the price of HD TV sets to as low as $1,500.

As the General Electric Company's recent withdrawal from consumer electronics suggests, initiatives in this field are likely to come not from companies that have manufactured TV sets in the past but from companies receptive to new technology. A new American HD TV industry would grow most naturally out of the manufacture of semiconductors and other solid-state products. Building on extensive prior investment and adopting automated manufacturing techniques, American companies could dominate the HD TV industry.

Will it happen? Given the major long-term investments that will be required, it is unlikely that a single corporation will undertake the effort on its own. It will take a vigorous joint effort of government, industry, and academia for the United States to capitalize on this opportunity. While the Department of Commerce, the Presidential Science Advisor's office, and several corporations have shown some interest, no effort has been mounted — and time is short.

Here is a splendid economic opportunity that promises to make a significant difference in our trade deficit. The scientic and technical talent are at hand. If American industry fails to become a significant factor in HD TV, it will be mainly for lack of will. ■

William E. Glenn is the director of the New York Institute of Technology Science and Technology Research Center. Karen G. Glenn is an experimental psychologist.

BUSINESS WEEK 12/21/87

been cooperating on a rival standard since 1985. A consortium led by the Netherlands' Philips is spending $232 million over three years to develop its own system, a prototype of which is scheduled to be ready in 1988. The goal is to match Japan's schedule and begin transmissions via satellite in 1990. "Europe got off to a late start, but the Japanese got off to a wrong start," asserts Philips Vice-President Piet W. Bögels.

While Europe and Japan are racing toward a 1990 launch target, the U.S. is still stuck on the starting block. The Federal Communications Commission hasn't yet decided whether to allocate the additional space in the broadcast spectrum that HDTV requires. Without more frequencies, broadcasters worry, HDTV will become the province of cable-TV and satellite systems, siphoning off broadcasting's audience and advertisers.

SATELLITES. Both Japan and Europe have already made the decision, in effect, to abandon traditional broadcasting in favor of satellite delivery of TV programs. American broadcasters and cable-TV operators have enough political clout to block that here. So before HDTV makes major headway in the U.S., the technology must be made compatible with the needs of those industries.

Until now, U.S. manufacturers have shrugged their shoulders at the new technology. "We won't work on anything we don't see a market for," explains Robert B. Hansen, head of consumer products at Zenith Electronics Corp., the last major U.S.-owned maker of TVs. But recently the AEA and the Commerce Dept. have begun to explore the possibility of a U.S. consortium to develop and perhaps build HDTV products. The AEA's Thomson says there is "serious interest" at such companies as Apple Computer, Motorola, Tandy, Tektronix, and Westinghouse.

However, some experts say such a program at this late date would be doomed before it started. "It's an object lesson in how the U.S. is losing its ability to manufacture hardgoods in competition with the rest of the world," grumbles William F. Schreiber, director of advanced TV research at Massachusetts Institute of Technology.

Still, such pessimism didn't deter NBC, GE/RCA Consumer Electronics, and RCA's former David Sarnoff Research Center (now part of SRI International) from unveiling yet another system—a hybrid that returns to the original 1,050-line proposal. What distinguishes the new entry, called Advanced Compatible TV (ACTV), is that present broadcast equipment could be used to produce both conventional and wide-screen pictures with somewhat enhanced resolution.

Ordinary TV signals would be beamed over regular channels, while the additional signals for widening the picture would be contained in a so-called "subcarrier" piggybacked onto the main transmission. Another supplemental frequency would convey information for filling in the extra 525 lines on future TVs, in part by "averaging" the lines above and below. Later, if the FCC allocates more spectrum space for HDTV, the full contents of the 525 in-between lines could also be broadcast. Developing the system over the past 10 years has already cost $45 million, and NBC Inc. figures that $30 million more will be needed to get it ready for the market.

LIGHT VALVES. A dark-horse hope for keeping a share of the HDTV business and preserving America's local-broadcast industry rests with William E. Glenn, former research vice-president at CBS Laboratories Inc. and now director of the New York Institute of Technology's Science & Technology Research Center in Dania, Fla. Glenn is developing a 1,125-line broadcast system based on radical "light-valve" electronics. It would eliminate the need for video tubes and cut the estimated costs of Japanese HDTVs and HDVCRs by half. With this technology, says Glenn, "it would be possible for America to go back in this business."

While those homegrown projects are still on the drawing board, the Japanese are greasing political skids in Washington. They have staged a series of HDTV demonstrations, including a standing-room-only gathering on Capitol Hill. One upshot: A blue-ribbon HDTV panel appointed by the FCC met for the first time on Nov. 17 and is slated to issue a preliminary report next spring. Some observers doubt the FCC can reconcile all the conflicting interests. As a result, the U.S. may "end up with an inferior signal," predicts Kenneth R. Donow, a senior analyst with Satellite Systems Engineering Inc. in Bethesda, Md.

Washington is coming to grips with this new technology none too soon. "In 1990," says Yuko Nakamura, Japan Broadcasting Corp.'s executive director of engineering, "an entirely new video culture will be born." The question is: Will the U.S. greet that milestone with will-o'-the-wisp policies that inflict second-best technology on U.S. viewers?

By Frances Seghers in Washington, with Neil Gross in Tokyo, Jonathan Kapstein and Joyce Heard in Brussels, Robert Block in Toronto, and Otis Port in New York

HIGH-DEFINITION IMAGE (above, transmitted by U.S. scientist William E. Glenn's system) and the same picture on a conventional TV screen: Will consumers be willing to pay the price for such compelling clarity?

PHOTOGRAPHS BY GERALD DAVIS

William Glenn: defining television's future

An FCC industry advisory committee has begun a two-year task to recommend the transmission system that appears destined to serve the United States for the next several decades at least. The key question: How much, if any, spectrum in addition to a conventional 6 mhz television channel will be required for broadcasters to compete with other television services in a high-definition age. One of the people responsible for the committee's existence is William Glenn

For about eight years Glenn has been developing an HDTV transmission system at the Florida research facility of the New York Institute of Technology. The VISTA (Visual System Transmission Algorithm) system would provide TV pictures asserted-ly equivalent to the 1,125/60 HDTV production standard, with 850 lines of vertical and 700 horizontal resolution and 5:3 aspect ratio, to American homes. But viewers of conventional NTSC sets watching the same transmission would get the same NTSC picture they have been receiving for years. This would be accomplished by transmitting with the 6 mhz channel and then augmenting the signal with an additional 3 mhz to 6 mhz channel from the UHF-TV band or some other spectrum source.

The VISTA system may sound familiar to those only recently following the advanced TV transmission debate. It is very similar to the two-channel ACTV (advanced compatible television)-II unveiled in computer simulation by NBC and the David Sarnoff Research Center during the National Association of Broadcasters convention last month.

"ACTV-II has a lot of our system in it," Glenn says. "The color processing and the way of removing cross-color and cross-luminance is basically our system and we have a patent on that. Also, the augmentation is basically the same." The Sarnoff lab, he says, has been combining the best ideas of several systems in the development of ACTV-I and ACTV-II. "The fact that their system is using our technology is all right with us, except that it doesn't give us a lot of recognition for having developed it. Royalty-wise, we get royalties that way just as well as if it came out in our system."

But unlike the NBC-backed system, NYIT's is hampered by a scarcity of funds. The institute's HDTV project, which has been carried out with a staff of about 20, is supported by small grants from broadcasting companies and organizations and by the school. Nevertheless, Glenn was able to claim development of the first two-channel transmission system to progress past the computer simulation phase by last month during a VISTA demonstration at the "Tomorrow's Television" HDTV room at the NAB convention. By the end of the year, prototype hardware of the complete system, including a VISTA camera, receiver and signal processor, are to be ready for field testing.

WILLIAM ELLIS GLENN—director, New York Institute of Technology, Science and Technology Research Center, Dania, Fla.; b. May 12, 1926, Atlanta; BEE, Georgia Institute of Technology, Atlanta, 1946; MS, 1949, and PhD, 1952, University of California at Berkeley; U.S. Navy, 1944-1947; research staff, General Electric Research Laboratories, Schenectady, N.Y., 1952-1967; director, applied research, CBS Laboratories, New York, 1967-1974; VP, director of research, CBS Labs, 1974-1975; present position since 1975; m. Karen Updegraff, June 8, 1980; children from previous marriage—Ross, 36; Doug, 34.

The Glenn system was designed according to psychophysical test results gathered by his wife, Karen Glenn. "We have basically measured what it is that your visual system can't see and then we leave that information out of the signal that is transmitted, as a way to save bandwidth," he says. Karen Glenn found that the optic nerve transmits color and detail to the brain much more slowly than it transmits motion information. Therefore, additional detail carried in the augmentation channel is sent at half the frames per second of standard TV pictures. This, theoretically, allows for transmission of the additional information in a 3 mhz rather than 6 mhz augmentation channel.

One of the biggest criticisms of systems such as VISTA and ACTV-II has been voiced recently by CBS's Joseph Flaherty (BROADCASTING, May 2), who cautioned that they may tend to perpetuate the artifacts of NTSC and that a completely fresh approach, not compatible with NTSC, might be the best road to follow. Glenn simply replies that the NTSC flaws have been eliminated. "I know we've removed them and so has the ACTV proposal." The main problems, he said, are cross-color and cross-luminance defects, which can be solved with pre-filtering of the signal along with a comb filter in the receiver.

Glenn's career as a scientist and inventor can be traced to his service in the Navy in the mid-1940's. He was the officer in charge of instrumentation in the resurvey of the Bikini atoll, one year after a nuclear bomb test there. The expedition was sent to find out "what radioactivity was left and what the long-term effects of the blast were," he said. "It was a fascinating expedition...a good chance to get to know the top scientists in a number of fields."

While attending graduate school at Berkeley, Glenn worked at the Lawrence Radiation Laboratory there. He was part of a team headed by Glenn Seaborg, who made several discoveries of heavier-than-uranium elements. "I was doing that work in his group when he won the Nobel Prize [1951]," Glenn says.

Years later at CBS Laboratories, Glenn worked with another Nobel laureate, Dennis Gabor, who won the award for physics in 1971 for his invention of holography. Because, according to Glenn, holography needs monochromatic light, lasers are needed to transmit it. Therefore, it is not practical for future use in broadcasting. However, other technologies are on the horizon, such as panoramic stereograms "that work like holography but do not have a lot of the limitations of holography," Glenn says. "That might turn out to be a useful technique in television."

Glenn had already been awarded two patents by the time he joined the General Electric Research Laboratories in 1952. He holds 96 patents today and several more are pending. Glenn inventions developed at GE included a thermoplastic recording system for color television, a form of film recording that had many of the advantages of videotape, such as immediate playback without developing, before tape was in widespread use. Glenn was awarded an Emmy in 1978 for a digital noise reduction system he designed at NYIT.

Glenn's greatest influence on the television industry may stem from his work in HDTV. It is an influence that he claims could do more than send better video to homes. He believes that the consumer television equipment industry, based on the traditional cathode ray tubes of NTSC technology, has been irreparably lost to Japanese and European companies. But in the solid state industry, the U.S. still holds the edge. "The thing is that high-definition television requires a much higher level of technology than standard television in terms of performance. I think that you can produce receivers that have better performance at a lower price by going to all solid state technology for the display as well as for the processing," he says. Semiconductors based on VISTA or some other American-developed transmission system, Glenn says, could be the opening America needs to win back the consumer market.

WALL STREET JOURNAL Circ. 1,952,000 8/24/87

Picture Perfect? Next Generation of TVs Promises Breakthrough in Image Quality

By JEFFREY A. TANNENBAUM
Staff Reporter of THE WALL STREET JOURNAL

Television sets of the 1990s promise supersharp pictures and superior sound on a reproportioned screen that is two-thirds wider than it is tall.

The future, it appears, lies in "high-definition television," or HDTV, a technology that broadcasters and set makers around the world are now developing.

High-definition television will have a near-total absence of the glitches technicians call "artifacts" that occasionally intrude on screens today—the electronic rainbows sometimes seen on plaid suits, for example. The change in screen design, or "aspect ratio," will enhance the visual drama in televised movies and sporting events, engineers say.

"When you see high-definition TV, you will be a believer; that's guaranteed," says Ted E. Hartson, a vice president and chief engineer of Washington Post Co.'s Post-Newsweek Cable Inc. subsidiary in Phoenix, Ariz. Says Paul A. Heimbach, engineering vice president of Home Box Office Inc., the Time Inc. cable subsidiary: "High-definition TV for the home is inevitable. It's the natural evolution of TV."

Problems to Overcome

The first high-definition sets are expected to reach the U.S. market no earlier than 1991 and initially cost between $3,000 and $4,000—at least until mass production and competition bring prices down.

But political and economic problems could delay the development of HDTV even longer. For one thing, there's a chicken-and-egg difficulty. "There's no point in putting out high-definition programs until there are high-definition receivers out there," says David J. Large, senior vice president for engineering for Gill Industries Inc., a cable operator based in San Jose, Calif. But manufacturers won't rush to produce receivers before high-definition programming is available.

The start-up problem is particularly acute for another reason. The most highly developed system now existing for high-definition transmission, a Japanese satellite system, is incompatible with conventional broadcasting.

The transition from black-and-white TV to color a generation ago was relatively painless, since black-and-white sets will receive color signals and display them without color. But signals from the new Japanese system can be received only on a high-definition television. And while high-definition systems that are compatible with existing sets are under development, they're farther from the marketplace than the Japanese system.

Even so, broadcasters have a powerful incentive to embrace high-definition television. Cable and videocassette programmers are likely to adopt an HDTV format whose high quality is expected to command even more of the viewer's time than cable and videocassettes do now.

Need for Bandwidth

The trouble is that a broadcast HDTV signal will require twice as much "bandwidth," or spectrum, as a conventional television signal requires. And broadcasters fear that there won't be enough bandwidth to accommodate both new conventional TV stations as well as high-definition broadcasting.

"Spectrum is a precious national resource, and there isn't a lot of it left," says Alexander B. Best, engineering vice president of Cox Cable Communications, a subsidiary of Cox Enterprises Inc. "In cable, we don't have that problem." Indeed, cable firms currently enjoy a surplus of bandwidth, which might be used for high-definition cable television.

> 'WHEN YOU see high-definition TV, you will be a believer; that's guaranteed,' says one industry official.

The Federal Communications Commission—which has yet to commit itself to providing the bandwidth needed for high-definition broadcasting—has frozen applications for television stations in 20 markets while it studies the allocation issue.

Several recent developments have quickened the television industry's interest in high-definition television. Victor Co. of Japan and its licensees have introduced improved, higher-resolution VCRs. While they don't match HDTV's quality, they do produce sharper pictures than current broadcast and cable signals do.

For another, sales of large-screen television sets, whose picture quality high-definition broadcasting could greatly improve, are booming. "Flaws in the picture really start showing up. It's like blowing up a snapshot too large," says Robert Hopkins, executive director of the Advanced Television Systems Committee, a standards-setting organization in Washington, D.C.

High-definition television owes its sharpness to its large number of electronic-scanning lines and dots called picture elements, or pixels. A high-definition signal broadcasts 1,125 lines and 1.5 million pixels per screen. The standard U.S. signal sends 525 lines and 212,520 pixels.

Lack of Standards

So far, however, engineers around the world have failed to agree on a single set of technical standards for high-definition television, or on a standard method of transmission. One reason is political. European manufacturers fear that endorsing a Japanese standard would give the Japanese a strong competitive edge.

"I'd guess it will be two years before people decide on all the details of a transmission standard," says William E. Glenn, director of New York Institute of Technology's telecommunications laboratory in Dania, Fla. His lab has spent about $3 million so far to develop a high-definition broadcasting system.

Even without a global standard, dozens of manufacturers, with Sony Corp. of Japan in the lead, are making equipment to produce high-definition programs. Within two years or so, the Japanese are expected to begin beaming high-definition television to Japanese viewers with home satellite receivers. Meanwhile, Mr. Glenn's group and several others in the U.S. and Europe are developing transmission systems, too.

High-definition television recorders and monitors are already used in a few studios in the U.S. and Europe to produce videotapes, usually as lower-priced alternatives to 35-millimeter film for commercials. Besides their lower cost, the tapes allow for more flexibility in special effects and editing. "High definition is as revolutionary as TV itself. It's the next big thing," says David Niles, owner of high-definition studios in Paris and New York.

Japanese manufacturers seem likely to introduce high-definition videocassettes or videodisks to American consumers in three to four years, whether or not the U.S. has developed an HDTV standard, along with the gear to play them. When that happens, people in the industry say, broadcasters and cable programmers will soon follow.

Some say that high-definition sets will take off as rapidly as VCRs and compact-disk players did. If they do, prices will come down quickly. But industry officials are betting that even the high initial prices won't faze many customers. Says Mr. Best, "If people will spend $15,000 for a car, they'll spend $3,000 or $4,000 for a TV of unsurpassed quality."