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ABSTRACT

Broadcasters, television engineers and the production industry have encountered many problems with diverse television standards since the introduction of color television. With the advent of high definition television (HDTV), the chance to have a common production standard for international exchange of programs and technical information has returned once again. However, this seems to be impossible with HDTV developers in Japan, Europe, and the United States supporting different production standards. International cooperation would be a means of reaching a single world production standard for HDTV. Such cooperation would reduce the high costs of reinventing the systems and would unite many-sided experts and resources to search for the best standard. The payoff of this cooperation would benefit all parties as they could share a larger market and eliminate the costs of converting from one system to another. Licensing agreements, worldwide investment, research and development, and the formation of consortia are examples of cooperative activities that would lead to this end. (16 references) (DB)

INTERNATIONAL COOPERATION FOR A SINGLE WORLD PRODUCTION STANDARD OF HIGH DEFINITION TELEVISION

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Broadcasters, television engineers and the production industry have encountered difficulties from diverse television standards since the introduction of color television. With the advent of high definition television (HDTV), the chance to have a common production standard for international exchange of programs and technical information has returned once again. However, this seems to be impossible with various HDTV participants supporting many production standards. This paper proposes international cooperation as a means to reach a single world production standard for HDTV. International cooperation would reduce the high costs of reinventing the systems and would unite many-sided experts and resources to search for the best standard. The payoff of this cooperation would benefit all the parties as they can share a larger market and eliminate the costs of converting one system to another. Some suggestions for international cooperation include: licensing agreements, worldwide investment, research and development cooperation and the formation of consortia.

INTERNATIONAL COOPERATION FOR A SINGLE WORLD PRODUCTION STANDARD OF HIGH DEFINITION TELEVISION

"Every 30 or 40 years, we have a chance to unify standards. We now have that chance," said Joseph Flaherty, Vice President and General Manager of CBS Engineering & Development recently. Television broadcasters and engineers, program producers, program distributors and equipment manufacturers worldwide have encountered many problems with diverse standards since the introduction of color television. Billions of dollars has been wasted on converting one standard to another. International exchange of programs and technical information is difficult. A single world production standard for television is very desirable. With the advent of high definition television (HDTV), the chance to have a common production standard has come back once again.

High Definition Television

High definition television (HDTV) is an improved television with visual quality comparable to 35mm film and audio quality of a compact disc, with wider aspect ratio. More than 1,000 lines are needed to enhance definition as the images get larger. When more information is transmitted, more bandwidth has to be used. HDTV needs a 30 MHz bandwidth which is equal to five ordinary television channels.

HDTV affects the economy of other industries besides telecommunications. It is expected to drive the semiconductor

industry because the semiconductor is one of the major components of HDTV. Other industries that need high resolution visual imaging such as national security, computers, printing are also following HDTV progress closely. It is also important to consider that for imaging in medicine and for providing text materials for global learning, a uniform and substantially high resolution standard may be necessary. At present, some countries are already developing this new television technology.

Japanese HDTV Development

High definition television was first developed by the NHK (Japanese Broadcasting Corporation) with the cooperation of 11 or more companies in 1964. Initially, this project was called "Hi-vision" ("High Definition TV," 1988). So far, NHK has invested approximately $750 million on HDTV research and development and the private sector has joined the government to develop HDTV related products such as HDTV receivers and video cassette recorders.

The Japanese HDTV increased the number of lines from 525 in the present NTSC system to 1,125. The field rate, which is the number of pictures per second, was doubled to 60 fields per second, and the aspect ratio (width to height) was also increased from 4:3 to 16:9.

It would require 30 Mhz bandwidth to transmit HDTV signal by over-the-air broadcasting. This would be five times the 6 MHz bandwidth used in the NTSC standard. Thus, Japan plans to transmit

the signals via direct broadcast satellites (DBS) in 1990 using the MUSE (Multiple Sub-Nyquist Encoding) system to compress the signal to fit the 8.1 Mhz bandwidth. This transmission system is now in the experimental stage.

European HDTV Development

Following the 1986 International Radio Consultative Committee (CCIR) meeting in Dubrovnik, Yugoslavia, where European participants opposed the Japanese proposal to adopt the Japanese HDTV system as the single world production standard, 18 European countries, plus Iceland, initiated the Eureka-95 project to develop their own HDTV system. The project was jointly funded by the private sector and governments with an investment of more than $180 million. Eureka-95 is now led by Philips of the Netherlands, Bosch of West Germany and Thomson of France.

The European HDTV parameter is 1,250 lines, 50Hz field rate with aspect ratio of 16:9. The signal will be transmitted by direct broadcast satellites using HD-MAC system ("Eureka HDTV System," 1988).

American HDTV Development

Recently, the United States has begun to pay more attention to high definition development. The NBC and David Sarnoff Laboratories proposed the "Advanced Compatible Television" (ACTV) system with 1050 lines 59.94 field rate with the aspect ratio of 16:9. It doubles the current NTSC 525 lines. Considering the

importance of over-the-air transmission in the U.S., the Federal Communications Commission (FCC) ruled that any transmission system adopted in the U.S. must be compatible with the NTSC system. The FCC is now testing several HDTV systems. ("Testing," 1989).

Production Standard

Three different standards which are involved in the implementation of a high definition television system are the production standard, the display standard and the transmission standard (Iredale, 1989). The term "production standard" refers to the standard that determines the design of production equipment as well as the production of program material. The production standard is important for three reasons. First, it affects the costs for program producers to distribute programs worldwide. Second, it is significant to the international marketing of consumer electronics and production equipment. Third, it is likely that the transmission standard will follow the adopted production standard.

The transmission standard refers to the format which is adopted to transmit the signals to the receivers. The display standard is the way HDTV signal is reconstructed to create high definition visual and audio quality. In this study, only the production standard will be discussed because of its importance in the international arena.

For a very long time, television engineers and the production industry have hoped to have a single world production standard for

television. The different television standards used throughout the world since the introduction of color television has caused problems in transcoding and exchanging television programs. Transcoding from one standard to another results in the imperfect picture quality and the cost of doing so is very high.

Three transmission standards are in use presently: NTSC, with 525 lines and 59.94 field rate (525/59.94) is used in the U.S. and most of South America, Japan, Canada and Mexico; PAL (625/50) is used in most of Asia and Europe, Africa and Australia; and SECAM (625/50) in France and the USSR. No transmission standard is used as the world production standard, and for 40 years, the international television programming exchange has been taking place in the 35mm film format, which is shot at the rate of 24 frames per second.

The 24Hz frame rate of motion picture cannot be used for television transmission because it causes a sudden change in brightness (flicker). Thus, it is necessary to use an interlace technique to divide a frame into sequential fields so that the picture repetition rate will increase to the tolerable 50Hz to 70 Hz level (Schubin, 1988). The decision to use the 50Hz and 60Hz field rates is also tied to the power supply e.g. 50Hz for PAL and SECAM and 60Hz for NTSC since the circuitry and hum bars resulting from power supplies were stable and indistinct (Head, 1988).

The problem of different field rates now in use is the main issue in setting the HDTV production standard. Converting one rate

of motion to another would cause motion discontinuity or jumps in continued action. Thus, countries which used a particular field rate prefer to stay with their system while suggesting that other countries convert to their own standard. Each system has designed a converter e.g. the 1,125/60 system converter changed 60 Hz to 50 Hz by examining adjacent frames and then filling in new frames (interpolating) to smooth over discontinuities (Lu, 1985). Although it is possible to agree on a standard and simply use the system converter, many still believe that adopting a different system would mean purchasing production equipment and converters from the countries which design them.

Current Proposed HDTV Production Standards

The Japanese proposed the HDTV parameters of 1,125/60/16:9 as the single world production standard. This was also supported by the U.S. during the 1986 meeting of the International Radio Consultative Committee in Dubrovnik. This committee is an organ of the International Telecommunication Union (ITU) which will recommend the radio standards. However, the European countries turned down this proposal, claiming that the standard was not suitable for the European PAL and SECAM systems currently in use with 50Hz field rate. The Plenary Assembly of the committee agreed to postpone the meeting concerning this issue until 1994 so that the participants could research various standards in more details.

It is believed that the reason the European governments opposed the adoption of the 1,125/60 system is to protect their

own consumer electronics and production equipment industries since there was no proposal of a standard from the Eureka-95 project until 1987. (Poynton, 1989., "Eureka HDTV System," 1988).

The United States, Canada and many other countries supported the 1,125/60/16:9 production standard as a means to reach a single world standard. The American National Standards Institute (ANSI), the Advanced Television Standard Committee (ATSC) and the Society of Motion Picture and Television Engineers (SMPTE) accepted the 1,125/60/16:9 as American HDTV production standard which is also called the SMPTE 240M standard. However, the National Telecommunications and Information Administration (NTIA) has asked the industry to reconsider the production standard in terms of its relationship with the equipment and transmission standard because the new production standard would affect the sale of American programming all over the world.

Table 1 -- Current Proposed HDTV Production Standards:

	SMPTE 240M	Eureka-95	NBC/David Sarnoff
Total lines	1125	1250	1050
Active lines	1035	1152	966
Field rate	60	50	59.94
Interlace	2/1	2/1	1/1
Aspect ratio	16:9	16:9	5:3/16:9*
Status	Operational since 1986	Demonstrated in 1989	Proposed only

*ACTV-1 for 5:3 and ACTV-2, 16:9
Table adapted from Iredale (1989)

Iredale (1989) suggested some characteristics for the ideal world production standard:

1. It should be convertible to conventional film and video formats

and to the future HDTV emission formats.

2. It should offer a high degree of spatial resolution, enabling multiple processing steps for special effects and film production.

3. The standard should be flexible enough for digital technology.

International Cooperation

Although the single world standard is on every mind and the International Radio Consultative Committee meeting (CCIR) was meant to set one, there was apparently no sincere effort to take any ccoperative action on this issue at all. What happened is the effort to compromise by testing or voting for a single standard. By compromising, one party would have to lose the advantage to the other, causing difficulties to reach the agreement. Even if it is possible to vote or test to single out one standard, the proponents of other standards would leave dissatisfied with the results and could choose not to adopt that standard. During the last CCIR meeting in 1986 and the extraordinary meeting in 1989 in Geneva, each system tried to compete with each other by forcing a vote whether to adopt its own system ("U.S. gets its way," 1989). The Soviet Union is now holding a test for many production standards in order to propose a common production standard ("The Soviet," 1989). However, it is now widely believed that there will be no single world standard for HDTV.

Reasons for Cooperation

Cooperation is the best solution to the conflict of HDTV

production standard for these reasons:

1. Economically, cooperation can reduce costs spent investing in research and development for a very high cost technology such as HDTV because the participants can share the expense for the investment.

2. It is easier to unite manifold resources and experts from different parties through cooperation. Thus, the shortage of some experts and resources within the party is reduced.

3. Sharing the existing technology can save the participants billion of dollars in initiating new research for a particular system.

4. Competition will result in several different systems. Manufacturers thus have to design and produce many different kinds of products for smaller markets. This is what has happened with television consumer and production equipment such as video cameras for NTSC, video cassette recorders for PAL, and receivers for SECAM.

5. Cooperation results in a long term benefit for the production industry since any innovative system can be based on this single standard to develop a new standard easier. Different standards cause conflict in introducing a new standard.

6. International cooperation may inhibit nationalism in the sense that some countries would be known as the inventor for some standard. However, in the long run, people tend to forget or not to pay attention to this minor issue e.g. how many people know that NTSC stands for "National Television Standard Committee" of the

United States and that SECAM was invented by France?

7. Competition causes adverse psychological effects such as fear of the competitor. The Eureka consortium was seen as a way to boost up Europe's weak electronics industries to compete with the Japanese because the European Commission feared that " if the Japanese control the standard, they can overrun the market," ~ Thomson executive said ("Adding hustle," 1989). This competitive fear can inhibit cooperation. While some U.S. companies, e.g. LTV and Digital Equipment Corp., have been invited into Eureka projects, the head of Sony Europe, Jack Schmuckli wanted to join the projects but was not welcome to do so because Eureka is "designed to keep the Japanese out" ("Adding hustle," 1989).

Although advantages of cooperation are obvious, people still do not want to work together. In the HDTV case, most manufacturers tend to work on their own path. Each hopes that its own system would control the world market. Moreover, many HDTV proponents have invested millions of dollars to develop their own project and would not want to abandon that investment.

These views have inhibited creative ideas which can lead all the proponents to reach mutual gains. When one system is accepted, its opponents are likely to compete. Most manufacturers realize this fact and would prefer a single large market to a fragmented market resulting from different technical standards (Flaherty, 1989). From the cooperative point of view, multiplicity of ideas can disclose the strength and weaknesses of the conflicting standards. The initial investment from each proponent would not be

dissipated but would rather render the integral technology to enhance and speed up the implementation of a common standard. Dahlman and Westphal (1981) stated,: "The opportunity is least when the new process technologies must be mastered. It is much greater if the new activity simply involves applying known process technology to the production of a new product."

Some Suggestions for Cooperation

Cooperation for the HDTV production standard may be slow in coming since Europe and Japan have spent billions of dollars and many years inventing their systems. However, it is still useful to collaborate because both systems need improvements. Converting from the current 59.94Hz field rate to HDTV's 60Hz reduces picture quality, so does conversion from 1,050 or 1,125 lines to 1,250 lines or 1,050 lines to 1,125 lines. Research on these issues is still in progress. In the meantime, Eureka is still developing its 1,250/50 to reduce flickers during conversion. It is more beneficial if both major HDTV proponents would integrate their resources to build on the technology they are now developing, in the light of a single world production standard.

Here are levels of cooperative efforts that are worth considering:

1. Licensing agreements. Participants may sell or give their technology as a patent, rights or process design to their partners in exchange for some renumeration or technology that has not been developed (U.S. International Trade Commission, 1979). Usually, the

participants would agree to exchange for only particular elements of the technology (Dahlman & Westphal, 1981). For HDTV, participants might exchange of the testing results of various field rates. The advantages of the licensing agreements are that participants can focus on the weaknesses of their technology and utilize the strength of others to improve it, and that it would be a first step to lead to other levels of cooperation. The disadvantage is that the partners may take advantage of one another.

2. Worldwide investment. Joint investment is not a new idea. Several countries have contributed more than $2 billion to the U.S. space program for the past 25 years. The Office of Technology Assessment also expected that the cooperative effort could give developing nations "an opportunity to the pursuit of space technology and thereby ease current difficulties in the United Nations, and make international consensus on issues such as frequency and spectrum allocation easier to obtain." (U.S. Congress, Office of Technology Assessment, 1984).

The single world standard issue should be considered by other countries all over the world, not only Japan, Europe or the United States. Developing countries may be interested in participating or investing their resources to develop this world standard. This investment may be further developed in the manufacturing stage. For instance, some participants would manufacture some particular parts of the equipment while others assemble them.

3. Research and development cooperation. Sharing costs, experts,

and technology is occasionally indispensable to carry out a large-scale and complex innovative project, especially during the research and development stage. For instance, the Canadian government's expenditures to develop the U.S. Shuttle's remote manipulator arm was over $100 million. The European Space Agency (ESA) invested more than $1 billion on the Spacelab program. NASA believed that without this cooperation, "the choice was not a less capable American spacelab, but no Spacelab at all." (U.S. Congress, Office of Technology Assessment, 1984).

In terms of the common production standard, major industrial countries could invest in research and development on the field rate. The participants of this project should be as creative as possible in order to search for the new field rate that is not based on any system now in use. Some have already proposed 75 Hz or 80 Hz (Poynton, 1989., Lu, 1985). Iredale (1989) proposed the HD-PRO format which promoted the 1,500 scanning lines. These new production standards incorporate the strength of the former ones. The research and development on the issue would be helpful even if participants are reluctant to cooperate on manufacturing.

4. **The formation of consortia.** It is possible to form a worldwide consortium for research and development, as well as manufacturing HDTV equipment, following the pattern of Eureka projects -- a continental consortium of Europe. Eureka has been very successful in supporting Europe's weak industries. The governments help their big companies to work with the consortium and thus strengthen their countries' images. The ideal consortium would be a more global

joint venture from many individual companies, sometimes with support from their governments. First, each company could collaborate with academic researchers in its own country to develop the technology. This would eliminate the problem of the shortage of researchers which usually constrains international cooperation in research and development. Then, these companies would join and split the cost of some complex research and development. They will get something in return if they share their existing technological development of HDTV. The costs for each company would be less than the money it would have to spend developing its own technology. After they succeed with R&D, they could proceed to develop and manufacture HDTV related equipment.

The world's major industries are now utilizing the cooperative approach. More companies and government agencies are now working together to reach more fruitful results while the costs for research and development and manufacturing of new high-tech products increase tremendously, and almost no company can stand alone on their own feet. Japanese companies are now investing money in major university laboratories throughout the Unites States. Simultaneously, there are approximately 137 labs in Japan that are owned and operated by U.S. companies. Motorola has jointly produced memory chips and microprocessors with its Japanese rival, Toshiba Corp. Union Carbide has owned many laboratories in Europe and Asia. Eastman Kodak is investing in research and development internationally. ("Spreading the Risks," 1989). Furthermore, Zenith has recently agreed to cooperate with AT&T to develop HDTV

in America. Zenith will be responsible for the research project and circuit technology while AT&T will handle integrated circuits production. Both also plan to spend $24 million to develop HDTV receivers (Sims, 1989). The examples could go on and on. There are obviously powerful advantages behind this cooperative revolution.

Through cooperation, international partners for HDTV can establish a global production standard, reducing problems of incompatibility of production and consumer television equipment and thus saving insurmountable amounts of money to convert from one system to another during the next several decades. Hopefully, during the next International Radio Consultative Committee meeting instead of competitive approach, there will be some truly cooperative efforts where participants are willing to work jointly for a common production standard for HDTV.

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