

SMPTE Demonstrations of Component-Coded Digital Video San Francisco, 1981

By KENNETH P. DAVIES

Background

For some time, the SMPTE has recognized the increasing importance of digital techniques for the processing, recording, and transmission of television signals. The initial response to the obvious need for a forum in which to discuss this emerging technology was the formation of the Study Group on Digital Television late in 1974. Charles Ginsburg has chaired this group since its inception. In the ensuing six years, the Study Group has investigated many areas of digital television technology.

As the technology matured and significant amounts of digital video equipment came into the marketplace, it became clear that standardization activity was required. The Society met this need by establishing the Working Group on Digital Video Standards in March 1977. Their goal was the preparation of recommendations for interface standards for 525-line television. This Working Group was initially chaired by Robert Hopkins. Its first task was the development of standards based on the encoding of the composite NTSC signal. However, as further studies took place, both within the Working Group and elsewhere, it became apparent that a standard based on the encoding of the video components might be a better approach. Since the latter part of 1979, the development of such standards has been the focus of activity.

In addition to the above groups, the

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Society found early in 1979 that there was a need to provide direct broadcaster and other user input early in the development of recording hardware for digital technology, and so established a Study Group on Digital Tape Recording. This group, now chaired by William Connolly, has conducted a users survey and is investigating the complex interaction between various components of digital recorders. Concurrently, the previously informal interaction with other groups engaged in digital video work, such as the New Technology Committee and the European Broadcasting Union (EBU), was formalized into a Task Force on Component-Coded Television in February 1980 under the chairman-

ship of Frank Davidoff. The Task Force of twelve especially selected experts acted both as liaison to other organizations and represented the various SMPTE groups and 525-line television users in the development of worldwide compatible standards for digital video. They also acted as a specialized steering committee to the digital groups in the New Technology Committee.

It was apparent in all this activity that the theoretical work generated by these four groups and the work sponsored by others outside the SMPTE would need to be proven in practice. A similar view was held in Europe, where it was suggested to examine the practical aspects of the 625-line proposals.

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This need culminated in a series of demonstrations in Europe in April 1980 to review and evaluate an EBU proposal of 12:4:4 for a component-coded digital video system. The SMPTE Task Force was invited to witness these demonstrations. Shortly thereafter, the Task Force recommended that the Working Group organize a series of demonstrations of component-coded digital video on the 525-line standard and scheduled it to precede the February 1981 SMPTE Television Conference in San Francisco. The challenge was accepted, and formal invitations were extended to manufacturers, suppliers, users, individual experts, and especially to the EBU Technical Bureau and its constituent organizations to participate in these demonstrations.

Objectives

The Task Force met late in May 1980 and faced the dual challenges of defining the demonstrations and finding the digital hardware and the associated operational infrastructure. The time frame allowed only eight months before the scheduled opening date to compile a "shopping list" that would be reviewed by the Study Groups and the Working Group. The Task Force recommended the inclusion of several priority items:

Picture Quality. How does it vary with sampling frequency and luminance/chroma ratios?

Hierarchy. What are the effects of conversions in a binary hierarchy on picture quality?

Chroma key. What are the basic signal requirements for good chroma keying and how do they relate to sampling frequency and chroma ratio?

NTSC Interface. What difficulties arise in transferring an analog NTSC signal into and out of a component digital environment, and what are the most effective methods?

Common Carrier Interface. How might a component-coded video signal best be transmitted over common carrier digital facilities and what would be the effects of that transmission?

Filters. What kinds of filters would be required in the "all-digital" studio and in transitional studios, and what constraints apply to them if they are implemented in digital or in analog form?

Digital Tape Recorder. How practical is the recording of component digital video signals at high bit rates and what appropriate technology would permit it?

The demonstrations would serve to provide data on these questions for the 525-line standard and to evaluate the possibilities of a worldwide compatible standard for both 525- and 625-line operation. In subsequent meetings of the other Groups and of the Task Force, it was agreed that the demonstrations would be in two parts to make them both educational and technically rewarding: (1) a series of formal picture-quality assessments using CCIR/EBU recommendations to gather firm data, and (2) a program of presentations to show the results of this work, the performance of the various proposals, and their limitations. It was also agreed that the demonstrations would employ the line-locked sampling rates of 768, 864, and 912 samples per line, which were felt to adequately span the area of interest. Interface arrangements were set up using luminance (Y) and color difference ($R - Y$, $B - Y$) signals for the digital connections, and R , G , B , and S (red, green, blue, and sync) primary signals for the analog component connections, with composite NTSC used where necessary.

Implementation

From the beginning, the demonstration project was well supported by the members of the Society, the members of the various committees and by sponsoring organizations — by those with a direct interest in digital technology and by those with an interest in supporting the standards work of the Society. This allowed the Working Group on Digital Video Standards to fulfill its charge to implement, operate, and report the demonstrations in all the expressed areas of concern except those of common carrier interface and filter technology. Subsequently, these concerns were adequately clarified by work in EBU demonstrations and in joint SMPTE/EBU discussions. The need for support equipment (cameras, scanners, distribution equipment, monitors, recorders, etc.), and for a suitable location for the work, were adequately met by sponsoring organizations from the U.S., Canada, Japan, Belgium, France, and the U.K. The need for specialized digital video experiments, forming the heart of the

demonstrations, was fulfilled by four organizations, and thirteen others filled the remaining specialized and conventional requirements.

In designing the demonstration installation, the Working Group had two main objectives: production of test sequences and production of demonstration presentations.

(a) *The production of the test sequences for the subjective assessments.* It was necessary that this activity be done in real time, and so it required close coordination of the experiments and the presentation team to ensure an uninterrupted flow of video and associated audio commentary to the assessment panels. These requirements demanded high-quality video switching at both component and composite levels and rapid configuration changes in the experimental equipment, and both had to be achieved without performance compromises.

(b) *The production of the demonstration presentations showing the performance of digital proposals.* This work required great flexibility in equipment interconnection, both in the analog component and composite sides and in the digital component side; again, performance had to be at a very high level in all possible paths.

Taken together these two major goals dictated many of the system design decisions, which are discussed in the paper by Merrill Weiss and Ronald Marconi. Descriptions of the individual experiments are contributed in papers by Takeo Eguchi, Yoshitaka Hashimoto, Peter Kwa, John Lowry, Glenn Reitmeier, and John Rossi, all of which are published in this special edition.

Because of the international concerns of the Society, it was decided that the formal picture assessments would follow, wherever possible, the CCIR and EBU recommendations concerning assessments, and that the demonstrations would also take place in a similar environment but with an extended range of test material and methods. The planning, execution, and reporting of the assessments is covered in this issue in a paper by David Bennett. The demonstration presentations were planned by the Working Group as a whole and served primarily to illustrate the potential and limitations of the various choices. The results of this activity are recorded in a wide-band, analog component form on videotape (with the R , G , and B signals recorded separately).

We are also indebted to Roland Zavada for his *Foreword*, introducing this special issue, and to Frank Daviddoff, whose *Afterword* presents conclusions and future objectives.

Conclusion

The organization of a series of demonstrations on this scale concerning new technology is a massive, costly, and time-consuming effort, and the Society recognizes with appreciation the contributions of all concerned with this work. It is clear that the work has moved the discussion of standards forward a long way in a very short time, and the Society eagerly looks forward to the consensus acceptance of specifications for component-coded digital video that will meet the needs of the worldwide television community for years to come and provide the basis for a worldwide compatibility while, at the same time, providing a basis for the

rational growth of new and expanded television services.

Acknowledgments

The success of these experiments in component-coded digital video lies, in

large measure, in the cooperation and assistance of many individuals and organizations who contributed their support to this important work. The Working Group recognizes particularly the important contributions of companies listed in the accompanying box.

Contributing Companies

Digital Experiments

Picture Quality, Direct Sampling — RCA Laboratories
Picture Quality, Hierarchy Conversion — CBS Technology Center
NTSC Interfacing — Digital Video Systems and Sony Corp.
Digital Recording — Sony Corp.

Support Equipment

American Broadcasting Corp./ABC Television
Ampex Corp.
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