

# Mastering and Archiving Uncompressed Digital Video Test Materials

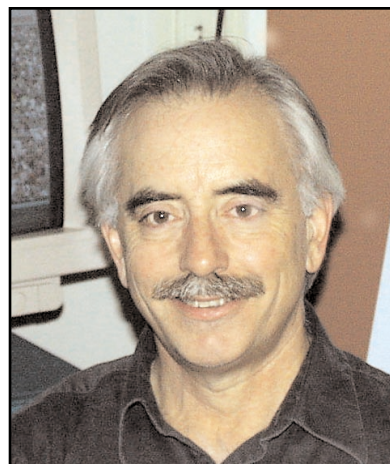
By Charles Fenimore

*This is a report on the status of the SMPTE Ad Hoc Group (AHG) charged with creating a master set of standard-definition video sequences for subjective testing of electronic systems. The images will be available from SMPTE, for use in the evaluation of electronic systems. The first task is to create a master representation of video sequences enabling preservation in a consistent and stable storage environment. Once the sequences are restored and returned to a pristine state (when possible), they will be provided in digital file format to SMPTE. The Society will then offer the video sequences in various formats (digital data media and uncompressed digital videotape) for testing electronic systems. This report also includes representative images from sequences in a set of standard-definition materials, the first production of the AHG. Finally, feedback and suggestions on the quality and interest of this process is requested.*

The Ad Hoc Group on television evaluation materials is concerned with the preservation of high-quality images and the process for mastering and archiving these images. The Group has decided on a strategy that recommends the use of uncompressed digital representations for image masters. This approach is expected to increase the likelihood of preserving the images in an error-free record.

Although the standard-definition materials made available to the AHG were delivered in D-1<sup>1</sup> uncompressed videotape format, the restored images will be archived in data media, such as data tape or disk. It is anticipated that active management of the archive in this format will facilitate future migration to new archival storage without the cost of further restoration and generational losses.<sup>2</sup> SMPTE will continue to use D-1 and other suitable uncompressed digital video formats as a distribution method.

The AHG expects materials to be used in evaluation and testing, and therefore seeks materials available for public demonstration. It is expected that the materials presented here will be directly used to test compression



systems and other high-quality image processing applications. Those requiring test materials in compressed formats are served only indirectly by this effort.

## Generating the Archive

Producing the SMPTE test image archive involves collection of source materials, selection of images for inclusion in the archive, restoration of visibly corrupted images, and transfer to the archiving data media.

## Sources

The sources for these standard definition television evaluation materials are the well-known "CCIR test tapes" documented in ITU-R Rec. 802 BT,<sup>3</sup> and materials contributed by Radio Televisione Italiano (RAI). All contributions are natively in D-1 format. Two ITU test tapes are available, one in 525-line, and the other in 625-line format. The latter materials from RAI provides sports action imagery not already available in the 625-line ITU test tape.

## Selection of the Test Materials

Each ITU test tape contains numerous 60-sec video frame sequences.<sup>3</sup> The current materials selected:

- are the most heavily used of the originals,
- represent the range of attributes in the originals, and
- fit on a 20-min videotape.

In some cases, it was not possible to correct visible errors in sequences which otherwise met the criteria for

Presented at the 142nd SMPTE Technical Conference (paper no. 142-7), in Pasadena, CA, October 18-21, 2000. Charles Fenimore is with the National Institute of Standards and Technology, Gaithersburg, MA, 20899. An unedited version of this paper appears in *Content Acquisition, Processing, and Distribution in the Digital Millennium*, SMPTE, 2000. Copyright © 2001 by SMPTE.

selection. For example, on the ITU tapes available to the AHG, the still image “Kiel Harbour 1,” which is similar to Figure 8-P, had only one field and was not included.

The AHG prepared a list of desirable attributes for subjective evaluation materials to guide the selection. Broadly, these attributes include ranges of resolution and detail patterns, image and camera motion, luminance variation, color saturation and hue, skin tones, noise, graphics and titles, and the sensation of reality and depth. This list reflects a variety of uses for uncompressed materials, particularly the evaluation of video compression; future uses may have very different requirements.

Most of the video sequences are 40 sec in length: 5 sec of black, 5 sec of title slate, and 30 sec of active video. Some of the shorter RAI sequences are expanded with black frames, to have a length that fits within 5-sec boundaries.

### **Restoration**

Some of the sequences on the available source tapes were mildly corrupted, but still regarded as potentially useful. To improve the utility of the selected sequences, they were restored to remove visible dropouts and other such errors. This restoration was performed with professional post-production tools. Best professional effort was used to insure that the digital video Rec. 601<sup>4</sup> samples were accurately reproduced from D-1 tapes. It was not necessary to apply error concealment in videotape recording playback. Although the restored sequences differ from those on the ITU test tapes, the only differences apparent to a subjective viewer would be potential defects on the unrestored versions of the tape missing on the restored ones. Besides these restorations and the color space conversions required by the posting tools, no other processing or lossy compression was applied to these materials.

### **Archiving**

The last step in this process was the creation and validation of the digital data media masters. The archival tapes were produced using Rec. 601 format. The materials were converted to RGB and, after restoration, were recorded on digital linear tape (DLT). Also, post-produced materials were backed up on D-1 tapes. SMPTE is currently seeking a copying service for dubbing the distribution copies, and the AHG is ready to deliver masters when requirements of the vendor become available.

### **Review**

The materials were exhibited for public comment at the SMPTE Technical Conference in New York City,

November 1999. They were balloted to the SMPTE Image Technology Committee at the Technical Conference and at the December 1999 Television Engineering Meetings in San Jose, CA. The comments received noted image impairments, which have since been corrected.

### **Table and Selected Frames from the Standard-Definition Television Evaluation Materials**

Table 1 summarizes the characteristics of the 525-line and 625-line materials. Descriptions of the attributes are derived from previous documentation (Rec. 802) where available. The categories in the Table are defined as:

**Material Identifiers:** Scene index is a single number for video sequences 01 to 12, which are available in both 525- and 625-line formats. Clip numbers followed by “-N” are on the 525-line format tape only and those followed by “-P” are only on 625-line format tape.

**Attributes of Source:** The selection of particular video sequences for inclusion was based on a list of desirable attributes. The “Attributes to be Examined,” and “Motion” are based on the original documentation of the CCIR test materials, where available, and on the review of the AHG. Attributes to be examined indicates those properties that may make the material useful in evaluating digital systems. The degree of motion in the clip is noted.

**Source of Scene:** In the Source column six identifiers are used.

- Slide: film-based material scanned, filtered, and sampled to Rec. 601 resolution.
- Video: existing video clip.
- Component: RGB component signals.
- Camera: generated by camera.
- Camera/CG: generated by camera and character generator.
- Camera/SE: generated by camera with special effects.

All of the 525-line materials (sequences 01 to 20) and sequences 01 to 12 of the 625-line materials are derived from ITU test tapes. For historical and archival purposes, the corresponding sequences on the ITU tapes<sup>3</sup> are designated as ITU index. Scenes numbered 13-18 for the 625-line system were obtained from RAI and are not indexed to prior standards.

**Selected Images:** The figures are presented at **quarter-resolution (half-resolution, both horizontally and vertically.)** The 38 images are selected from each of the frame sequences described in the table. Each frame is labeled with the corresponding title and with the scene index, which is a sequence number followed by “-N” for 525-line and “-P” for 625-line formats. There are twenty 525-line and eighteen 625-line images.

**Table 1—SMPTE 525- and 625-line Test Pictures and Sequences Derived from “CCIR Test Tape” ITU-R BT.802 and “RAI Test Tape”**

Materials Identifiers		Attributes of Source		Source of Scene			
Scene Index	Title	Attributes to be Examined	Motion	Source	525-line	625-line	ITU Index
01	Formal Pond	Luminance resolution	Still	Slide	x	x	1
02	Clown	Horizontal resolution	Still	Slide	x	x	3
03	Boy With Toys	Skin and color edges	Still	Slide	x	x	4
04	Young Couple	Fine detail, NTSC luma/chroma crosstalk	Still	Slide	x	x	6
05	Blackboard	Color, vertical resolution	Still	Slide	x	x	7
06	Flower Garden	Color details	Slow pan	Video	x	x	15
07	Susie	Skin tones	Slow	Video	x	x	16
08	Kiel Harbour 4	High resolution in horizontal, vertical, and temporal dimensions	Fast pan/zoom, five cuts	Component	x	x	26
09	Balls of Wool	Moving colors	Medium	Video	x	x	27
10	Popple	Moving colors	Pan/rotate	Video	x	x	28
11	Table Tennis	Multiple rapid motions	Pan/zoom/cut	Video	x	x	29
12	Mobile and Calendar	Random motion of objects	Slow	Video	x	x	30
13-N	Birches	Luminance details, sky	Slow tilt down	Camera	x		33
14-N	Bicycles	Bicycle wheels	Complex, fast	Camera	x		35
15-N	Carnival Ride	Luminance and color details	Fast, complex	Camera	x		36
16-N	Football	Sports	Rapid motion	Camera	x		38
17-N	Cheerleaders	Fast, complex motion	Zoom	Camera	x		39
18-N	Diva	Cuts on titles/busy scene	Cuts	Camera/SE	x		43
19-N	Tempête	Horizontal and vertical luminance, color details	Random motion	Camera	x		44
20-N	Un Générique	Rolling and crawling titles	Crawl/roll	Camera/CG	x		50
13-P	Bicycle Race	Saturated colors, 1 cut	Rapid motion	Video		x	RAI
14-P	Kayaks 1	Water flow, bright reds, details	Moderate, water flow	Video		x	RAI
15-P	Kayaks 2	Bright reds, background detail	Moderate, water flow	Video		x	RAI
16-P	Cross Country Race	Three cuts, detail in background	Moderate	Video		x	RAI
17-P	Arrivederci a New York	Three cuts, colors, faces, lettering	Fast	Video		x	RAI
18-P	Formula 1	Saturated colors, motion, lettering	Fast	Video		x	RAI

**Conclusion**

Creating a master set of images for subjective evaluation is work-in-progress. Based on viewing by the AHG, the standard-definition images were restored to a pristine state. Images for which the best available copy was visibly impaired were replaced with an improved or lower noise restoration. The remaining step in completing the standard-definition archive is to transfer the master to the working format of the copyist selected by SMPTE.

It has recently been suggested<sup>2</sup> that the lack of standards for content exchange limits the useful life of digital assets. Extending the useful life and improving

access to high-quality images is the main motivation for this work. While it is anticipated that data media will provide long-term lossless archives, the AHG has yet to consider a migration strategy for the images.

In addition to standard definition, the AHG plans to produce an archive of high-definition images. In this case, requirements that the archive contain uncompressed images must be relaxed, because current offerings of source images are all subject to moderate levels of lossy compression. Mastering the archive in data media may be possible; however, doing so on decompressed imagery requires much more storage. It appears that the greatest challenge lies in developing high-definition image archives.





Figure 01-N. Formal Pond.



Figure 01-P. Formal Pond.



Figure 02- N. Clown.



Figure 02-P. Clown.



Figure 03-N. Boy With Toys.



Figure 03-P. Boy With Toys.





Figure 04-N. Young Couple.



Figure 04-P. Young Couple.

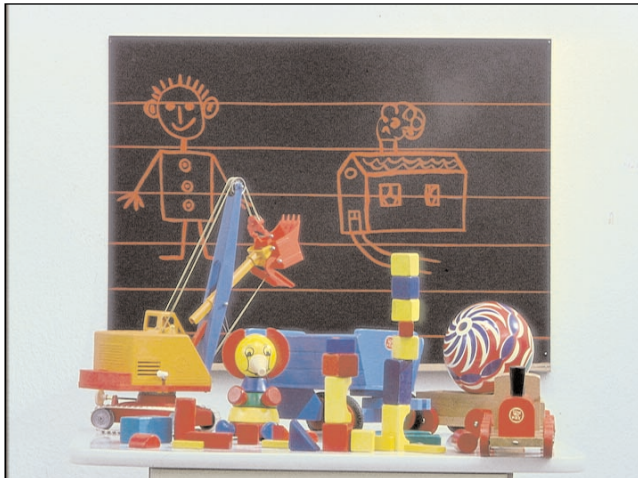


Figure 05-N. Blackboard.

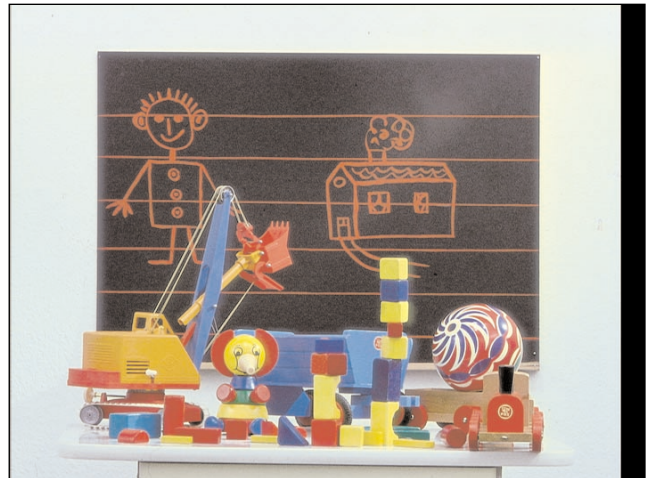


Figure 05-P. Blackboard.



Figure 06-N. Flower Garden.



Figure 06-P. Flower Garden.





Figure 07-N. Susie.



Figure 07-P. Susie.



Figure 08-N. Kiel Harbour 4.



Figure 08-P. Kiel Harbour 4.



Figure 09-N. Balls of Wool.



Figure 09-P. Balls of Wool.





Figure 10-N. Popple.



Figure 10-P. Popple.



Figure 11-N. Table Tennis.

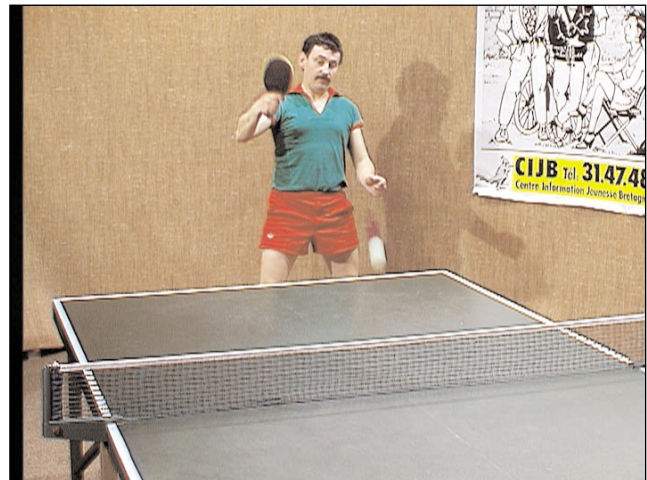


Figure 11-P. Table Tennis.



Figure 12-N. Mobile and Calendar.



Figure 12-P. Mobile and Calendar.





Figure 13-N. Birches.



Figure 13-P. Bicycle Race.



Figure 14-N. Bicycles.



Figure 14-P. Kayaks 1.



Figure 15-N. Carnival Ride.



Figure 15-P. Kayaks 2.





Figure 16-N. Football.



Figure 16-P. Cross Country Race.



Figure 17-N. Cheerleaders.



Figure 17-P. Arrivederci a New York.



Figure 18-N. Diva.

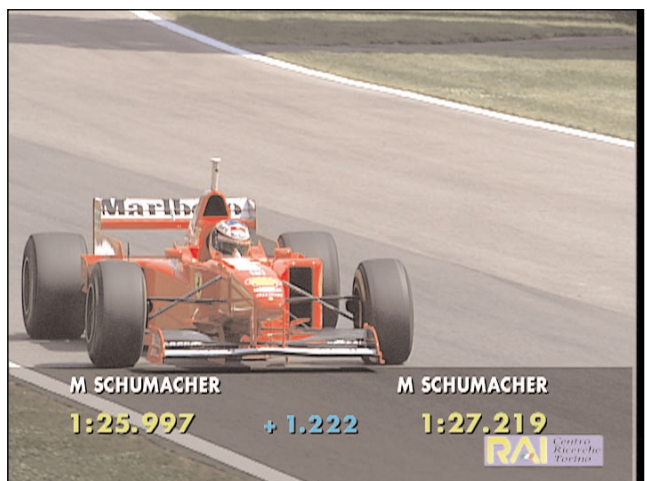


Figure 18-P. Formula 1.



Figure 19-N. Tempete.

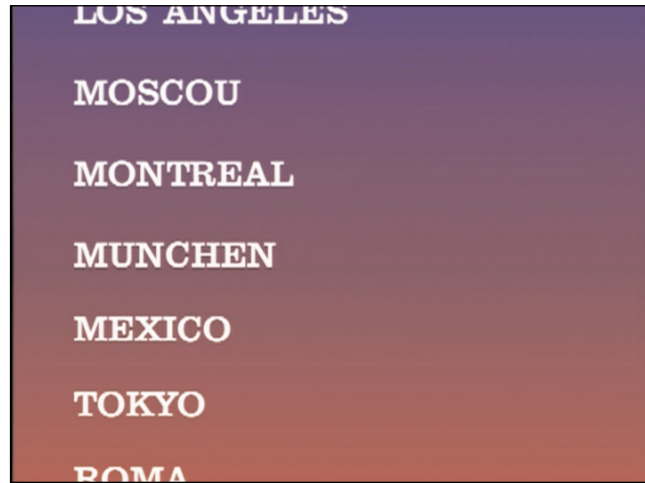


Figure 20-N. Un Generique.

### Acknowledgements

In the contribution of these standard-definition materials, the Canadian Broadcasting Corp., the European Broadcasting Union, and CBS Inc. have provided copies of the existing ITU test tapes. RAI has provided original sports materials in the 625-line Rec. 601 format. The restoration of these materials has relied heavily on access to the post-production facilities and staff of Level 3 Co. (formerly The Four Media Co.) Sony Corp., Panasonic Corp., Roland House, Tektronix Corp., and Complete Post have generously contributed technical support for the selection and review of these materials by the Ad Hoc Group.

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### THE AUTHOR

**Charles Fenimore** leads NIST's Digital Cinema Project. He is interested in quality measurement in digital cinema and video systems. Fenimore is active in SMPTE Engineering and leads the AHG on Television Evaluation Materials.



