Afterword

SMPTE Digital Video Activities — Achievements, Conclusions, Future Objectives

By FRANK DAVIDOFF

The SMPTE has taken the leading role in North America in studying digital techniques for program production plants and television studios. The initial use of digital equipment was in the form of digital black boxes, such as time base correctors and synchronizers, with composite analog signals as their inputs and outputs. These boxes were generally isolated digital devices in an analog environment.

When the SMPTE began work on a standard for the interface between adjacent black boxes, it was generally recognized that the digital processing should be based on the composite signal, rather than the component signal with its separate luminance and color difference components. Processing a component signal in these black boxes with analog inputs and outputs would have required decoding the input composite signal to its components and then re-encoding after processing. Such a repeated procedure would have resulted in unacceptable signal degradation.

In Europe, the European Broadcasting Union (EBU) groups studying digital video techniques were primarily concerned with a common digital standard for international program exchange, one that would be compatible with the composite coding preferred by the Phase Alternation Line (PAL) countries and the component coding required by the Sequential Color and Memory (SECAM) countries.

In 1979, there was a surge of interest in the coding for the all-digital television studio. Component coding has the advantages of higher signal quality, ease of complex signal processing, and the elimination of subcarrier complications in editing and other broadcast operations. The advantages of component coding led most engineers to prefer it for this purpose. Preliminary discussion exploring the possibility and potential of a worldwide unification was cleared with the officers of the EBU.

The SMPTE digital groups began talking about component coding at this time. They were concerned with a potential digital standard being considered by the EBU that might have precluded a worldwide, compatible digital standard. Because of these concerns, the SMPTE organized a Task Force on Component Digital Coding in February 1980. Its membership was drawn from the three other digital groups. Its principal charge was to act as a liaison with other organizations engaged in the same studies, and then to coordinate studies of component coding in the new technology committee.

The Task Force discussed basic questions relating to component coding and issued two brief documents on "Quality Objectives for Digital Television" (Appendix A) and "Worldwide Compatibility for Digital Television" (Appendix B). The Task Force also prepared a document on basic parameters of component coding which served as the basis for a United States CCIR* Study Group 11E submission to the CCIR in September 1980. One fundamental parameter, the sampling frequency for the luminance signal component, required further study. The choice of this parameter, in fact, has been the principal focus of the various studies and demonstrations during the past year in both Europe and North America.

Although the Task Force had been invited to witness various EBU digital demonstrations on the 625-line system, it was recognized that it would be necessary for the SMPTE to conduct a series of demonstrations on the 525-line system. The purposes, implementation, and results of these demonstrations are described by the articles in this special issue of the *SMPTE JOURNAL*.

To summarize, there was a slight increase in picture quality as the sampling frequency was raised from 12.0 to 14.3 MHz. There was an appreciable difference in picture quality at the different levels of the binary hierarchy. It appeared that either 13.5 or 14.3 MHz would fulfill the requirements of picture quality and chromakey, with the choice being made on grounds other than quality. The ratio 4:2:2 clearly appeared to be the appropriate quality level for the studio output and program exchange.

Immediately after the digital demonstrations in February 1981, the SMPTE met with the Bureau of the EBU Technical Committee to discuss the question of a common sampling frequency. Many members of the EBU favored a lower sampling frequency on the order of 12 MHz, but the consensus was that they would be willing to compromise on 13 MHz. The SMPTE favored 14.3 MHz but stated that they would consider a lower frequency if it would result in a worldwide compatible standard.

The EBU and the SMPTE agreed to cooperate in further urgent studies and to meet in March 1981 to attempt to resolve the question of sampling frequency. Mr. Peter Rainger, Chairman of EBU Working Party V, orga-

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nized Action Groups in cooperation with the SMPTE to investigate five areas of digital technology relating to the choice of a sampling frequency. The Task Force and selected members of the Working Group met with Working Party V in Brussels in March to review the work of the Action Groups. The result was the EBU statement that they would adopt a luminance sampling frequency of 13.5 MHz, provided it led to an international standard. The SMPTE Task Force also issued a statement (Appendix C) recommending to the Working Group, which is the body empowered to make the initial decision on a standard, that 13.5 MHz be adopted as the sampling frequency.

The Task Force reported the results of the Brussels meeting to the Working Group at their next meeting. Some members of the Working Group felt that an objection to the 13.5-MHz number would be that, during the transition period from analog to digital television, decoding the composite analog signal would be appreciably more costly (up to five times more) than decoding at 14.3 MHz. They felt that this factor would be more important than the benefits of a worldwide compatible standard. Accordingly, the chairman of the Working Group established a special subcommittee to study the effects of decoding at the two different sampling frequencies.

This subcommittee included specialists from the United States, Canada, Japan, and the United Kingdom, thus bringing the best current knowledge to bear on the critical questions of National Television System Committee (NTSC) decoder complexity variations with sampling frequency and required performance level. The report indicated that a fairly sophisticated decoder would be required for professional use. Also, if a 13.5-MHz sampling frequency were chosen the complexity of the decoder would be increased— by an amount between 0 and 10 percent— dependent on the performance level selected. The report showed a similar trend for the NTSC encoder, with a possible increase in complexity of up to 12 percent.

With this new input, the Working Group was able to balance more precisely the compatibility requirements for NTSC with those of worldwide compatibility and, after some consideration, the majority of the Working Group voted in favor of a recommendation to the United States Study Group (USSG) 11E for CCIR that 13.5 MHz be supported as the sampling frequency for luminance, with the expectation of achieving a worldwide compatible standard at that frequency (Appendix D).

The United States CCIR 11E Study Group has distributed a draft document prepared by its members, which is supported by the experts in the SMPTE Working Group. Other organizations, such as the Technical Committee of the North American National Broadcasters Association (NANBA) and the Engineering Advisory Committee of the National Association of Broadcasters (NAB), also advised the 11E Study Group and the SMPTE Working Group of their preference for 13.5 MHz as the luminance sampling frequency. (The pertinent parameters of the United States CCIR draft document are extracted for information that is given in Appendix E.)

At the meetings of the SMPTE Working Group discussed above, the Japanese Ad Hoc Study Group submitted documents indicating its preference for 14.3 MHz as a sampling frequency. It was clear that an exchange of opinions would be helpful to both the Japanese and the SMPTE Groups. An invitation was issued to the SMPTE and EBU by the Japanese Ad Hoc Digital Group to meet in Tokyo in May 1981. An SMPTE/EBU delegation met at that time with the Japanese group and exchanged views and information. A joint statement (which is given in Appendix F) was issued summarizing the results of the discussions and stressing the importance of achieving a worldwide compatible digital standard.

Further work on digital technology will take place in the near future by interested parties all over the world. The SMPTE digital groups will begin to discuss more detailed parameters necessary for a realistic digital standard. The CCIR interim meetings in Geneva in September 1981 will discuss the question of sampling frequency and other parameters on a worldwide basis, and will hopefully achieve agreements that can be used as a foundation for national standards. The SMPTE will continue to offer an open forum for resolving engineering and technical issues will offer leadership in the documentation of specifications, and will encourage the exchange of views with other organizations so that those who follow standard practice may enjoy the benefits of worldwide compatible digital television.

Appendix A

Quality Objectives for Digital Television Statement by the Task Force on Component Digital Coding of the SMPTE, August 27, 1980

Digital Television standards for 525 line/60 Hz and 625 line/50 Hz systems must be subjected to critical examination prior to adoption if they are to endure 20 to 30 years as have our current analog standards. Because of rapid technological advances in the past and anticipated advances in the future, it is imperative that digital television standards have flexibility for growth. This growth can be accommodated with a hierarchy of standards.

Different levels of user needs can be anticipated today. The highest quality level in the hierarchy would be used for the most demanding production requirements. Since it is expected that radiation standards will remain as they are in the near future, and since it is expected that the most demanding production requirements will result in a quality which exceeds radiation capability, a lower quality level in the hierarchy could be used in a broadcast facility where bit rates are a greater concern. Furthermore, there will be occasions when quality is not of prime importance but the bit rate is an overwhelming factor. In such situations, still lower quality levels in the hierarchy are justified. A digital television standard, to stand the test of time, must accommodate divergent needs.

The Working Group was able to balance more precisely the compatibility requirements for NTSC with those of worldwide compatibility. . . .

A hierarchy of standards which can be conveniently derived from one another may satisfy these needs. Such a standard must be based on component coding with co-sited luminance and color difference samples. The number of samples of the luminance and color difference signals must have an integer relationship. Because of interest in production, the highest quality level in the hierarchy must have sufficient bandwidth for downstream chroma-keying, picture expansion, etc., and should provide a margin for future requirements. The hierarchy levels

must be simply related permitting ease of translation from one level to another. Obviously, the quality level of a signal originating in a lower level in the hierarchy will not increase as it is converted into a higher level in the hierarchy, but this translation will be required in many cases to integrate various inputs into one production.

Appendix B

Worldwide Compatibility for Digital Television Statement by the Task Force on Component Digital Coding of the SMPTE, August 27, 1980

There are two major television scanning systems currently in use, the 525 line/60 Hz system and the 625 line/50 Hz systems. It is anticipated that these systems will remain in use for the foreseeable future due to the large number of receivers installed. Digital television coding formats must accommodate the needs of these two separate scanning systems. At the same time, digital television offers an opportunity to minimize the differences in the studio, accomplishing a greater degree of compatibility than has existed in the past.

It is not envisaged that an appropriate choice of coding formats would remove the problems of the 50- and 60-Hz field rates. Standards conversion would still be necessary for program exchange. Standards converters presently have a satisfactory performance; the coding formats need not be chosen to minimize the technical difficulty of the relatively small number of machines that are required. However, optimizing coding formats so that only minor differences are encountered in equipment meeting the different scanning requirements has potential for more cost-effective equipment. In particular, achieving a minimum number of differences between 525/60 and 625/50 coding formats could lead to videotape recorders that operate in both environments.

When seeking worldwide compatibility, the goal should be commonality of equipment, not uniformity of standards. This leads to compatibility of standards from an operational, rather than a technical, point of view. To achieve this compatibility, studies must be made of various types of equipment (production effects, VTRs, distribution) to determine optimum coding formats.

Appendix C

Statement on a Digital Standard

The SMPTE Digital Task Force and selected members of the SMPTE Digital Working Group have attended a joint meeting with EBU Working Party V on the subject of digital parameters at which presentations were made by various Action Groups and comprehensive discussions took place. The selection of a digital standard involves many factors and a degree of compromise is necessary to achieve agreement in the presence of differing opinions.

Working Party V has decided to recommend a luminance sampling frequency of 13.5 MHz to the EBU Technical Committee with the understanding that this will lead to a worldwide compatible standard. If agreement on this frequency cannot be reached, they may choose a lower frequency which is preferred by several of their members.

We have determined that there is no possibility of the EBU agreeing on a 14.3-MHz sampling frequency. Because of the importance of a worldwide compatible digital standard, the consensus of the individual experts of the Task Force and Working Group present at the meeting with Working Party V is to recommend that the Working Group propose a luminance sampling frequency of 13.5 MHz at a 4:2:2 quality level as the basis for North American* contributions for a digital standard to the CCIR.

Appendix D

SMPTE Statement from the Working Group on Digital Video Standards to United States Study Group 11E *Re:* CCIR Recommendation AA-11 May 6, 1981

The Working Group on Digital Video Standards of the SMPTE recommends support of the CCIR draft Recommendation AA-11, including Recommendations 1 through 6.

In addition, the Working Group recommends a specific sampling frequency of the luminance signal of 13.5 MHz as the most logical choice for achieving a worldwide digital video standard for studio operations. In the event that agreement on an international standard cannot be reached by the end of the current CCIR cycle, the SMPTE may wish to reconsider its position.

The Working Group has determined that this sampling frequency is acceptable from the standpoint of picture quality and constitutes an acceptable balance between compatibility of 625- and 525-line systems and ease of interface of the 525-line digital system with the current analog composite NTSC system.

* *Note:* an editorial correction was made to clarify jurisdictional responsibility.

Appendix E

Extract from United States CCIR Study Group 11E Draft Document: Encoding Parameters for Television Studios Using a Worldwide Compatible Digital Code

1. Component Coding: The digital coding should be based on the use of one luminance and two color-difference signals; or red, green and blue signals.

2. Extensible Family of Compatible Digital Coding Standards: The digital coding should allow the establishment and evolution of an extensible family of compatible digital coding standards. It should be possible to interface simply between any two standards of the family. An example of such a family is the one in which all the luminance and color-difference sampling frequencies possess simple numerical relationships such as 4:4:4, 4:2:2, 4:1:1, and 2:1:1. The level of the family to be used for the standard digital interface between main digital studio equipment and for international program exchange shall be 4:2:2.

3. Spatially Static Sampling Pattern: The picture sampling pattern should be spatially static. For that level of the family to be used for the standard digital interface between main digital studio equipment and for international program exchange, the sampling pattern should also be orthogonal.

4. Spatial Co-siting of Samples at Each Level of the Family: If the samples represent red, green, and blue signals, they should be co-sited. If the samples represent the luminance and two simultaneous color-difference signals, each pair of color-difference signals should be co-sited.

At that level of the family to be used for the standard digital interface be-

tween main digital studio equipment and for international program exchange, each color-difference sample-pair should also be co-sited with a luminance sample.

5. Spatial Co-siting of Samples at Different Levels of the Family: All samples at any level of the family should be co-sited with luminance samples at the highest level.

6. Compatible Number of Samples Per Line: The number of samples per line for all television systems should be compatible. (For instance, there may preferably be an equal number of samples per line.)

7. Sampling Frequency: At the level of the famly 4:2:2 to be used for the standard digital interface between main digital studio equipment and for international program exchange, the sampling frequency of the luminance signal shall be 13.5 MHz and the sampling frequency of the color-difference signals $(B - Y)$ and $(R - Y)$ should be 6.75 MHz. For the luminance signal that is equivalent to 858 f_H for 525-line systems and 864 f_H for 625-line systems. Sampling frequencies at other levels of the family shall be derived from the binary relationships specified in paragraph 2.

8. Encoding Methodology: The samples should be encoded using linear, pulse-code-modulation (PCM) employing positive binary coding for the luminance signal (Y) and offset binary coding for the color-difference signals $(B - Y$ and $R - Y)$. Positive binary coding should be employed if the samples represent red, green, and blue signals. Each video sample should be represented by eight bits.

Appendix F

Meeting on Digital Television SMPTE/EBU/Japanese Ad Hoc Group (Joint Statement) May 14, 1981

The Japanese Ad Hoc Study Group on Digital Video hosted delegations from the European Broadcasting Union and the SMPTE at the NHK Technical Research Laboratories in Tokyo for two days of discussion on the subject of digital video. OTI (Ibero-American Television Organization) was also represented in the discussions.

Through discussions and exchanges of documents, the four groups were able to obtain a clearer understanding of the various views concerning the evolution of digital technology in the television field.

The participants discussed the important technical parameters of future digital television systems and the approaches that might be followed to bring such systems into use.

In the meetings the importance of achieving a worldwide compatible standard for digital video was stressed.

As new results are obtained from the continuing work in the various organizations, it is anticipated that further discussions and exchanges of information will take place among these groups.

Fay Kanin Guest Speaker at SMPTE Conference Luncheon

Fay Kanin, President of the Academy of Motion Picture Arts and Sciences, will be the guest speaker at the SMPTE Honors and Awards Luncheon, it was announced by SMPTE President Charles E. Anderson, Ampex Corp.

The luncheon will be held Monday, Oct. 26, at the Beverly Hilton Hotel in Beverly Hills. The luncheon is part of the 123rd SMPTE Technical Conference that will run from Sunday, Oct. 25, to Friday, Oct. 30, at the Century Plaza Hotel in Los Angeles. Bus service will be provided from the Century Plaza to the Beverly Hilton for the luncheon.

That luncheon will feature the presentation of SMPTE awards that recognize outstanding achievements in motion pictures and television and in services to the Society. SMPTE President Charles E. Anderson will preside at this major SMPTE event and will introduce the guest speaker.

Fay Kanin is well known for her writing—for the screen, Broadway, and television. Some of her most recent credits include writing and co-producing "Friendly Fire," an ABC drama and winner of the Emmy Award for Best Television Film, winner of the Best Television Film Award from the San Francisco Film Festival, and nominated for a Humanitas Award; "Hustling," another ABC drama special, written by her, which was nominated for an Emmy and won the Writers Guild Award for Best Original Drama; and "Tell Me Where It Hurts," written by her for CBS, for which she won an Emmy and Christopher Award.

Among her many feature film credits are "Teacher's Pet," with Clark Gable and Doris Day; "Rhapsody," with Elizabeth Taylor and Vittorio Gassman; and "The Opposite Sex," starring June Allyson. She wrote all of these films with her husband, Michael Kanin.

Included in her writing credits is a stage version of the award-winning Japanese film, "Rashomon." This play, which was co-authored by Michael Kanin, has been translated and performed in theaters throughout the world.

Kanin, as a member of the Academy of Motion Picture Arts and Sciences, has chaired the Writers Branch Executive Committee and the Policy Committee on Rules. She has served as a member on both the Borowsky Lecture Committee and the Academy's Special Projects Committee.

Kanin was first elected to the Academy's Board of Governors in 1974, and has remained a Board member since then, with the exception of only one year. In 1979 she was elected president of the Academy, the second woman ever to serve the Academy in such a capacity.

In addition to her years of involvement with the Academy, Kanin is a former president of the Screen Branch of the Writers Guild of America and currently is a member of the board of trustees of the American Film Institute.