HDTV: A Preview of the Future

By Arthur Schneider

For more than five years, the Education Committee of the Hollywood Section of SMPTE has been offering courses on all aspects of television and motion pictures. These range in length from one-day seminars to twelve-week sessions for students and professionals.

Until recently, most of the programs offered were coordinated with the University of Southern California (USC) School of Continuing Education and the Dept. of Cinema-Television. In early 1987, it was decided to expand the scope of activities to include the University of California at Los Angeles (UCLA) in this endeavor.

To that end, the Hollywood Section Education Committee, headed by Bob Ringer, president of RTS Systems, divided into two groups, each to work with coordinators of both universities on different topics. The first of these programs, sponsored by UCLA and the SMPTE Hollywood Section's Education Committee, was presented on October 24, 1987, as a one-day seminar on High Definition Television (HDTV). It was held in the 400-seat dubbing theater at the Walt Disney Studios in Burbank, Calif.

Registration began about 8:30 a.m. in the Disney commissary. More than 300 people registered for this seminar, indicating a great interest in HDTV. Handouts were provided to those attending describing the variety of HDTV hardware available.

Opening remarks were given by Ronnie Ruben, head of the Performing and Integrated Arts Div., UCLA Extension, who handled the administration of the program. She introduced Richard Stumpf, vice-president of engineering development at Universal City Studios, who gave an overview of the day's events and introduced the speakers.

Stumpf introduced SMPTE President M. Carlos Kennedy, who offered comments on the Education Committee's task of putting on a program of this type. Kennedy remarked that in Japan, "High Definition" is sometimes referred to as "High Vision," while others talk of this new technology as "Heavy Duty Television." He further stated that this technology will have a profound effect on both motion pictures and television, affecting the future of all craft people in both industries.

In answer to a question posed by a reporter asking why Hollywood has been resisting High Definition, Stumpf answered that although there have been a number of HDTV demonstrations, most of those participating are technical people. Stumpf feels that more directors, producers, writers, and other creative people who are often turned off by technical discussions and hardware should see demonstrations of this equipment to understand the potential value of this technology. The focus of this one-day seminar was to discuss High Definition as a production and post-production tool rather than for broadcasting, satellite transmission, or home use.

An audience poll was taken by Dick Stumpf to determine how many had seen HDTV demonstrated. The majority raised their hands. A smaller number had seen HDTV transferred to film. Another show of hands indicated that a large number of people in the audience had film backgrounds or were directly involved in film production. Nearly half of those responding had backgrounds in both film and tape.

HDTV Parameters

The first speaker of the morning was Craig Tanner, business manager of High Definition Video Systems, Sony Communications Products Corp. To give the audience some background information, he outlined the history of the development of NTSC black-and-white and color television and the desire for compatibility between black-and-white and color. Tanner pointed out that High Definition research began in Japan in 1970 to determine what the parameters would be for the television system of the future.

Aspect Ratio

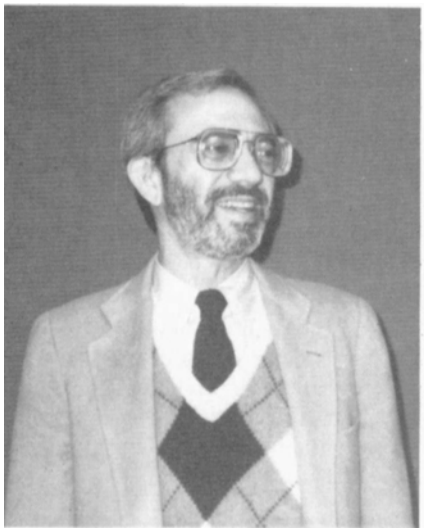
One of the first considerations was the shape and size of the television screen, or the aspect ratio. It was found that the closer one gets to a television screen the greater the resolution required in order to see fine detail. Results of this investigation showed that 1125 horizontal lines as opposed to the 525 lines of NTSC would provide resolution equal to or better than 35mm direct photography when projected, as well as being able to standards-convert to NTSC, PAL, or SECAM television signals. Another reason it was chosen was bandwidth conservation.

It was felt that the aspect ratio should be wide-screen format, which was determined to be a 5×3 or 1.67 aspect ratio, as opposed to the 4×3 or 1.33 aspect ratio in NTSC television. This may ultimately be modified into a slightly wider aspect ratio of 5.33×3 or 16×9, which translates into 1.78 aspect ratio. It is felt this would be a good compromise for many different film formats in televison, allowing the director to protect the image for many different types of release formats.

The technical specifications used in HDTV indicate that the horizontal resolution is about double and the vertical resolution is more than double that of a standard NTSC studio camera. The luminance or general number of picture elements of HDTV is about four times that of standard television. The color bandwidth of a studio HDTV camera signal is about five times that of an NTSC studio camera.

Currently there are between 25 and 30 manufacturers worldwide producing High Definition hardware. According to Tanner, Sony has sold about 30 HDTV cameras and more than 60 1-in. reel-to-reel HDTV VTRs around the world.

This is a brief summary of the one-day seminar on HDTV held October 24, 1987, by the SMPTE Hollywood Section Education Committee jointly with UCLA at the Walt Disney Studios in Burbank, Calif. Arthur Schneider, A.C.E., is a consultant in Agoura, CA 91301.



Charles Swartz, program manager, UCLA Extension.

Richard Stumpf introducing speakers at the seminar.

Bob Ringer, chairman, Hollywood Section Education Committee.

Future Applications

Tanner stated that in the future he felt motion-picture theaters will use High Definition video projectors instead of film projectors. One approach may be to install one or more video projectors, depending on the number of individual screens in a theater complex. This projection process would probably be completely automated. Even further into the future, satellite distribution to a large number of theaters using one HDTV tape player would send a motion picture to hundreds or thousands of theaters simultaneously. It appears obvious that film prints will no longer be distributed to theaters, since cost savings would be significant.

EBR Transfer

Two feature films have been made to date, along with many commercials and music videos. The edited videotape was transferred to motion-picture film using the electron beam recorder (EBR). Using a special HDTV VTR that operates at $^1/_{30}$ of real time (1 frame/sec), it records each film frame in the EBR recorder at double the number of scanning lines of the tape, completely removing any artifact of horizontal line structure. Since there are about 1035 active video lines in an HDTV picture frame, this process results in about 2070 active lines of information actually recorded on the film. Each adjacent line, however, contains essentially the same information.

The EBR transfer process produces a single strip of black-and-white film with each picture frame exposed as three separate red, green, and blue images serially on the film. In another step, when combined in an optical step printer through a rotating color filter wheel and recorded on fine-grain color internegative film, a full-color master negative is produced from which prints may be made. One advantage of this process is that it provides a black-and-white separation master which may be archived. These films have a very long storage life and may be used to produce other high-quality color master negatives at a later time.

Image compositing and manipulation are other powerful uses of High Definition to create special optical effects that are not easily created or even cost-effective on film. If, as it has been suggested, motion pictures are to be shot at 30 frames/sec, it may make sense to produce in HDTV, since the frame-rate compatibility factor will provide even better video-to-film conversion with no strobing or other artifacts.

Problems

Currently, the process of converting 30 video frames to 24 film frames requires the elimination of every fifth video field, which results in some nonlinear motion strobing and "jutter," a form of the "picket fence effect." To minimize these effects, careful selection of camera angles, fast panning, and lateral action are required during production. Since this approach is not practical, another method is being developed to help the problem of tape-to-film conversion without these artifacts detracting from the continuity of the image. Sony, NHK, and others are working on an electronic motion-adaptive interpolation process that will create 24 smooth film frames from 30 video frames in a very complex but clever way that will eliminate most or all of those problems.

Tanner pointed out that digital VTRs are being developed, and that sometime in the next year or two they will be able to duplicate tape with no loss of quality, essentially maintaining original production quality throughout the post-production process no matter how many generations of optical effects or changes may be required to generate the final edited master tape.

Some of the disadvantages of present equipment are the size and weight of equipment, the fact that it is ac-powered, and the relatively low sensitivity of the camera. Tube lag is another problem that must be reckoned with. Charge-coupled device (CCD) image sensors with zero lag are being developed, and it is hoped they will have a great impact on picture resolution and sensitivity. Motion interpolation also needs to be considered.

Finally, the capital cost of equipment is another prime consideration. Currently, most VTRs cost about $200,000, and the cameras about $250,000 each. Unfortunately, because of the rapidly changing technology, the useful life of electronic cameras and other equipment is relatively short compared to say, a Panavision film camera, which has a much longer useful life. Despite some of these disadvantages, there appears to be a

". . . more directors, producers, writers, and other creative people who are often turned off by technical discussions and hardware should see demonstrations of this equipment to understand the potential value of this technology."

number of people getting into the field of HDTV. They apparently see some advantages, especially when it comes to generating optical effects, despite the high initial investment in hardware.

A member of the audience asked, "What was the vertical resolution of 750 lines quoted by Sony?" Tanner stated that reference was to television lines, not film resolution. HDTV has a possible 1125 horizontal lines/picture frame. However, about 1035 lines actually make up the picture. In reality, because of a phenomenon known as the Kell Factor in interlaced video systems, the number of visible lines are reduced to about 0.7 of 1135 lines, or about 750 lines.

Film Projection Study

CBS did a study of film projection in theaters using state-of-the-art film projectors, and determined that most viewers of films in local cinema houses watched pictures on a screen with a good deal less than 650 or 700 lines of vertical resolution in the picture. This is due in part to the photographic process from camera to optical printer. Somewhere during the printing process, high-frequency jitter may be introduced, along with weave that blurs out a lot of the high-frequency detail. Part of it has to do with film stretch, wear on the sprocket holes, warping of the film, different shaped sprockets, and a general lack of cancellation of this ever-so-slight film movement.

Film-to-HDTV Tape Transfers

A final comment from the audience concerned the ability to transfer motion-picture film to High Definition tape. Tanner stated that at present Rank Cintel and Ikegami both have hardware for this purpose. NAC in Japan has built a laser telecine system. Steadiness is a prime consideration in film being transferred to videotape, since video images which are rock steady cause a certain amount of relative motion when combined with images transferred to tape from a film projector. Ikegami has a pin-registered projector for this purpose.

Tanner summed up his presentation with the following thoughts. First, there are significant savings in raw stock as compared to film production. Second, there is a reduced shooting time, with corresponding savings in above- and below-the-line costs. Third, editing time is significantly reduced, allowing the producer to get his or her product to the screen quicker, thus avoiding interest charges on borrowed money.

Image Compositing

The second speaker of the day was Paul Vlahos, president of the Ultimatte Corp. His talk centered around the use of image compositing. Showing a short demonstration film made from High Definition-edited videotape, Vlahos impressed the audience with the "electronic wizardry" that appeared on the screen as a realistic composite of activity scenes with exterior background scenes.

Special Optical Effects

From the very early days of motion-picture photography, producers and directors had a desire to use special optical effects. Vlahos outlined some of the techniques used to achieve these effects, such as the painted backdrop, hand rotoscoping, and rear projection. He gave an example of a problem that became visible because of the color difference in the projected background image. It was possible to show snowflakes falling on the projected image that have a pink tint while snowflakes in the foreground may be blue or white.

Blue Screen Process

The original traveling matte process known as the blue screen process had its own set of problems. Some of the evident problems included blue fringing at the matte line, restriction of fast movement, and the inability to create shadows. Even though the results were not always satisfactory, this process was used extensively for many years.

Infrared System

The next step forward in film compositing was known as the infrared system. The background was lit with infrared light, and the matte was made inside the camera using a special two-strip or bipack system. This process eliminated the blue fringing problem, but, because infrared is a long-wavelength light, it created mattes that were oversize showing a dark edge at the matte line. This process was short-lived because of the undesirable matte line artifacts. Next, a matting system using ultraviolet was attempted. Again, using the bipack camera, instant mattes were created. However, because the light was of a short wavelength, the mattes were undersized.

Front Projection

Following this failure, front projection was tried. Unlimited sized screens were possible, there was some limited pan and tilt capability, and the results were instant. Limitations included the need to provide extremely accurate camera-to-projector alignment, but there were problems of matching color and contrast between the foreground and background images. None of the systems described allowed the use of shadows, and all required the use of practical floors.

Sodium System

Another attempt at image compositing was the sodium system, which was first developed in England. A white screen was lit with yellow sodium vapor lamps, and, using a two or three-strip camera, instant mattes would be made in the camera in a process similar to that of the infrared and ultraviolet processes. Now, because the wavelength of the yellow color fell between the red and green color spectrums, the size of the matte was accurate and no matte line fringing was visible. Still, no shadows could be created, and practical floors were a firm requirement.

Blue Screen Color Difference Process

Finally, the blue screen color difference process, the workhorse of the industry, was developed by Petro Vlahos. Its advantages were unlimited screen size, no practical floors needed, background images could be low-contrast mattes allowing the camerman to include shadows, transparencies, and fine detail, and no matte line giveaway in the composited image. Still, there were some disadvantages, in-

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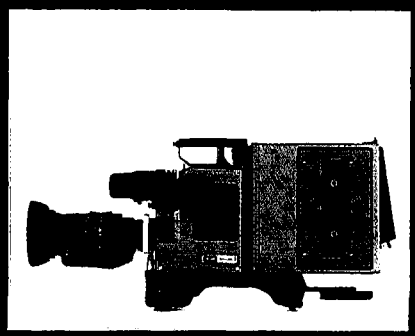

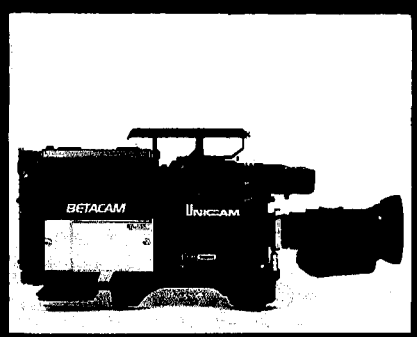

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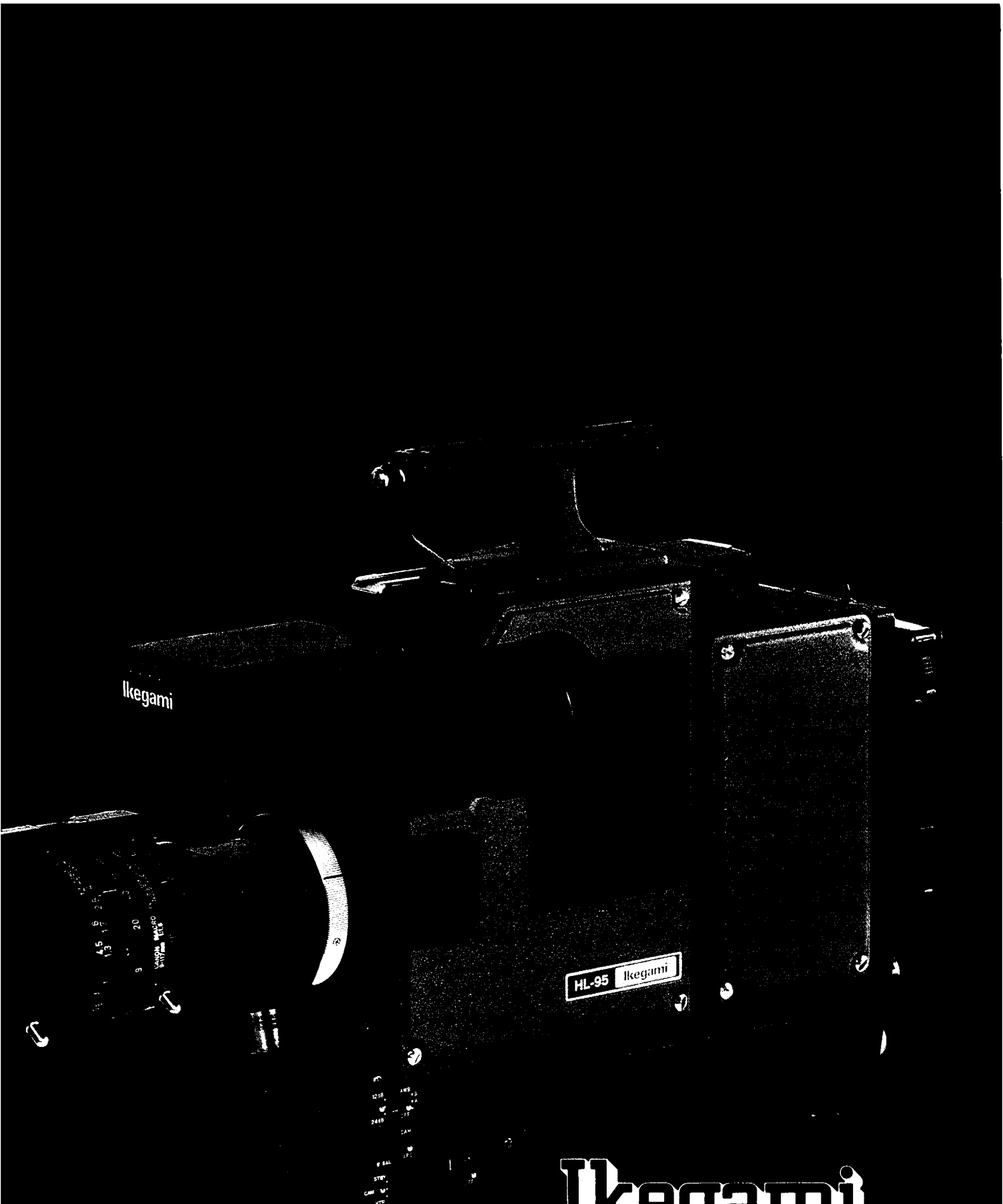

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cluding not being able to see the results until after processing. It also required a high level of skill on the part of those on the stage in setting up the shots as well of those technicians in the lab to achieve optimum results. Another drawback was the time delay in seeing results, which might vary from one week to a super rush of about two days.

Electronic Compositing

Petro Vlahos investigated electronic compositing as early as 1953, but found that the electronics simply did not exist. The Ultimatte was designed as a high-definition film-compositing system. As it turned out, the Ultimatte provided between 5 and 6 MHz of information, which incidentally worked well in the video world. Because of this, the use of the Ultimatte is prevalent in the television and motion-picture industries. Complete control of the image now gives the director instant results during production.

Even though this device appears to solve problems during production, it may lead to a false sense of security. Without proper planning or doing adequate homework, no amount of technical equipment will solve certain types of problems. Lens sizes, lens heights, and camera angles, if not carefully planned and rehearsed in advance of shooting, may cause severe production limitations. In those cases, the use of modified plans to work around improper planning may have to be implemented. Large crews standing by while decisions are made reduces the amount of material scheduled to be shot that day. Compromises in lighting and staging may have to be made, and what should have been an experience in increased productivity and cost savings ends up being one of frustration.

Paul Vlahos summed up his discussion by stating that when you have image compositing in an electronic form, there are a number of variables available to control the image, which allows for the best possible compromise in terms of coming up with an image composite that is realistic. The ability to deal successfully with smoke, glass reflections, and shadows, all with no edge effect, is only a small part of what represents a convincing image composite. Currently, the primary use of image compositing in HDTV is for commercials and music videos.

Directing HDTV

Standing in for the morning's third speaker, David Niles, who was in production in Paris, was Dennis Orner, executive vice-president of 1125 Productions, who gave a director's view of HDTV. Orner outlined a number of projects he and Niles have in progress in this field. The theme of his presentation was that creative, inventive people make pictures that work, producing ideas that affect our moods and emotions. He stated that High Definition was another medium in which to present these emotions.

Orner stated that High Definition appears to complement rather than replace motion-picture film. He pointed out that in many applications, 35mm film was intercut with High Definition film, and the results were most satisfactory. Orner then showed a short film made from an edited High Definition tape-to-35mm film called *Stairway to Heaven*, which was quite impressive.

Since David Niles was unavailable to appear in person for this seminar, he videotaped his thoughts (in High Definition, of course) for the audience. It seems as though Niles is quite comfortable behind the camera but a bit shy when it comes to speaking on camera. The entire videotaped interview was framed in an archway showing only his nose, mouth, and hand. The audience never got a good look at this shy man.

Niles stated that when he first saw HDTV, it was as though someone had just cleaned a window and he could see things he had never seen before on film or video. He felt that it was a whole new image expression. Niles also commented on the fact that in all their shoots, they never had a failure or any type of downtime that affected the production, indicating the high reliability of this equipment. The crews used in High Definition production are the same as those used in film production, so retraining is not necessary for most jobs.

HDTV Applications

Stumpf next introduced Charles Pantuso, director of engineering for Northernlight & Picture Corp., a coproducer of a CBC miniseries called "Chasing Rainbows." Pantuso gave a brief technical overview of some of the HDTV applications used in the series. "Chasing Rainbows" is a 14-hour miniseries produced entirely in High Definition, but it was also designed to be downconverted to NTSC. A total of 350 hours of original material was recorded for the series.

A skilled film editor, who learned to operate the editing system within three weeks without having worked in video previously, edited the series. An NTSC camera pointing at the High Definition monitor made a converted ¾-in. NTSC work tape with time-code and reel numbers burned into the video. The task of editing was done by assembling a first cut and using this cut as a playback tape to create subsequent versions. Using this technique, as many as eight sets of changes were made. Commercial software programs were used in the same manner as in NTSC editing to sift through the various versions and to come up with an edit list suitable for automatic assembly.

During the lunch break, portions of "Chasing Rainbows" were shown by playing in sync an HDTV tape alongside an NTSC-converted signal. The downconversion quality appeared to be as good as an original NTSC production. In addition, the same segment was also transferred to 35mm film using the High Definition EBR process, enabling the audience to see yet another format of this process.

Considerations in Using HDTV

Financial

Following the lunch break, Dick Stumpf introduced Mark Blandford, executive producer of "Chasing Rainbows," and John Galt, president of Northernlight & Pictures Corp., who was also the director of photography on the series. Blandford stated the production began shooting in March of 1986 and was completed in October 1987, more than 19 months later. He pointed out that one of the primary reasons for shooting in High Definition was financial. The cost of the series was about 11 million Canadian dollars, which breaks down into $800,000/hr Canadian or about $600,000/hr U.S., which is much less than budgets used for 1-hr programs produced on American television.

Technical Quality

The second reason for shooting in HDTV is technical quality. The Canadian Broadcasting Corp. (CBC) produces all of its drama programs in 16mm, and Canadian audiences can't understand why their programs don't have that "American look." Bland-

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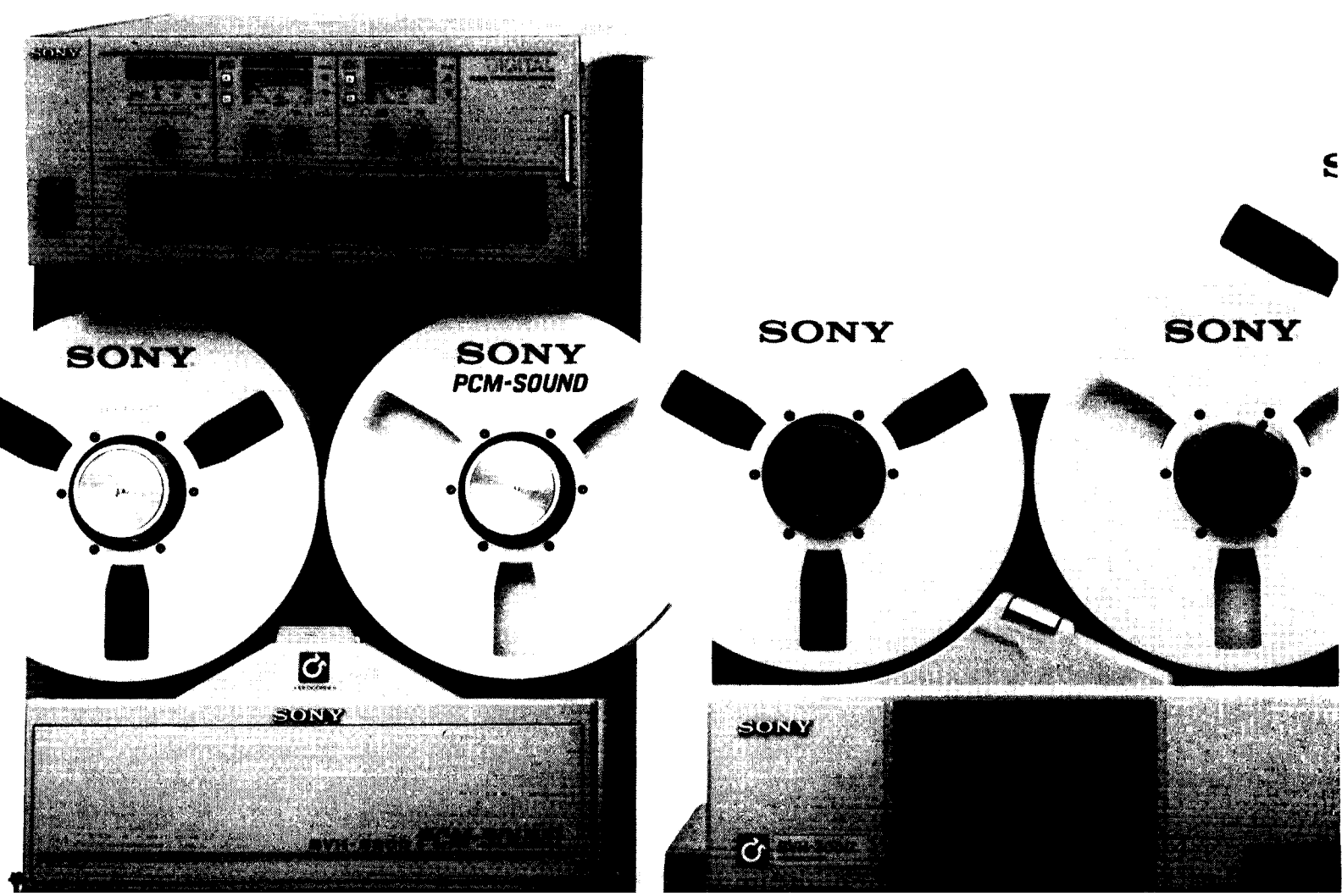

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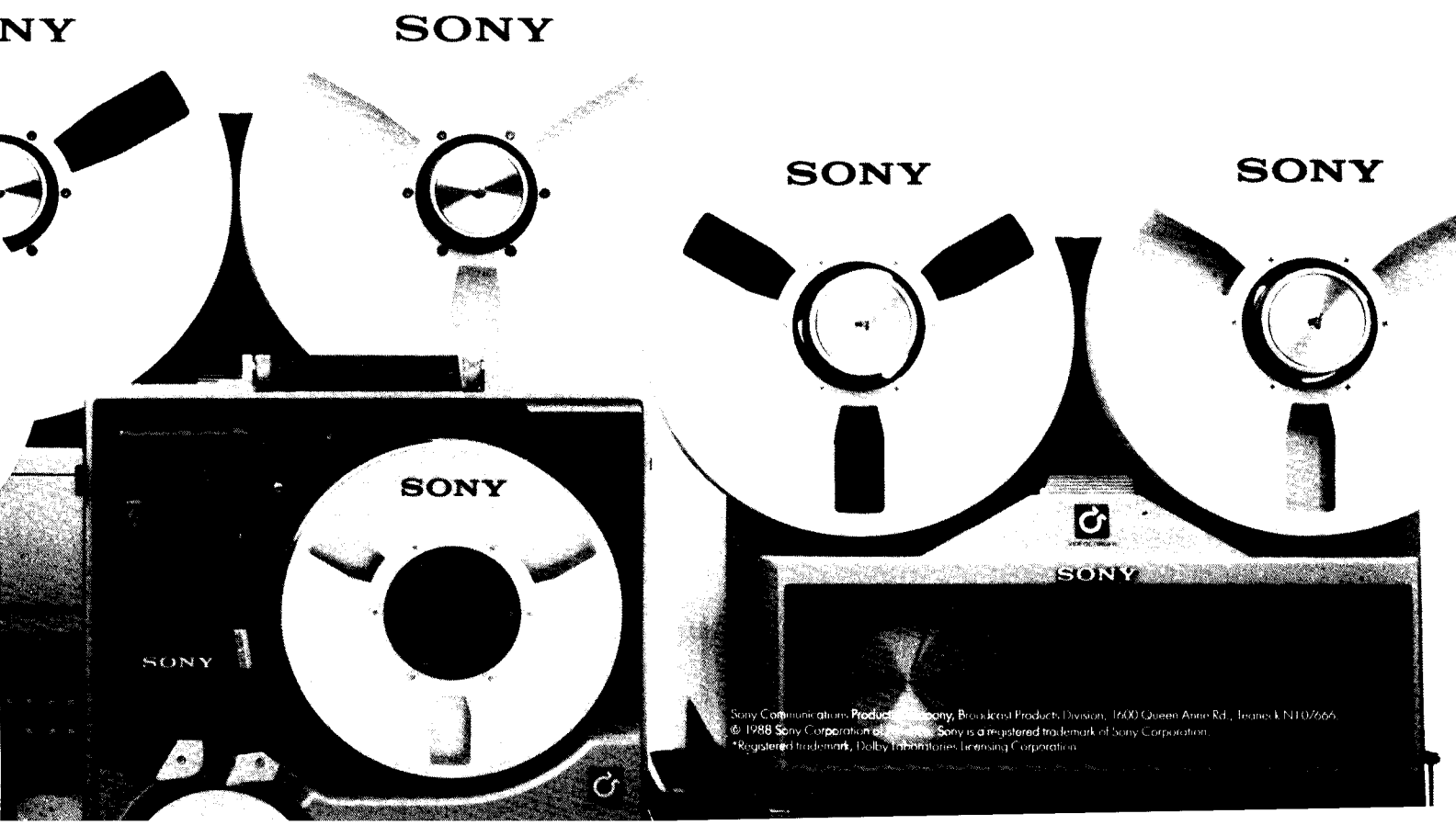

ford pointed out that the "look" was due to the use of 35mm film in American television.

Because he fought and lost the battle of shooting in 35mm with the Canadian Government, he then met with John Galt, who suggested the use of High Definition for production instead of 16mm film. Since High Definition was so new at the time, Galt persuaded Sony to rent them the equipment for about what it would cost to use 16mm film.

After a screening of the first 20 minutes of the series on film, Blandford said he was a convert to High Definition. Other changes he mentioned included a forced relationship between the production designer and the director of photography. Blandford reiterated that the movie set was not the place to be creating but rather the place to be revising and improving. The production averaged 25 setups and 4 finished minutes per day, which is very good considering the magnitude of the production. There was no video monitor on the floor, which eliminated "directing by committee," a problem often encountered when the production staff views each take and starts getting ideas on how to improve the product.

John Galt then stated that "High Definition to me simply represents the first electronic medium that is worth the trouble that one would take if one were shooting a 35mm film." Many questions from the audience kept the speakers on their toes. One question was the level of light used during production. Galt indicated that studio light levels varied between 80 and 125 fc at $f/2.8$. Night photography was shot using between 20 and 40 fc of light.

Demonstrations

Next, a very impressive film was shown which compares side-by-side 35mm direct-film photography with High Definition photography converted to 35mm motion-picture film. This demonstration was prepared by the Imagica Corp. of Tokyo using the NAC laser beam real-time HDTV-to-35mm film recorder. Many scenes shot in the same location side-by-side on film and on HDTV were to the eye identical in quality, which confused the audience since most were unable to tell one from the other.

Production Techniques

Barry Rebo, of HDTV Studio, Inc., in New York, discussed production techniques and showed several examples of his work transferred to film, much of it involving the Ultimatte and multilayer compositing. Denis Bieber, Rebo's partner, then discussed how they developed sales and marketing plans for this new medium using, for example, music videos to test their ideas. From this evolved a graphic design market plan enabling them to create background mattes. That led to their first feature film based on the drug world.

Bieber feels that in the future, a linear High Definition feature film, that is, one with no special effects, will cost between 20 and 25% less than shooting the same project on 35mm film. Adding complex special effects will mean even greater savings.

Robby Benson then answered questions from the audience relating to the feature film he directed, stating that he believes High Definition is just another tool. However, the ability to replay a take to see if there is a boom in the frame is a powerful feature of electronic cinematography, saving time and money as long as it isn't overused. It was pointed out that if this feature had been shot on film, there would have been another 6 or7 days of production.

Discussion

Following the afternoon break, the round table panel was assembled to discuss production techniques and to answer questions from the audience. All the speakers were invited to be part of the panel, together with the invited guests. The latter included John Whitman of Universal City Studios; Robby Benson, actor-director; Jeremy Kagen, director; Doug Trumbull of Showscan, and Laszlo Kovacs, cinematographer, among others. There were ten in all.

John Whitman stated that on the surface it might appear that High Definition at the present time would save producers a great deal of money, when in reality, after factoring in fringe benefits and other costs, actual savings are only about 8 to 9%. Laszlo Kovacs feels that this process will fill the need for television but will not replace film as a production medium. Doug Trumbull expressed his feelings about such things as the human physiological responses to various picture frame rates and found that 60 frames/sec is substantially better than 24 frames/sec. For one thing, flicker is not as apparent to the viewer as it is at slower frame rates.

Jeremy Kagen sees High Definition as quite different from regular television and as another "experience." He pointed out that watching a program in NTSC and watching the same program on a High Definition receiver next to it, one would find that they are totally different experiences. The audience applauded loudly when John Galt summed up the day's proceedings by stating that "Hollywood is a state of mind, not a place."

At the close of the seminar, participants were asked to fill out an evaluation form and to express their opinions on the quality of the one-day program. An overwhelming number of those responding rated this seminar as "very well organized," "excellent," and "everything was on the cutting edge — thank you," along with many more comments expressing their appreciation for this fine program.

The entire proceedings were audio taped. These are available through SMPTE headquarters for those who missed this informative program.

Acknowledgments

Thanks are due to Dick Stumpf, SMPTE coordinator of this extremely valuable seminar, and the following members of the Education Committee for their assistance in putting together an outstanding program: Bob Ringer, Hollywood Education Committee Chairman; Gail Ringer, Chairperson of Education Subcommittee for UCLA; Marshall Boshes, Bill Hogan, Lou Bardfield, Paul Carey, Richard Wolfe, Elizabeth Wolfe, Lou Wolf, and a big "thank you" to Walt Disney Studios for providing the auditorium, audiovisual facilities staff, parking, and the good weather for the participants.

Last but not least, we would like to thank the following members of the UCLA staff who helped make this a successful and rewarding experience. Ronnie Ruben, head of the Performing and Integrated Arts Div., UCLA Extension; Charles Swartz, program manager, and Shannon Battle, program administrator.

I, too, wish to express my thanks to all our volunteers for their dedication and untiring efforts to help educate and inform all those interested in the technical arts, and for making this another successful educational program of which we are all very proud.