High Definition TV—The Television Standard(s) of the Future

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ABSTRACT

Why has the opportunity for a single, worldwide HDTV standard been lost? It would seem that a global format offers obvious benefits. But on closer inspection it becomes clear that disincentives for standardization abound. Consider, for example, what governments find most important: is more value placed on enhanced international communications through a common television standard, or on the development of unique, domestic HDTV technologies which bolster the local economy? Are countries attracted to the prospect of a single, global marketplace for advanced television products (offering enhanced economies of scale), or is such a benefit outweighed by fears of technical dependence on outside sources of innovation?

These are the types of questions which this research addresses. This paper places HDTV in an historical frame of reference by reviewing the international standards debates which have gone on before. Comparisons are drawn with the early competition between mechanical and all-electronic television formats, and, naturally, with the debate over color TV standards during the 1960s.

> There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain of success, than to take the lead in the introduction of a new order of things, because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new.[1]

Insightful words which have not lost their ring of truth since Machiavelli penned them in "The Prince." Indeed, the crusaders for high-definition television can attest to the difficulty of proposing a "new order of things." Technology, once again, is bumping heads with other forces in society.

High-definition TV (HDTV) brings the promise of cinema-quality pictures and CD-quality sound for television viewers of the 1990's and beyond. And the new technology promises applications beyond the home receiver: medical displays, computer imagery, engineering graphics, military surveillance and more. But to get the big picture you have to look beyond the picture screen. Many industry analysts predict that HDTV will create a stellar market for semiconductors, a strategic industry. Even more important, the spin-offs from the development of this emerging technology are expected to be essential to any region hoping to be a force in the global marketplace. The technology that HDTV is expected to breed may be more important than HDTV itself.

And for those non-believers who think that high-def will go the way of quadraphonic sound and 8-track tape players, think again. The HDTV ball is rolling and its momentum is unstoppable. Richard Wiley, past chairman of the Federal Communications Commission (FCC) and chairman of the FCC's Advisory Committee on Advanced Television (ATV) Service, has stated, "ATV in some form, is definitely coming to the U.S. in the 1990s. Only the details--the myriad of details--remain to be decided."[2]

One such detail to which Wiley alludes is the question of what standard the United States will choose for its HDTV service. The Japanese, for example, have been researching HDTV for at least 15 years and have provided the impetus for the introduction of HDTV service. With their production equipment already in limited use around the world, Japanese companies have been pressing since 1986 to have their HDTV format recognized as the global standard.

The European Community (E.C.) has responded in a knee-jerk reaction: finding itself behind the Japanese in technology development and concerned that it would not be able to catch up in time to capture a significant share of its home market for HDTV equipment, the E.C. has won a delay on the choice of a global high-def standard and bought time to develop its own HDTV format, one perhaps better suited to its own particular needs.

The American reaction mirrors that of the Europeans, but perhaps slightly more frantic. With only one domestic television manufacturer to its credit,[3] the U.S. has, belatedly, been the third major player to jump into the HDTV picture. Testimony before the House Telecommunications and Finance Subcommittee, which is exploring the implications of HDTV for U.S. industry, has warned of the impending economic disaster that will occur if American companies fail to gain a foothold in this critical technology.

Much as SECAM became a "national champion" for the French during the debate over color TV standards in the 1960s, HDTV has become the U.S. center of attention for meeting the Japanese and European industrial challenge.

Perhaps Dr. William Schreiber has said it most succinctly. Schreiber, head of advanced television research at the Massachusetts Institute of Technology's Media Laboratory, summed up his observations: "This is about jobs and money, not picture quality."[4]

Three regional players, three regional HDTV formats. What are the chances for reconciliation? Practically, there is only a brief window of opportunity during which a global standard can be agreed upon. After a certain amount of time, the financial and political investment which any country has made in its own communications technology prevents it from changing course and subscribing to a universal format. For HDTV, it would appear that the sands of time have run out.

And yet, this situation of multiple television formats is not without precedent. The early race between mechanical and electronic black-and-white TV led to different standards being established throughout the world. Years later, when three color TV formats competed for universal adoption, politics and economics intervened, and the global television picture became even more blurry. What are the implications of differing television standards? And, judging from its heritage, did HDTV ever really have a chance to unite the cathode-ray tubes of the world? A common high-def format would certainly uncomplicate the global television picture and might even aid international communications, but at what price?

> The focal point of the dilemma for each nation is the determination of the relative advantages or disadvantages of standards compatibility. Do the advantages of compatibility and the ability to communicate with other nations outweigh the advantages of incompatibility, the ability to protect domestic industries, or control broadcasts or information transmitted across national airwaves?[5]

WHAT IS HDTV?

The term "high-definition" television is somewhat ambiguous. For instance, a plaque on the wall of Alexander Palace, twelve miles north of London reads: "The world's first regular high definition television service was inaugurated here by the BBC. 2 November 1936."[6] Yet the pictures that were broadcast from the Alexander Palace studio were based on a standard of 405 scanning lines! Of course, compared to the 180 scanning-line system that was being used by the Germans, the British system was truly "high-definition" for its time.

For a modern television signal to be considered high-definition it must meet four criteria. First, a marked improvement in the sharpness or "definition" of the TV image. For example, the National Television Standards Committee (NTSC) standard currently being used in the United States uses 525 scanning lines to make up the broadcast picture. Most high-def systems being proposed use a minimum of one thousand scanning lines. A useful rule of thumb is that an HDTV system must approximately double the number of scanning lines that we are used to seeing in today's TV systems be-

fore it can be considered high-definition. Otherwise, the system qualifies merely as an enhanced-definition (EDTV) or improved-definition (IDTV) format.

This is an important consideration because the number of scanning lines in the television picture determine in great part the clarity of the images. However, there is a ceiling above which the addition of more scanning lines does little to improve the sharpness of the images as perceived by the viewer. Psychophysical research indicates that roughly 1,100 scanning lines is the optimum standard.[7]

A second important consideration is the aspect ratio, or ratio of width to height, of the television screen. The aspect ratio of current TV sets is 4:3. These dimensions were decided upon by the NTSC in 1936 and followed the same format used by movies at that time. Films later went to a more dramatic, wide-screen format, but by then television was locked into more narrow dimensions.

HDTV will change all that. Like its celluloid cousin, high-def will take advantage of a wider display area, generally in the range of 5:3. The emotional impact of the wider screen format should not be underestimated as it provides a more realistic viewing experience.

> Such a wide-screen display, coupled with the high resolution, provides a more natural interface with the eye, which accommodates a wider angle of view horizontally than it does vertically.[8]

A third criteria for true high-definition images is improved color rendition. The current U.S. television signal mixes the color information with the black-and-white information. The result may explain why NTSC is often humorously referred to as "Never Twice the Same Color." This composite signal, admittedly, has weaknesses in transmitting sharp, true colors.

Proponents of HDTV boast that its component signal comes close to duplicating the realism of color on 35 mm film. (The component signal keeps the color and black-and-white signals separate.) While Kodak might take issue with that claim,[9] the HDTV color picture certainly lacks many of the defects of its forebears.

Finally, television sound has always taken a back seat to the visual image--but, no more. The fourth advantage of HDTV will be digital audio, as crystal clear as that found on the popular compact disks that are making phonograph records obsolete. Today's TV audio is based on analog technology, meaning the signal is in the form of a sine wave which is more prone to defects and degradation. Using digital technology, the HDTV signal is coded through a language of ones and zeros that simply provides better and more consistent reproduction of sound.

THE PRICE OF PROGRESS

This is what makes high-definition television "new and improved." And while not everyone is dazzled by the changes that HDTV will bring, few would dispute that its arrival is written in the stars.

Julius Barnathan, president of Broadcast Operations and Engineering at Capital Cities/ABC, admits that, "Around here, we call [HDTV] the emperor's new clothes," adding in the same breath that such disrespect is regarded in the industry "like speaking against motherhood and progress."[10]

Meanwhile, some broadcasting critics contend that the television picture is fine as it is--instead it is the programming that needs to be tweaked. As one dissenting voice put it, "Having watched 'Dallas' and 'Morton Downey'... a little fuzziness is not only cheaper, but preferable."[11]

It would seem, however, that the steamroller of progress is not about to be stopped. In the case of high-definition TV, the skeptics are heavily outnumbered. Producer Barry Rebo, for instance, was one of the first devotees to embrace the new technology. Since opening an HDTV studio in New York in 1986, Rebo has shot more than 25 TV commercials, a documentary, and three shorts using Japanese high-definition equipment. And Rebo is not alone. HDTV productions have already been undertaken by CBS in the U.S. ("Littlest Victims"); RAI, the Italian network ("Julia and Julia"); and NHK, the Japanese public television network (coverage of the 1988 Olympics from Seoul, Korea), to name just a few. Even filmmaker Francis Ford Coppola has gotten involved and has prophesied HDTV as the arrival of "the electronic cinema."[12]

What Rebo and other high-def pioneers have learned is that HDTV is more than just super television: it combines the best image features of film with the convenience and technical advantages of video. Where this new nedium really excels is in creating exceptional special effects.

> HDTV's biggest impact will be cutting post-production costs by eliminating film and creating special effects. Normal TV cameras can't easily produce multiple-image trickery, because their fuzzier images won't fool the eye into blending two overlayed pictures into one. Those created with HDTV show no outlines of separate scenes.[13]

For example, producer John Galt was able to stretch a limited budget during the shooting of "Hello Suckers" (working title) for the Canadian Broadcasting Corporation by using high-definition TV. Special effects technicians used the medium to combine background paintings with live action to convincingly recreate the atmosphere of Montreal in 1919. As a result, HDTV made it possible for Galt to reallocate money that would have been spent on set design and location shooting, leading him to conclude, "I can't imagine being able to do this series in any other medium."[14]

The cost savings of shooting in high-def as opposed to film have been estimated to be about 15 percent.[15] That is, assuming a production company can afford the initial investment. Many of the early HDTV experimenters have taken advantage of loaner equipment, or production gear rented at favorable rates, which manufacturers were only too happy to make available for the exposure opportunity. When the time comes for station managers to actually purchase the new technology, some wonder if high-def's picture could be dimmed by the hefty cost.

Burnie Clark is an advocate of HDTV. As president and chief executive officer for KCTS-TV, the public channel in Seattle, Washington, Clark remains undaunted by the price of progress:

> While the purchase of this new equipment requires an estimated $750,000 investment for a camera and a one-inch VTR [videotape recorder], most experts believe the difference eventually will be reduced to 15 percent or 20 percent above the cost of our NTSC equipment. Clearly, the new technology could become both affordable and in demand as that narrowing of equipment costs occurs over the next few years.[16]

THE POTENTIAL IMPACT OF HDTV

The United States Department of Commerce (DOC) has taken notice of HDTV and recognizes that the new technology will bring more than just pretty pictures. According to a recent report by the National Telecommunications and Information Administration of the DOC, the United States represents between one-third and one-half of the total world market available for ATV-related receivers and videocassette recorders (VCRs).[17] The threat here is that unless the U.S. can mount a revival of its domestic consumer electronics industries, much of this potential market will be lost to foreign competitors.

The DOC has forecasted a representative growth path for the acceptance of HDTV consumer products by analyzing the past market histories of such items as home computers, stereo audio systems, large screen receivers and conventional color TVs. Using this technique, the DOC estimates that:

> ...one percent household penetration of these products might be achieved within 6-8 years after product introduction. Within fifteen years following introduction, the simulation indicates that over 50% of U.S. households may be using ATV products.[18]

The report continues that after twenty years of HDTV sales over 90 percent of U.S. families may own an ATV receiver, and almost 75 percent may also own a high-definition VCR. It is estimated that the annual sales of ATV products at that time will exceed $15 billion. [19]

> Price and consumer perceptions of the quality of ATV products will, of course, be instrumental in shaping the pace and pattern of household diffusion. Product prices will have to fall substantially from their expected introductory level [$2,500 for a receiver and $1,500 for a VCR] if high household penetration is to be achieved. However, the economics of ATV production are expected to display falling costs (from both scale and learning economies) over time and as market volumes mount. Extending recent historical trends in consumer electronics market behavior indicates the likelihood of continued growth of household expenditures on so-called home entertainment products and services. Continuation of this trend strongly suggests consumer buying patterns capable of supporting widespread and rapid diffusion of new ATV related household entertainment products. [20]

Even more important than the direct economic benefits that HDTV may bring through the sales of new receivers and VCRs is the ripple effect expected to impact other information technologies. The DOC has identified ATV and electronic visual technologies (EVTs) as "cornerstone" industries necessary to the infrastructure of the United States. Other markets expected to be affected by ATV advances include the computer industry, companies using computer and television display technologies (including medical and military imagery), videotex and videoconferencing applications, electronic publishing services, and, above all, the semiconductor field.

The semiconductor, which is used extensively in computers, is considered to be a key bridge between markets for HDTV products and other information age technologies. The inside of a high-def television receiver, in fact, will look more like a computer than a traditional TV set, stacked with circuit boards and a variety of memory and signal processing chips. It is estimated that a typical HDTV set will have memory capacity equal to the one megabyte of internal memory found in the Apple Macintosh Plus.[21] Because of the synergistic relationship between HDTV technology and the semiconductor field, large scale participation in high-def equipment development is expected to bring parallel advances in semiconductor materials and manufacturing processes.

HDTV provides American industry a brief opportunity to reenter the consumer electronics market and, thereby, bolster its interests in the semiconductor industry. The DOC report on advanced television lists a variety of advantages to U.S. involvement in the high-definition field:

> Scale economies in semiconductor production are more readily attainable in the presence of high volume demand from the consumer electronics sector;... the cost of R&D for a wide range of commercial, industrial and governmental applications [for semiconductors] can be amortized across the consumer-electronics driven base;... the fairly stable demand for consumer electronics products can provide insulation from the more volatile demand for semiconductors from other sectors...[22]

Additionally, the international trade implications of a rejuvenated U.S. electronics industry cannot be overlooked. During the past decade alone, a wide variety of new electronic products have been introduced and represent an ever increasing share of the world trade picture. HDTV represents the most recent addition to this line of products--an addition which will be with us for decades to come.

The potential size of the HDTV market in the United States makes it a plum target for consumer and professional sales. And the extent to which high-def products are manufactured domestically or imported from off-shore could have a significant impact on the composition and balance of the nation's trade account. The current weak position of the U.S. consumer electronics industry does not bode well for American involvement in the international ATV market.

> As projected from current trends and apparently differing national priorities, future participation of U.S. companies in domestic and foreign markets for ATV products clearly risks being next to negligible. Governments and industries in countries that we count among our major trading partners have clearly outlined and are pursuing coordinated strategies designed, in part, to capture dominant shares of

the U.S. market, while protecting home sanctuaries for their domestic producers.[23]

It should be pointed out that not everyone is in agreement on the competitive advantage which HDTV could provide to American electronics companies, and some openly protest its projected effectiveness. For example, a recent study by the Heritage Foundation, a conservative think tank based in Washington, D.C., discredited the HDTV effort as a "boondoggle" with little guarantee for success.[24]

The Congressional Budget Office (CBO) also casts clouds of doubt over the optimism attached to high-def proposals. The CBO has produced an analysis of the private forecasts used to promote support for HDTV involvement; its report specifically focuses on the claims concerning the market size for HDTV receivers and, secondly, the importance of HDTV in stimulating the competitiveness of U.S. electronics firms. Robert Reischauer, CBO director, summarized the findings while speaking before the Committee on Governmental Affairs of the United States Senate:

> Exactly how the HDTV market would change the competitiveness of U.S. producers is unclear. The entire world market for electronic equipment grew by $54 billion in 1988 to reach $461 billion. The world market for HDTV receivers and VCRs is forecast to be less than $30 billion (in 1988 dollars) by the year 2010. It seems counterintuitive to suggest that such a small market that may exist in the future is a more important driver of economies of scale, technology, and competitive success than is the growth in the present market. It would be a case of the tail wagging the dog. [25]

More recently, in an about-face--and in spite of the importance attached to HDTV in the aforementioned DOC report--even Commerce Secretary Robert Mosbacher has withdrawn support for a high-def initiative and shifted attention to government policies designed to improve the competitiveness of American industries across the board. A DOC spokesman explained, "What we've learned in the last six months is that there are a lot of other technologies that are equally important."[26]

It was to be expected that the early warning call sounded by high-def proponents would be tempered by opposing voices. As a result, conflicting figures continue to fly and speculative reports abound as concerned groups struggle fiercely to snatch glimpses of the future. The one finding, however, which all would agree upon is that HDTV is coming, regardless of any preparations made in the U.S. to take advantage of its arrival. And, if nothing else, this new technology bears significance by providing a test case for American efforts to restore national competitiveness in the world marketplace.

Global Television Standards

Joseph Flaherty, engineering vice president of the CBS Broadcasting Group, has referred to the multiple television standards that exist today as a 'television "Tower of Babel."'[27] And with good reason. In addition to the sixteen odd countries that still use a variety of different monochrome systems, the rest of the planet is further fragmented by three incompatible color formats: PAL (Phase Alternation by Line), SECAM (Systeme Electronique Couleur Avec Memoire), and the American system, NTSC. To complicate

the picture even more, some governments have chosen to implement variations on these three primary color TV standards, giving birth to at least eleven other different variations.[28] (Approximately nine countries have no television service.)

But there is a ray of hope on the horizon. In addition to providing an improved color TV picture, HDTV is important for the opportunity it presents as an umbrella format to unite the world's television sytems. If the PAL countries, and the SECAM countries, and the NTSC countries, and all the countries in between, can come together on the choice of a single HDTV format, then national boundaries would no longer present a barrier to international program exchange. Programs could easily be shared between Egypt and England, for example, or the U.S. and U.S.S.R., without having to go through an inconvenient and costly conversion process. Unfortunately, history has shown that technology allows only a short period of time for the politicians to catch up with the scientists. And if no international agreement can be reached, time marches on and the opportunity is lost.

> In practice, there is a brief temporal window for the establishment of a technical standard. If a standard is established too early, the technology involved may not have been refined sufficiently to match the current operational need. If the standard is established too late, manufacturers will have developed multiple formats, and users will have installed various and incompatible operating equipment. In such a case, neither manufacturers nor users will be willing to abandon their major capital investments in favor of a new standard.[29]

Common sense plainly shows that a single world television standard would be preferable to the present situation. For one reason, a larger marketplace for the sale of home receivers would drive down the price thanks to economies of scale. The larger the market for TV sets the greater the potential for sales, with the benefit that manufacturers can turn out sets for less. Increased global competition would also insure that the consumer gets the best price on his TV. These same economies obviously also apply to the production of professional studio equipment.

The cost of programs would also come down without the need for electronic conversion to different formats. The conversion process involves the use of expensive equipment that isn't always readily available. And anytime a television signal has to be run through additional electronic processing, some picture quality is bound to be lost. In addition, the financial cost of making format changes doesn't even take into account the inconvenience of having to arrange for special conversions. Taken as a whole, the necessity of conversion is a very real detriment to information exchange.

> Today, in addition to hundreds of thousands of hours of television programs delivered by domestic satellites throughout the world, more than 80 transponders are delivering over 50,000 hours of international television programs per year. Program exchange using videotape adds further to this volume of interchange. In this activity, the multiplicity of standards and the time and cost of standards conversion and its concomitant degradation in quality is an untenable situation as we prepare to enter the 21st century with the "Television of Abundance."[30]

Idealistically, the time couldn't be better to establish a single television standard. As the world is faced with a variety of problems manifest on a global scale--worsening pollution, overpopulation, the depletion of natural resources--international cooperation and communication are urgently needed to create a forum for discussion. An agreed-upon HDTV format would make it simply that much easier for countries to address common problems. To quote futurist Arthur C. Clarke, "If you share information, nobody gets poorer."[31]

(Then again, if the world's nations cannot come to an agreement on something as straightforward as a standard for HDTV program exchange, how can they be expected to tackle more trying problems like global hunger and growing illiteracy.)

There is another side to the debate over global TV standards. If, at first glance, the economic advantages to a single ATV standard would seem compelling enough to drive international agreement, look again. Economic disincentives abound. Consider the perspective of various countries with domestic patents on television sytems which may be rendered obsolete by the choice of a competing nation's technology.

> In such situations, the economic rewards from patent and license rights to a technology may be so great that a country simply cannot afford to sacrifice the economic interests of domestic industry in favor of the technical convenience of sharing another nation's standard. Moreover, differences in standards may provide a country with leverage to protect its industry from market invasion from the industry of another country.[32]

Differing television standards serve as nontariff trade barriers. Such a situation favors the domestic manufacturer who either owns the patent to the technology or is able to negotiate a more favorable royalty fee than that which is available to the foreign competitor. [33] Lower royalties translate into attractive pricing advantages for the home industry, which is already in a better situation thanks to lower product transportation costs. In addition, since the engineering know-how which produced the product is "homegrown," the company that designed the accepted television system often has a broader knowledge base than its competitors, giving it a technical advantage.

In an article entitled, "The Name of the Game, or How to Play Standards for Foreign Markets," Leon Podolsky sums up the advantage of using standards as nontariff trade barriers: "...Standards are the primary rules of the game. He who writes the standards specifies the terms on which the game will be played on his home ground."[34]

When a country chooses to back a domestic technology as its own standard, it, in effect, creates a home sanctuary for the industry. It also inherently creates the opportunity for foreign sales of the innovation. If the supporting government and industry representatives can convince other countries that their technology (and the format that it advances) is superior to that of their competitors, they will have created an outside market that their manufacturers can develop. Therefore, a unique domestic standard not only protects jobs and markets at home, but creates an opportunity for the export of products to other countries supporting that standard. In essence, the same advantages that the technology had on its home ground are now expanded beyond the nation's borders.

Unlike the development of international standards for many other commodities, the propagation of a country's television format brings with it double benefits: that is, the potential for trade in the hardware and the software involved. So, not only are there increased opportunities for the sale of TV sets but also for the sale of TV programs. Certainly other countries operating on different television standards are not technically barred from marketing their programs abroad; they are simply placed at a disadvantage due to the added cost of having to convert their shows to another format. Additionally, since a country's choice of a television standard is often influenced as much by political ties as it is by technical performance of the equipment, any nation accepting another's broadcasting format is frequently predisposed to the other's programming as well. Sharing a similar TV standard often implies an increased likelihood for the sharing of TV shows.

Taken together, the insulation of domestic markets from outside competitors, the profit potential of developing foreign markets, and, in the case of television, the double bonus for the sales of TV sets and programming, all work to discourage cooperative agreement on unified standards. But there are other barriers to global standardization that are not as easy to quantify. They are based more on emotions than they are on ecomonic criteria. And they involve a country's perception of reality as opposed to what that reality may actually be.

Consider that every country has a "mental image" of its position in the world--its own strengths and weaknesses; its competitive position when compared to other nations. Part of this "national consciousness" includes a fear of dependency. In other words, how much can one country afford to rely on another for its technical and scientific advances? What technologies need to be developed on home soil because they are too critical to be trusted to someone else? No country wants to be held hostage to the scientific advances claimed solely by another. And this leads nations to develop their own technical abilities rather than import the technology from abroad.

Another part of any country's "personality" is the desire for international prestige. Who owns the bragging rights to a particular invention? Who can lay claim to new scientific developments? Taking the lead on technological advances certainly brings economic benefits as well. But the importance of national pride or "self-esteem" cannot be passed over when considering obstacles to the acceptance of another country's proposed standards. The "psychological" barriers that compel a country to hold fast to its own technology often make international agreement on a single standard impossible.[35]

Each country, then, approaches discussions on global standards with its own list of pros and cons. Although worldwide acceptance of shared technical and manufacturing guidelines would bring lower production costs and better prices for consumers--not to mention some semblance of order--the chances for cooperation and agreement hinge on different countries' perceptions of what they stand to lose and what they hope to gain.

In sum, each nation approaches the issue of compatible standards with a parochial point of view. The determinations of whether it is necessary as well as desirable to adopt standards compatible with other nations will be based upon an evaluation of several factors involving the national interest. These include national

political strategy, national technical needs, public opinion, estimates of the value of the services, economic status, balance of payments, the costs of not agreeing, history, and experience. Once standards have been adopted, it is virtually impossible to change them. [36]

HISTORICAL REVIEW

Television truly has an international heritage. From its earliest years, experiments in "tele-viewing" have yielded a variety of systems across the globe, all vying for popular usage.

Each technological advance has brought competition for selection as the worldwide standard. And, every time, a lack of consensus has led to the establishment of multiple formats left to divide and conquer the world marketplace. So, today's debate over a common HDTV standard seems simply an extension of the pattern that has persisted during the evolution of the television medium and gives prophetic meaning to the quotation: "History teaches everything, even the future." [37]

Let's start with the question of who won the international race to invent television.

> Whether any one person can be declared the winner of that race is still a matter of debate and national pride. What is certain is that the roots of television go back more than a hundred years. From the 1880s, experiments in Russia, Germany, and the United States, France, and Great Britian paved the way.[38]

Part of the reason it is so hard to name one man as the sole inventor of television is that each new development, taking place at different locations arond the world, added another link in the chain needed to devise a complete, practical television system. Advances in technology were not independent but interdependent. For example, the cathode-ray tube (CRT), which was a key element in the design of an electronic TV display, was invented by K. F. Braun in Germany in 1897. In the early 1900s, building on the electronic methods evidenced in the CRT, both A. A. Campbell-Swinton (an Englishman) and Borris Rosing (a Russian) independently developed the principles that underlie today's television systems. However, it took the invention of the iconoscope by Russian emigree Vladimir Zworykin in the United States in 1925 to bring these principles to fruition. Zworykin had been a student under Rosing years earlier in Russia.

The fire of competition between inventors around the world was fanned as much by nationalistic zeal to develop the first public television service as it was by claims of superiority hurled back and forth by scientists supporting two opposing television standards: one was electronic and the other mechanical. It eventually became evident that the bulky size and poor performance of the Nipkow Disc, the main element of a mechanical system, left it at a severe disadvantage. However, by serving as an adversarial impetus to developers of the electronic system, proponents of the mechanical standard had hurried along implementation of the first practical TV broadcasts. The British Broadcasting Service went on the air using all-electronic equipment beginning

in 1936.

> The [electronic] system was completed by a brilliant group of scientists and engineers who, with massive financial backing, managed to produce it 5 or 10 years before it would have appeared in the normal course of events. It was not that the supporters of all-electronic systems wished to have one in operation as early as that. The driving force was provided by the supporters of an alternative, *mechanical*, system of television, which had been progressing independently of the electronic system.[39]

And so, the electronic system of television became the worldwide broadcasting standard; or, more accurately, became several worldwide standards. Although the electronic system had been found to be superior, different variations on the main technical theme actually went into operation. The British system used 405 scanning lines to compose the TV picture; the U.S. standard was 525 lines; in France, transmissions started on 441 lines and later were raised to 819 lines at the end of World War II; and the Dutch and Swiss promoted a system with 625 lines, which spread throughout the rest of Europe.

To further complicate the global black-and-white television picture, the systems implemented in Europe and North America were based on different frame rates because the two continents use different power line frequencies, 50 hertz in Europe and 60 hertz in the U.S. As a result, the American system broadcast 30 pictures a second and all the TV systems in Europe transmitted on a standard of 25 pictures per second. (This difference in frame rates still exists.)

And so it was that the electronic system of television gave birth to a family of international standards. At the time, the different TV formats didn't present much of a problem: domestic programming needs took priority and cross-border exchanges were infrequent. But the stage had been set for dramatic conflicts in the years ahead. A pattern for diverse TV standards was in place, and technical differences (like the various frame rates) were established that would serve as impediments to future cooperation.

A WINDOW OF OPPORTUNITY

The development of color television during the 1950s and early '60s offered countries another chance to unite under a single TV standard. While the British had been the first to introduce regular black-and-white service, the Americans led the way with color.

In late 1950, after considerable testing and debate, the FCC had chosen the Columbia Broadcasting System's (CBS) "field sequential" format as the American standard for color broadcasting.[40] The victory for CBS proved short-lived. This new system, which made use of a mechanical, spinning color wheel, was incompatible with existing black-and-white sets. In essence, this meant that viewers had to purchase new receivers if they wanted to watch any of the CBS color shows. (At this time there were over six million black-and-white sets in use.)[41] When sales of the new TV sets failed to materialize, leaving CBS with virtually no audience for its programming, it became

obvious that the "field sequential" system was doomed.[42]

About this same time, the Radio Television Manufacturers Association (RTMA) proposed that the National Television Standards Committee, made up of various industry representatives, be revived to develop consensus on the best color system to be implemented. (The NTSC was the organization that had led development of the American black-and-white TV format in 1940.) On December 17, 1953, the FCC changed course from its earlier decision and adopted the NTSC specifications, based on major contributions from the Radio Corporation of America (RCA) and Hazeltine, as the new color television standard for the United States. The new NTSC format was fully-compatible with existing monochrome TV sets.

As a result of the domestic race for a color standard, the U.S. had gotten a jump on the Europeans with the introduction of color television service. However, public demand for the new TV sets remained sluggish for about a decade. As one British writer noted in 1966:

> Indeed it has only been in the last two years [since 1964] that colour has really gotten off the ground [in the U.S.]. Last year over 2 million colour receivers were sold and all the major networks were offering colour programmes. It was this cold reception of colour which made the Europeans so wary of starting their own services, but an equally important factor was the relatively under-developed state of the black and white receiver market. Manufacturers were in no hurry to launch colour when they had not even achieved saturation level in black and white sales.[43]

Leading the way in Europe with color television technology was France. You could say it was fear that motivated the French to develop a domestic color TV industry--fear of economic and political domination by the industrially powerful United States. The French were, and still are, sensitive to technological and manufacturing advances from across the Atlantic. Their collective "self-esteem" had been bruised by repeated economic losses to the Americans, and their "national consciousness" was troubled by the perception of a growing dependency on the U.S. for strategic needs.

> It was a French ambition to become the scientific-technological leader of western Europe and large areas of the non-Western world. The American superiority in strategic technologies such as computers, aerospace, and atomic energy was distressing to the French and other Europeans, because these technologies were perceived as basic to industrial-military power in the contemporary world.[44]

Perhaps the most important event to convince the French of the growing U.S. technological threat was the weakening of their domestic computer industry during what came to be known as "L'Affaire Bull." Over a number of years, despite generous assistance by the French government, their primary computer manufacturer, Compagnie des Machines Bull, lost ground to its American rival, IBM. Finally, in 1964, a 49 percent share of the company was sold to another IBM competitor, the U.S. firm of General Electric, to provide a much-needed influx of capital. What had been an independent French industry became simply another victim of "American economic

aggression."[45]

The demise of Bull had economic and military ramifications. Bull had been expected to compete in the scramble to capture a large share of the blossoming computer market in western Europe. Additionally, the computational capabilities of Bull were necessary for development of "Force de Frappe," the French independent nuclear deterrent program. It was unthinkable that the nation should rely on outside sources of technical assistance to support its own military objectives. "L'Affair Bull" proved to be a powerful blow to both French pride and European efforts toward economic (and, indirectly, political) independence.

Urgently, the French began searching for answers to strengthen their economy and place them on more equal footing with the Americans. The government would not tolerate another embarrassing economic defeat, and a special committee was assembled to report on what steps could be taken to prevent the repeat of another strategic loss. An added incentive for quick answers was the protection and cultivation of a new patent for a color television technique invented by Henri de France. This new French technology became known as SECAM, and it promised a new presence in the field of electronics.

> In sum, the development of an independent electronics industry in France was found to be dependent upon several factors. Crucial to the success of a company was a French-owned patent, the industrial capability to produce it, and some control of the political, economic, and technical forces in the external environment in order to protect it. Protection of an industry was the key element. It was realized that the SECAM color television system fulfilled these criteria, and standards could be utilized as protectionist nontariff barriers to develop the French industry. The outcome of "L'Affair Bull" had been to dramatize the possibility of American domination of key sectors of the economy. To the French, SECAM represented one step toward preventing this from happening again.[46]

The patent for SECAM, the new French "national champion," was owned by the combined enterprise of Compagnie Generale de Telegraphe Sans Fils/Compagnie Francaise de Television, or CSF/CFT. In the past, it had not been uncommon for the West German firm of A.E.G.-Telefunken to enter into cross-licensing agreements with CSF, reducing mutual royalty payments as both companies shared in the development of new patent rights. But the French were determined to deny cross-licensing benefits for SECAM to A.E.G.-Telefunken. Made impatient by France's distant behavior, the Germans proceeded to invent their own color television system, known as PAL, which incorporated the best characteristics of both SECAM and NTSC. And where once France had had a potential ally for promoting SECAM to the European market, it now found a challenging competitor.

What followed was a mad rush by the French to garner support for their technology and isolate the new PAL system, hoping to force West Germany to discard its color television plans. The French first courted the British, whose BBC had come out strongly in support of American NTSC. When political differences prevented a SECAM partnership from taking hold, the French perceived they had but one slim chance remaining to salvage the European market. If they could lure the Soviet Union into the SECAM fold, they surely would carry the satellite countries as well. This would give the

French strength in numbers and a psychological advantage. In addition to swaying western European nations to follow suite, such a bold union might even convince West Germany to acquiesce because of its emotional ties to East Germany and a desire to keep lines of communication open. The Economist reported in February of 1965:

> No conclusive evidence has yet been produced that anyone in western Europe, apart from the French, is at all happy with SECAM. But the east Europeans are crucial: the French have made a massive effort to sell SECAM to the Russians, sending M. Peyrefitte no less, the Minister of Information, to Moscow with a high-powered industrial-cum-political delegation where the Americans, in their innocence, sent mere engineers.[47]

One of the American engineers who traveled to Moscow in December of 1964 was Dr. George H. Brown. Dr. Brown was a primary contributor to the development of the RCA compatible color television system which later became the basis for the NTSC color format. He also played host to a Russian delegation of scientists who came to the U.S. in March of the following year to observe NTSC in practical operation. It was during a demonstration of broadcast transmissions between New York and WNBW in Washington, D.C., that Dr. Brown, and his guests, first learned of the Franco-Soviet accord.

> The atmosphere in Washington was strained, for on our arrival we and our Russian visitors heard for the first time that Charles de Gaulle had just announced a gigantic trade agreement between France and Russia which involved oil and many other imports and exports and included an announcement by the Russian government to the effect that SECAM had been found to be so superior that it would be adopted as the Russian color television system.[48]

The strategic timing of this Franco-Soviet agreement had been fine-tuned for maximum political impact. For the very next week was scheduled a planning session for study groups X and XI of the Comite Consultatif International des Radio Communications (CCIR) in preparation for the Plenary Assembly to be held in 1966. The CCIR is the radio communication division of the International Telecommunications Union (ITU), which in turn is an agency of the United Nations. In addition to studying technical questions dealing with radio propagation, the CCIR is a forum for the discussion of problems related to television communications, radioastronomy and satellite telecommunications.[49] It was the assignment of Study Group XI that year to arrive at a consensus for a world color television standard, or at least a common format to be implemented in Europe. Participants at the meeting expressed outrage that the French would apply political muscle to force a technical decision favorable to SECAM interests.

> Delegates looking to expert evaluation of the three methods (NTSC, SECAM, and PAL) here in Vienna, for their strictly technical merit and operation possibilities and economics, declare themselves shocked by the Paris accord. They view it as a political-prestigue maneuver which can make these sessions meaningless. It also can delay the whole future of color TV in Europe.[50]

The chairman of Study Group XI, who was adamant about reaching a color television decision based on technical qualifications, declared in warning: "We are not

here for politics."[51] And yet, the politics which had begun before the first meeting even convened were destined to overshadow any decision that was to be made.

In an effort to mount an effective challenge to SECAM's Soviet bloc contingent, proponents of PAL and NTSC joined forces under the single banner of QUAM, for QUadrature Amplitude Modulation. QUAM was not a new color television system, but, rather, a tactical maneuver recognizing similarities between NTSC and PAL which made them easier to convert than either could manage with SECAM.[52]

When the smoke cleared, SECAM had collected twenty-one votes while QUAM registered eighteen.[53] And although SECAM had won a few more supporters, its backing had come largely from the communist satellite countries, which simply were not ready to install color television equipment. Meanwhile, QUAM (PAL and NTSC) had captured most of the western European market, with its greater potential for fast implementation. As a result, a stalemate was declared, and any decision on a world color TV standard was delayed until the CCIR Plenary Assembly to be held in Oslo in 1966.

George Brown was a delegate to the Oslo convention and summed up his thoughts: "If the whole affair had not been such an abysmal time waster, it would have been amusing to see pompous bureaucrats making resounding speeches that pretended to be technically based but were only thinly disguised political statements."[54]

The French, of course, were in attendance, only now proposing a family of standards designated SECAM I, SECAM II, and SECAM III. In addition, SECAM IV was mentioned with the caution that it was still in the experimental stage. The Russians also talked of their own system, referred to as NIR (an acronym for National Research Institute). But, as Dr. Brown relates, NIR proved to actually be "SECAM IV with a Russian accent."[55]

Although the Oslo meeting was intended as a final opportunity to develop common ground concerning a color TV format, what the delegates actually witnessed was a display of how the bonds of allegiance had grown stronger during the past year and positions in support of incompatible standards had become even more entrenched. The assembly could have aptly been described as being more frustrating than fruitful.

> Finally in desperation, the chairman asked a question which revealed a true state of affairs. "Are you in favor of a single system of color? If so, are you authorized by your government to change your vote?"
>
> The spokesman for West Germany conceded that he could change his vote only after returning to Germany to consult with and obtain the agreement of at least six agencies or committees of government and industry and this would take a minimum of one year. The British stated that they could not change their decision since it had been made at home in governmental committees and the delegation had no authority to deviate. Only the French solemnly declared that they had complete freedom of movement, as long as the system was SECAM III or SECAM IV. The Russians remained silent, perhaps because they regarded the answer to be self evident.[56]

And so, the "window of opportunity" for a global color TV standard had slammed shut. That is, of course, assuming there had ever been a chance for cooperation in the

first place. Unfortunately, the annual meetings of Study Group XI had proven ineffective as forums for technical debate and, instead, had been misdirected by political wrangling and behind-the-scenes maneuvering. The Oslo conference ended bitterly with various factions determined to move ahead with development of their own incompatible color television systems. And so it would remain for twenty years.

HISTORY REPEATS ITSELF

The place was Dubrovnik, Yugoslavia in 1986; the event was the 16th Plenary Session of the CCIR; and the heated discussions were reminiscent of the impasse that had occurred in Vienna and Oslo two decades earlier. What was at stake was no less than a new global standard for color television. This time high-definition television.

The Japanese had approached Study Group XI with a proposal that their high-def format, based on 1125 scanning lines and 30 pictures a second, be accepted as the world standard. The new system had been developed at the NHK laboratories in Tokyo at a reported cost of $100 million. Over fifteen years of research and testing had gone into the project, called Hi-Vision or MUSE.[57]

It is interesting to note that the Japanese position at this point bore strong resemblance to the American situation in the sixties. Back then, the Americans had been the leader in color television technology, far ahead of the competition, only to lose momentum and, eventually, large foreign markets for NTSC. Japanese industries could only hope that the American debacle was not a foreshadowing of things to come.

And, looking even further back in time, the NHK Hi-Vision technology has sparked interest in high-definition TV in other parts of the world, much as the early mechanical systems using the Nipkow Disc sped development of alternative electronic formats. Without a doubt, the Japanese have provided the forward motion propelling acceptance of high-definition television. And judging by the degree of activity on American and European drawing boards up to 1986, high-def would have stayed on the shelf a few years longer had the Japanese not pushed it so eagerly.

For all the reasons that American color television met with resistance in the sixties, Japanese Hi-Vision was likewise snubbed. According to an ITU news report released at the conclusion of the Dubrovnik meeting, the delegates "unanimously decided to postpone the taking of a decision on a standard at this time."[58] Visions of Vienna.

The U.S. State Department had actually come out in favor of the 1125-line/30-frame format, and it was primarily the European countries, led by France, that raised objections to global acceptance of the Hi-Vision system. They had several concerns.

Because of the long-standing difference between the European system and Japanese/American system in regards to frame rate (25 pictures a second as opposed to 30), countries that had been using SECAM or PAL felt that the NHK standard with a 30 frame per second display placed them at a disadvantage. Converting Hi-Vision programs to PAL or SECAM for broadcast to the millions of standard receivers already in homes would seriously degrade picture quality, delegates argued. Although the Japanese dem-

onstrated converters which produced PAL and SECAM transfers of good quality, the Europeans countered that the high cost of the equipment made it less attractive.

A more rational contention with Hi-Vision drew on concerns of economic and scientific dependency. Just as the Europeans had feared that NTSC service would portend a loss of domestic jobs and technology, the Japanese high-definition system was considered equally threatening.

> Great Britian, France, the Netherlands, and West Germany--which have large domestic television industries and produce both broadcast and consumer equipment--were not about to let the Japanese follow their takeover of the home videocassette recorder market by staging a coup in high-definition television.[59]

Although the CCIR meeting in Dubrovnik failed to produce agreement on a single format for HDTV, it did work to bring some countries together in common understanding. Within weeks, the European Community had initiated a $240 million cooperative project called EUREKA-95 HDTV with the sole directive that it produce an HDTV format for Europe. The joint program, led by the E.C.'s four big electronics firms--Philips (the Netherlands), Thomson (France), Bosch (Germany), and Thorn-EMI (Great Britian)--has kept busy six hundred European researchers from nine different countries perfecting a system that will be distributed by satellite to home receivers.[60]

Two more recent developments emphasize the E.C.'s commitment to a "domestic" high-definition standard. At the urging of French President Francois Mitterrand, a commercial marketing branch of the EUREKA program has been established to promote use of EUREKA-95 HDTV through projects such as the broadcasting of the 1992 Barcelona Olympic Games using the new format. Another assertive effort called MEDIA 92 provides financial assistance to help develop the production and distribution of new shows originating in the European Community.

Judging by the financial resources which the E.C. has invested in EUREKA-95, the marketing group, and MEDIA 92, it seems likely that the 1990 CCIR world summit will be less concerned with choosing a single high-def format than it will be on finding a way to reconcile the two incompatible systems advanced by the Europeans and the Japanese.

THE UNITED STATES

If formation of the investigative committee following "L'Affair Bull" in France in the 1960s indicated concern by that government over foreign domination of strategic industries, then today's proliferation of committees in the United States agonizing over the HDTV challenge must be diagnosed as extreme paranoia. Soothsayers abound warning of the impending crisis that will follow unless the U.S. moves ahead quickly on HDTV research. It would seem that the American reaction to high-def mirrors that of the French to NTSC in the sixties, only magnified.

Since the American delegation, led by the U.S. State Department, came out in favor of the Japanese Hi-Vision standard during the 1986 Dubrovnik assembly, the HDTV picture in the United States has taken on a somewhat different hue. On the home

front, the FCC has taken a new tack by outlining a set of domestic requirements that any American HDTV standard will have to meet. And while the NHK system can still be considered as a possible candidate for FCC approval, the commission has employed standards to put HDTV competition on more level ground, giving U.S. firms the chance to make a stronger showing.

> As HDTV designers from other countries looked on incredulously, the FCC declared that "any spectrum capacity needed for [a] broadcast ATV system will be obtained from the spectrum now allocated to broadcast television." But the clincher--setting the American HDTV system apart from any other in the world--was this: "Existing service to viewers using NTSC [standard television] receivers must be continued irrespective of the actual manner in which ATV services are delivered..."[61]

As a result of the FCC's "Tentative Decision and Further Notice of Inquiry" (NOI), announced in September 1988, American HDTV service must be possible from terrestrial broadcasting stations. (America has 1,300 such stations--far more than the E.C. or Japan.)[62] This is an important difference between the American and the Japanese and European services, which will be delivered by satellite.

Also, any American high-def standard must be compatible with existing home receivers, either by use of a truly compatible signal or by simulcasting the new HDTV signal along with the old NTSC signal. The tremendous public investment in 160 million home sets, colored by memories of the CBS "field sequential" flop in the 1950s, has made clear the importance of a compatible HDTV service.

The FCC's 1988 "Tentative Decision" is important because it signalled a division in American support for the Japanese standard and has led the way in promoting a domestic answer to HDTV requirements in the Unted States. Most recently, the Advanced Television Systems Committee (ATSC) and the American National Standards Institute (ANSI) have withdrawn their support from the 1125-line/30-picture format as a worldwide standard.[63]

On another front, testimony before congressional committees has spurred legislative action intented to foster an American technological response to the HDTV challenge. One report published by the American Electronics Association sums up the change in congressional awareness and attitudes which had occurred at that time.

> The majority of public debate a year ago [early 1988] viewed ATV singularly--only as an improved television technology. More today understand that it is a fundamental new imaging technology with long-term and far-reaching competitive implications. Television may be the market entry-point, but the ATV technologies predictably will migrate rapidly into spin-offs.[64]

What has followed is no less than the crowning of HDTV as a "national champion" for the United States with the expectation that this new technology will carry the nation atop its broad shoulders to a stronger economic position in the 21st century. For example, Representative Don Ritter (R-Pa.) recently sponsored the High-Definition Television Competitiveness Act of 1989 intended to promote HDTV development by

creating tax incentives and relaxing anti-trust laws in this area. And, of course, recognizing the importance that standards can play, the bill would also increase funding to the FCC so that a transmission format can be decided quickly.

During the hours of HDTV hearings that have taken place before congressional committees, a myriad of suggestions have been put forward as to how best encourage domestic technology to compete. And, not too surprisingly, the American response to HDTV resembles the French response to NTSC, merely transplanted in time and place. Take, for instance, the "Strategies for Solution" put forward by the American Electronic Association, which are quite similar to the Franco response after "L' Affair Bull."

> A comprehensive strategy for developing significant new U.S. presence in ATV markets includes plugging holes in the U.S. technology base, pursuing breakthrough innovations; building world-class manufacturing, component, and design infrastructure; *selecting and administering standards in a way that fosters development of a strong U.S. based ATV industry*; making lower cost capital available for manufacturing; and investing in "pump-priming" to boost programming (software) availability leading to creation of a substantial consumer base.[65] (Italics mine.)

Perhaps the greatest potential for HDTV lies in its ability to awaken American industry and government to weaknesses that must be corrected if the country hopes to maintain a position of strength in world markets, much the same way that "L' Affair Bull" prompted action by the French. Of course, the danger is that the United States might embrace HDTV as a panacea for its economic woes and fail to take action shoring up the complete industrial base. In its report on HDTV and the competitiveness of the U.S. economy, presented to the House Telecommunications and Finance Subcommittee, the Advanced Television Committee of the Electronic Industries Association warns against taking such a myopic stance:

> A fundamental premise of this Report is that competitiveness is primarily an economy-wide issue and is logically distinct from the competitive position of the nation's producers in a particular industry or activity. A corollary is that the most effective policies to improve national competitiveness must address broad-based problems, such as the low rates of national saving and investment, the high cost of capital, an inadequately educated and skilled workforce, and insufficient public support for generic or middle-ground R&D, all of which adversely affect private sectors across the industrial spectrum.[66]

CONCLUSION

It has been said that there are three sides to every issue: my solution to the problem, your solution, and the correct solution. That same approach seems to work well when confronting the on-going dilemma of global television standards. It was true with black-and-white TV, it held true for color, and it is a sure bet with HDTV. (Of course, the number of solutions multiplies depending on the number of formats being considered.)

The argument in favor of a world TV standard cites greater economies of scale

and increased competition which would drive down costs for home and professional television equipment. It also tends to draw idealistically on the advantages of a unified communications medium which would stimulate international cooperation.

Realistically, if countries want to solve multinational problems, they'll find ways to communicate, even if some countries use Hi-Vision while others use SECAM IV. Also, typically, countries lacking any new technology feel threatened by greater worldwide industrial competition. In response, they find it economically desirable to use standards as barriers to trade and as tools for delineating foreign markets. As a rule of thumb, whenever it is not financially advantageous for a country to agree to a single standard, quite frankly, they will use any excuse to cling to their own domestic format.

In reference to the fight over HDTV standards, Joseph Flaherty of CBS hit the nail on the head when he proclaimed: "Anyone who thinks this isn't an all-out economic war with billions at stake is singularly naive."[67]

And, yet, Flaherty is only half right, because what is at stake is both money and technology. Technology that tends to breed other new inventions (bringing in more money); technology that provides military superiority over others; technology that allows a nation to puff out its chest and stand tall with pride. Money may be at the heart of the matter, but control of technology is in the back of every country's mind.

That is not to say there isn't a way to develop agreement on a global television union. Although the opportunity may have past for HDTV, when holographic TV arrives in the year 2020 the CCIR needs to make an effort to promote a "third viewpoint" on the standards problem--one which is a compromise that all parties can live with. Of course, for that to happen, the CCIR will have to make some changes of its own.

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