

The Technical Sessions

Study Group on Digital Television Tape Recording

The Monday, October 26, 1981, meeting of this group was heavily attended and was graced by a number of people from Canada, France, Germany, Italy, Japan, and the United Kingdom.

Mr. Connolly, the Chairman, opened the meeting with a summary of the digital television recommendations and reports approved at the final meetings of the 1978-82 study period of the CCIR. The most significant recommendation for the digital VTR design was AA/11—Encoding Parameters of Digital Television for Studios, which was unanimously approved by all delegations. Recommendation AA/11 specifies 13.5 MHz as the sampling frequency for both 525-line and 625-line countries, and specifies 4:2:2 as the ratio of the luminance and two color difference sig-

nals as the one to be utilized for main studio equipment (including digital VTRs), and for international program exchange.

Other agenda items discussed included the possible co-existence of composite and component coding in the television plant, and the assignment of priorities to the list of parameters developed at an earlier meeting, which would have to be specified to ensure tape interchange.

The question of reforming the study group into a standardization body was reviewed, with the result that it is considered to be premature at this time.

Committee on Audio Recording and Reproduction Technology

Some of the subjects dealt with by this heavily attended committee, chaired by Mr. M. Strong, included:

- The ISO document (36N527) on

PH22.183 (A12.29), Method of Calibrating Effective Modulation of Photographic-Type Sine Wave Sound-Level Motion-Picture Test Films, which will be appropriately modified in accordance to the ANSI format.

- Mr. I. Allen requested that PH22.202M (A12.63), Measurement and Characteristics of Electro-Acoustic Response of Motion-Picture Control Rooms and Indoor Theaters, be modified to correspond with the ISO document (ISO 2969), Acoustic Response of Control Rooms and Theaters. The committee concurred and the document will be so modified.

- It was agreed that both RP 76, Specifications for Flutter Test Film for 16-mm Sound Reproducers, Magnetic Type; and RP 78, Specifications for Azimuth Test Film for 16-mm Sound Reproducers, will be modified.

Lengthy discussions were held on the position of the photo data records on super 8 prints due to the possible

Chairmen for the Technical Program

Techniques and Technologies for the Eighties

Chairman: Julian D. Hopkinson, *Agfa Gevaert N.V.*
Vice-Chairman: Howard T. LaZare, *Consolidated Film Industries*

Laboratory Practices I

Chairman: Robert P. Gyori, *Deluxe General*
Vice-Chairman: Richard Grenier, *Deluxe General*

Film Technology: Production and Post-Production

Chairman: Gary L. Borton, *Eastman Kodak Co.*
Vice-Chairman: Dick Barlow, *The Burbank Studio*

Laboratory Practices II

Chairman: William C. Ogletree, *Carter Equipment Co.*
Vice-Chairman: Joshua Zubko, *Consultant*

The International Scene

Chairman: Dennis J. Kimbley, *Kodak, Ltd.*
Vice-Chairman: Chip Wilkinson, *Eastman Kodak Co.*

Lighting and Projection Practices

Chairman: Richard B. Glickman, *Consulting Engineer*
Vice-Chairman: Ralph Woolsey, *ASC*

Health, Safety, and Environmental Practices

Chairman: James J. Nowack, *MGM Labs, Inc.*
Vice-Chairman: Jack Spring, *Eastman Kodak Co.*

Advances in Television Camera Technology I

Chairman: Donald McCroskey, *American Broadcasting Co.*
Vice-Chairman: John Aalto, *American Broadcasting Co.*

Laboratory Quality Control

Chairman: Leonard Sokolow, *Consolidated Film Industries*
Vice-Chairman: David Rabin, *Consolidated Film Industries*

Microwave and Antenna Systems

Chairman: Thomas Vaughan, *Micro Communications, Inc.*
Vice-Chairman: George Townsend, *Townsend Associates, Inc.*

Sound I

Chairman: John D. Mosely, *Consultant*
Vice-Chairman: Barry M. Stultz, *Film Processing Corp.*

Sound II

Chairman: John D. Mosely, *Consultant*
Vice-Chairman: Barry M. Stultz, *Film Processing Corp.*

Advances in Television Camera Technology II

Chairman: Frank Haney, *American Broadcasting Co.*
Vice-Chairman: Lou Bardfield, *American Broadcasting Co.*

New Applications of Technology to the Film Industry

Chairman: Michael V. Chewey, III, *Lab Methods Corp.*
Vice-Chairman: Ron Little, *Consolidated Film Industries*

The Film-Tape-Film Interface I

Chairman: Robert Ringer, *Ringer Video Services*
Vice-Chairman: Michael Coan, *Bluth Video Systems*

The Film-Tape-Film Interface II

Chairman: Toni Roth, *Image Transform, Chicago*
Vice-Chairman: Thomas Mann, *Image Transform, Hollywood*

Digital Video Tape Recording Technology

Chairman: Fred Hodge, *3M Co., Mincom Div.*
Vice-Chairman: George R. Swetland, *EECO*

A Video Anthology

Chairman: Bebe F. McClain, *B. F. McClain Productions*
Vice-Chairman: Dan Mulhern, *Cramer Video*

Computer Graphics

Chairman: Larry Evans, *Ampex Corp.*
Vice-Chairman: Rodney Stock, *Lucasfilm Ltd.*

Digital Signal Processing and Transmission

Chairman: Charles P. Ginsburg, *Ampex Corp.*
Vice-Chairman: Merrill Weiss, *KPIX Los Angeles*

interference between the edge printing of the raw stock and the data track. Also covered was a comparison study of the CCIR method of measuring signal-to-noise and that proposed by Mr. R. Uhlig. The committee agreed that both methods should be incorporated in the document to be prepared by Mr. R. Uhlig for committee considerations.

The report submitted to the Data Track Committee by Mr. M. Strong on the Time and Control Code (A12.9) will be rewritten by Mr. R. Uhlig for committee consideration.

Committee on Image and Sound Presentation

The chairman of this newly formed group, Mr. E. Efron of DiscoVision Associates, noted that the committee has been charged with defining test methods and materials to evaluate key aspects of the data, audio, and video images. The committee recognizes the need to work in close liaison with other committees and organizations that are concerned with the elements leading to the displayed video image and its audio.

A lengthy discussion on definitions for video parameters resulted in the following points to be considered:

- a listing of audio and video parameters which can be measured by using committee-specified test signals,
- test signals which would be appropriate for measurement of parameters,
- selection of laboratories having equipment to perform the measurements on audio and video parameters using specified test signals, and evaluation of laboratory tests and tolerances to be documented and recommended to the parent committee (New Technology Committee).

The above activities will become the basis for the system approach of measuring techniques in the videodisk media.

Working Group on Digital Control of Television Equipment

At its October 27, 1981, meeting, this Working Group discussed the SMPTE Digital Control Interface Electrical and Mechanical Characteristics, and the final draft document will be forwarded to SMPTE Headquarters for publication in the *JOURNAL*.

The parallel EBU effort on control of television equipment was presented by Mr. M. J. Stickler of the BBC and Mr. Karl-Heinz Trissl of IRT, ensuring interaction between our respective organizations. Discussions indicated a strong probability of achieving compatibility between serial digital control standards being proposed by our respective groups.

The Bus Supervisory Protocol (Document 2) was reviewed, and minor changes were made to clarify nomenclature prior to balloting later in the year.

The EBU representatives submitted a proposal for consideration as the Message Text Structure (Document 3).

Mr. T. Meyer reported a layered model for "Open System Interconnection," which has been adopted by the International Organization for Standardization (ISO). It is anticipated that our Message Text Structure will fit into specific layers of this model.

Working Group on Editing Procedures

Formal meetings of this group took place on 27 and 28, October 1981.

The group is currently working on standards for the interchange of edit decisions information between computer-assisted editing systems, with four documents in preparation.

The Chairman, Mr. R. Lund, reported that the draft proposal specifying data formats for 8-in and 5 1/4-in flexible diskettes has been completed, and will be submitted to Headquarters for balloting by the main committee (VRRT—Video Recording and Reproduction Technology Committee).

Work is nearing completion for a Recommended Practice describing an edit list format similar to, but more



Robert C. Lovick (Eastman Kodak Co.)

comprehensive than, those widely used in the industry. A detailed progress report on the subject will be submitted for *JOURNAL* publication.

The group will also prepare a separate Recommended Practice specifying a format for information too complex for inclusion in the basic edit list, such as special effects, audio mixing, variable speed, color correction, and other data.

Working Group on Digital Video Standards

The subject of standards for the digital television studio continues to be a major concern of the engineering committees of the SMPTE, and the high attendance of 45 people at this meeting confirms the interest in the group's work.

Although much remains to be accomplished, the meeting represented a milestone along the path to standards, as it received and examined the report by Messrs. Green, Powers, and Tarnai concerning the recent landmark unanimous decision of the CCIR (International Radio Consultative Committee). This recommendation is for the 13.5 MHz 4:2:2, component-coded digital video standard developed jointly by SMPTE, EBU, and others for worldwide application in the studio, and as a basis of an extensible family of compatible standards. Mr. K. Davies noted that the group is turning to the practical incorporation of these principles in a studio interface standard, with the first step being the establishment of a subgroup on Digital Studio Implementation chaired by Mr. F. Davidoff.

Further examination of communication media, coding, multiplexing,



Toni Roth (Image Transform, Chicago) chairing the Film-Tape-Film Interface II Session, accompanied by Vice-Chairman Thomas Mann (Image Transform, Hollywood).

and mechanical considerations are scheduled for subsequent meetings, with the next one scheduled to take place in New York City on December 2, 1981.

Committee on Theatrical Projection Technology

In the absence of Mr. J. Baer, the Chairman, Mr. J. Pytlak, assumed the position of Chairman Pro Tem.

The proposed SMPTE Engineering Guidelines on Projection for Conferences (EG 3) had been circulated to the committee for ballot, and the majority of comments received were editorial. The guidelines specify the conditions and parameters for effective presentation of papers at a technical conference, including seating, lighting, projection, audio, equipment, and staffing.

The subgroup studying Guidelines for Theater Design, under the direction of Mr. W. Szabo, agreed to develop a document to aid theater designers and architects to understand the technical considerations required for optimal presentation of picture and sound. Participation of companies dealing in theater design and equipment is solicited.

A report on the subgroup studying the effect of stray light on picture contrast was given by Mr. G. Berggren. Dr. F. Kolb suggested that the ISO (International Organization for Standardization) document on the method of measuring stray light on theater screens, which he helped to prepare, could be used as a basis for a proposed SMPTE Recommended Practice for a test film on the subject. The paper, "A Film and Procedure to Assess Dynamic Luminance Reproduction of Film by Television," presented by Mr. R. Lovick at the Conference, may have application in formulating measurement techniques.

A subgroup will be formed to draft a Recommended Practice on a unified technique for measuring luminance or light output of projector light sources. Messrs. G. Berggren and R. Freeman will be assisted by representatives of light source manufacturers.

A revised draft of a proposed Recommended Practice was presented by Mr. J. Pytlak for the Specification of Color Deviations in Motion Picture Projection. It calls attention to the component factors affecting the color of light reflected from the screen in motion picture projection. The original

draft was written by Mr. G. Berggren. A unified method of specifying the color contribution of each component will aid the user in matching projection systems and meeting pertinent standards. The draft will be circulated to the committee for balloting.

The Working Group on Entertainment Motion Picture Film Damage, scheduled to meet on Thursday of Conference week, will formulate a list of recommendations based on the survey of factors causing film damage. A slide presentation on film damage was given at the meeting, and will be presented at the Committee of Laboratory Services Technology meeting.

The task of producing tutorial material relating to the basic concepts of projection has been assigned to a group chaired by Mr. G. Berggren. The responsibility for assembling the "nuts and bolts" techniques will be undertaken by the Cochairman, Mr. R. Wollrich. The Society will collaborate with the Inter-Society Committee on the enhancement of theater presentation, and the material gathered will be used in the preparation of a new projection manual.

Dr. F. Kolb reported on the activities of ISO/TC 36 regarding the interchanges of film materials. Preparatory Working Group-3 (Projection) will hold a meeting at the ISO/TC 36 Plenary in Germany, F.R., during May 1982. Those willing to participate as members of the USA Delegation to this meeting should contact Mr. A. Alden at SMPTE Headquarters.

It has been suggested that a study group be formed to define parameters relating to high-definition projection, and experts in the areas of projection and image evaluation will be asked to aid in promoting this effort.

Subjects to be reviewed in 1982 include: PH22.194, 35-mm Projector Usage; PH22.195, 35-mm Projectable Area; and RP 33, 35-mm Subjective Test Film.

Committee members are urged to review the above documents to facilitate approval.

The next meeting of this committee will be held in conjunction with the 124th SMPTE Technical Conference in New York City.

Committee on New Technology

Founded in 1976, this committee is charged with looking beyond current standards activities in film and television and with sponsoring studies and

investigations into new and emerging technologies which have an impact on film and television.

Major emphasis is placed on television, particularly in its digital format, and it is the parent of seven subgroups involved in digital video, digital recording, videodisks, and high-definition television.

Generally, the committee meets to review the activities of its subgroups and to consider recommendations for standards or new studies at the SMPTE Technical Conference.

The reports presented at the meeting included:

- CCIR Activities—the Engineering Vice-President, Mr. R. Zavada, and the Chairman of the Working Group on Digital Video, Mr. K. Davies, reported on the background and details of the SMPTE's participatory contribution to the recent worldwide adoption of the 13.5 MHz, 4:2:2 component as the digital video standard. The standard forms the basis of worldwide compatible standards for the emerging technology of digital television.

- Study Group on Digital Video—temporarily, the group is inactive, primarily due to the CCIR deliberations, but it will be reactivated. The Chairman, Mr. C. Ginsberg, noted that the group will direct its attention to the transmission of digital television signals on satellite digital communication channels.

- Study Group on Video Disc—this group has met four times to define areas of interest and to undertake studies in the rapidly moving area of image technology.

Activities proposed include studies of both professional and consumer level disc systems, and of the practical problem of videodisc production and mastering. It is anticipated that this work will define specific objectives for upcoming intensive study meetings.

- High-Definition Television—this study group, chaired by Mr. D. Fink, was recently reactivated to organize studies in both high-definition and enhanced performance broadcast and cable television systems for consumer use. The work is imperative, as the technology in this area is rapidly developing and the broadcast applications will require government actions at WARC (World Administrative Radio Conference) in 1983 to reserve spectrum space. Activity is also being directed toward the application of electro-cinematography.

- Working Group on Digital Video Standards—the major activity of this group has been the planning, management, and reporting of the SMPTE digital video demonstrations held in San Francisco, California, during February 1981, which was reported in the October *SMPTE JOURNAL*. Based on the CCIR agreements achieved recently, work is currently under way to define practical interface specifications for the component-coded digital video signal in studio and VTR applications. This group has also responded to an IEC question on digital audio standards and has prepared a recommended position for the United States National Committee for the IEC. The position as submitted is as follows:

Summary of Concerns

It is clear that a well-defined relationship must exist between the digital words representing audio channels and those representing the video channel in the professional television tape recorder. It is desirable that this relationship be simple numerically and that the relationship to the frame-rate of 29.97 Hz (30/1.001) in 525-line television, 25 Hz in 625-line television, 24 Hz in motion picture film and to the transmission rates of common carriers (which are based on an 8 kHz/8 bit sampling strategy) be structured to avoid problems in editing and switching of the combined audio and video signals.

It is also desirable that the sampling frequency and the coding of audio be the same for all professional applications worldwide, including television, film, and all branches of audio recording, to foster interchange with a minimum of impairments and equipment complexity. There will be advantages also if the sampling frequency of digital audio discs were to be identical to that selected for professional audio production from the viewpoint of cost reductions through commonality in studio use of such discs.

Sampling Frequency

Of the many sampling frequencies considered, two have been identified as meeting these requirements and may be acceptable to 525-line television users:

(a) 60 kHz — This frequency is considered very desirable technically, producing an integer number of samples per field and per frame for all image-related applications — 525- and 625-line television, 24 fps motion picture film. The relationship to the 32 kHz transmission word rate recom-

mended by EBU and in use in Europe is non-ideal, having an integer relationship of 15/8. This permits simple rate converters having low levels of impairment, which would form part of the transducer. This sampling frequency is considered, however, to be excessively high for many applications.

(b) 48 kHz — This frequency produces good relationships in 625-line television and 24 fps motion picture film yielding an integral number of samples per frame and per field and is 3/2 related to the 32 kHz transmission word rate.

In 525-line television (29.97 or 30/1.001 frames/sec), an integral number of samples occurs only every 5 frames. This has the effect of placing more audio samples in one (or more) video frames than others. (This five-frame cyclic irregularity is commonly called the "leap-frame" sequence.) This relationship is considered undesirable in videotape editing and requires correction to maintain a proper sequence of "leap-frames" in any recorded or transmitted data-stream. While much work remains to be done, it now appears the necessary hardware would not be a significant burden nor would there be significant operational constraints.

The 48 kHz frequency is slightly above the lowest acceptable sampling frequency for professional recording.

This sampling frequency is favored by many 625-line countries and is also used operationally in some recordings made for analog disc applications.

Split-Sampling Frequencies

The proposal to employ different sampling frequencies for various recording applications, such as 525-line television, 625-line television, and film is not viewed with favor at the professional level, though the technical and economic factors in support of such a proposal for consumer applications are well understood. A simple sampling frequency worldwide will allow freedom in the use of the same audio track(s) in professional applications without pitch and timing compromises, or the need for rate converters.

Word Coding

For applications in professional television, it is believed that 16-bit linear PCM will provide adequate performance. The precise definition of the coding format requires further study.

Conclusion

A single sampling frequency for professional audio applications worldwide is of paramount importance. At this



Arthur Schneider (Consolidated Film Co.)

stage of our investigations, only two frequencies, 60 kHz and 48 kHz, are considered to be acceptable for image-related audio applications.

- Study Group on Digital Television Tape Recording — this group is engaged in examining all aspects of its format, coding, and operation. Recent work has included detailed review of the digital audio requirements and of the effect of metal film tape on the design.

- Task Force on Component Coded Digital Video — this unique liaison group has completed its work and was disbanded, with thanks from the Engineering Vice-President. It successfully negotiated the international compromises leading to the adoption of compatible international recommendations to the CCIR national committees.

- Image and Sound Presentation Committee — problems exist in measuring and categorizing quality levels in situations involving image interchange between media, such as videotape and videodisc. The committee was established to recommend methods of measurement, assessment, test materials, and reporting methods, particularly in regard to videodisc application, under the Chairmanship of Mr. E. Efron.

In conclusion, Mr. R. Hopkins stated that the major achievement during the year was its contribution to the recent CCIR agreement on a worldwide standard of 13.5 MHz sampling frequency, 4:2:2 quality level for the main studio digital video interface. Progress was also reported in studies into the technology and standardization needs of the videodisc in professional and consumer use, and in the effort to achieve a multi-media image and sound quality assessment and reporting system.

Ad Hoc Meeting of the VRRT Committee

Convened by the Chairman of the Committee on Video Recording and Reproduction Technology, Mr. D. Fibush, the discussions of this special meeting revolved around the potential formation of a working group to define a single format for use in professional quality VTRs, which are contained in a combined camera/recorder. The interest in this subject is attested to by the attendance of 35 experts who are knowledgeable in all aspects of the use and manufacture of portable VTRs.

Investigations since the introduction of the camera/recorder systems did not indicate a desire by manufacturers to consider a single compatible format. However, the users' concern and need prompted the formation of this Ad Hoc Committee.

In summarizing the meeting, the majority of users felt that there is an urgent need for a single format, since the operational and economic consequences of two or more formats would cause extreme difficulty to the users as well as manufacturers and industry in general.

Opposition to the working group formed their opinion on the known reluctance of manufacturers to consider a compatible compromise format. The manufacturers are non-committal, since they feel their technical approach is closely related to a consumer product line which provides cost-effective components for the professional product.

Despite the problems associated with achievements, it was felt by a significant number of people at the meeting that a working group should be established.

Mr. Fibush appointed Mr. B. Dickens of the CBS Technology Center as the Chairman of the Working Group. Mr. Dickens announced that

the first meeting of the group will be held on December 9, 1981, at the San Francisco Airport Hilton Hotel.

The purpose of this group is to develop a single VTR format to be used in professional camera/recorder combination equipment. No specific requirements for the format were given, but it must clearly meet the user needs, which creates the strong desire for a single format. It is expected that proposed formats will be prepared identifying the user needs, which could possibly lead to the basis for a compromise format.

SMPTE Subcommittee on Recommended Practices for Medical Diagnostic Display Devices (Electrical/Photographic)

Attendance at the three meetings of this committee held during the year was extremely good. The committee membership was originally directed toward equipment manufacturers and suppliers; however, in recent months a number of clinical users have joined the committee, providing much-needed practical input.

The group welcomed two contributing members, one from England, who will provide pertinent information relating to the European medical community, the other from Haifa, Israel, who will attend all meetings as an active member.

The committee completed 75 percent of its planned objectives. However, the controversial subject of defining resolution resulted in a subgroup being formed, which is chaired by Mr. David Haddick. The function of this committee is to recommend test patterns so medical users can evaluate resolution in the context of usable image quality.



Ludwig Schneider (Kem Electronic/Mechanik GmbH, Hamburg, Germany)

This group suggested that some form of "black box," generating signals such as multiburst, gray scale, etc., be employed to certify diagnostic image quality. The proposal will be discussed in detail at the next meeting (held in conjunction with the Radiological Society of North America) in Chicago, Illinois, on November 19, 1981.

Committee on Laboratory Services Technology

This well-attended meeting, chaired by Mr. J. Ehrenberg, reviewed the many questions dealing with practices and general laboratory services.

Mr. P. Kurtz, reporting on the activities of film storage, indicated that the subcommittee met on October 26, 1981, to organize its efforts in the development of the film storage practices. The format for the Recommended Practices should be completed by the end of 1981, and specific drafting assignments are to be made early in the Spring of 1982.

A report by Mr. J. Pytlak on "Entertainment Motion Picture Film Damage" covering all phases of motion picture print handling was presented to this committee, but was restricted to film damage found to originate in motion picture laboratories.

It was reported that the ACVL (Association of Cinema and Video Laboratories) Manual is currently being updated and should be completed in early 1982. Mr. I. Young of Du Art Laboratories is responsible for preparing the new manual.

The task of finding a method of identifying, for the projectionist, the type of sound records on the theater release print continues to be worked on.

Consideration was given to the need to expand the work of the committee to include the many post-production services being offered by laboratories.

Committee on Educational, Industrial, and Consumer Technology

The Chairman, Mr. W. Smith, reported that the committee's scope and functions were discussed in full in order to make certain that its responsibility in the educational and industrial field is fulfilled.

The committee, under Mr. P. Deer, has completed its version of the motion

The Motion Picture Sessions

picture super 8-mm projector performance checking film, commonly referred to as the "Jiffy," and recommends that it be made available through the Society's Test Materials Program.

The interrelationship between this committee and the PH7 Committee (Instructional Audio-Visual Systems), which also develops American National Standards for the educational field, was discussed. It was noted that the PH7 Committee has embarked on several projects dealing with motion picture subjects, specifically one having to do with test methods for checking performance parameters for 16-mm projectors. This committee agreed that a draft document should be prepared by the PH7 Committee as a written specification and that such a document is definitely needed. The final version will be circulated to this committee for review.

Working Group on Entertainment Motion Picture Film Damage

Formed in May 1976, the group is charged with the study of film before and after damage, basic physical properties of motion picture prints, a study of motion picture hardware, and film-handling practices and procedures.

The meeting of this group was preceded by an hour-long slide presentation on film damage, outlining the findings of a survey of film and film-handling practices at laboratories, exchanges, and theaters. Incidents of film damage and probable causes of film damage were supported by interviews and pictorial documentation. The presentation was first given at the technical session of the NATO (National Association of Theater Owners) Convention that was held in October 1980.

The Chairman, Mr. J. Pytlak, submitted a preliminary 26-page listing of "Problems, Comments, and Solutions" based on the survey findings, soliciting committee input based on members' own experience and engineering judgment. The final report will be written by Mr. J. Pytlak and submitted to the Committee on Theatrical Projection Technology for ballot. Specific recommendations will be forwarded to the Committee on Laboratory Services Technology and to organizations that may be able to assist in implementing some of the changes that have been recommended.

In the opening remarks of her address, Fay Kanin referred to the continuing importance of the SMPTE Conference as a technical forum. Drawing a distinction between content and form, she described imaging technology as the indispensable form for the incontestable power of the communicated image. Kanin spoke specifically of the power of American films to portray, through their diversity, our freedom of expression. In a similar manner, through the diversity of its program, the 123rd SMPTE Technical Conference attests to the comparable energy of international technical innovation in every element of image-making and display, from scene to screen.

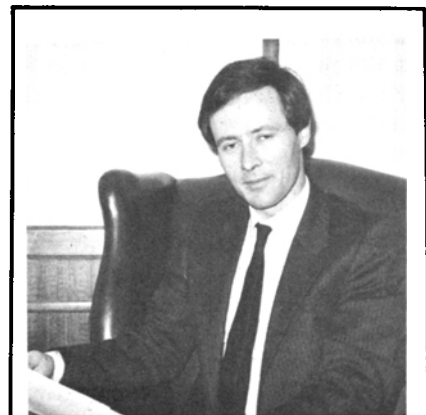
In taking an overview of the various topics presented in the motion-picture sessions, several perspectives serve to highlight present trends and developments. For example, it is evident that motion-picture technology in particular and technical advancement in general share an increasing rationalization of design and function that results in greater efficiency, versatility, and control. Appropriate scales of data processing continue to be introduced into all fields of film handling where the parameters of operation and control can be precisely quantified and sequenced. There have been several advances in MSI (medium-scale integration) and LSI (large-scale integration) applications for the control of laboratory equipment. Microprocessors are used extensively in the generation of timing and FCC (frame-count cuing) data, and their applications have been extended to novel microcomputer-based laboratory process and quality control systems. Microcomputer technology is also incorporated into the growing sophistication of camera designs offering SMPTE time coding.

There were several reports of improvements in the design and performance of lenses, light sources, and film materials. There were interesting discussions of xenon short-arc light sources operating in unitary consoles, as well as discharge lamps that offer efficient 3200 K lighting. There was also a keen interest at the conference in Kodak's high-speed film stocks. These stocks will unquestionably expand the photographic options available to the filmmaker, while also offering economic advantages with reduced production lighting costs.

Several papers outlined the conditions that should be met for the archival preservation of color photographic materials. These presentations convincingly demonstrated the cost-effectiveness of low-temperature storage.

Advances in computer-aided and video-assisted film editing methods were discussed in detail. Several rather elegant approaches for dealing with the 30 video frame/24 film frame rate differences were offered. Video-assisted editing is quickly becoming an integral part of film post-production techniques. An impressive demonstration of high-definition television, together with progress in electronic cinematography, foreshadow the wide use of video systems for both film production and distribution. These developments stimulated renewed discussions of the film/tape debate.

Although this issue is a problem that has been discussed at length, it is becoming clear that this matter is not simply a question of whether video will either supplant film in most areas or continue to supplement film in an evolving media mix. In light of the conference papers and subsequent discussions, it would appear that a dimension to this question is emerging



David H. Phillips was the special correspondent for the *SMPTE JOURNAL* at the 123rd Conference, reporting on the motion picture sessions. For five years he has been associated with Agfa-Gevaert's Eastern Division, where he is now Technical Manager, Motion Picture Productions. He is a graduate of Lehigh University and specializes in photographic science and the philosophy of technology.

that is not strictly translatable into terms of technology and economic advantages.

The interaction between film and video roughly parallels the interaction between earlier forms of image-making. For example, several professionals have suggested that film and video are undergoing a differentiation of methods and approaches to the image that is analogous to the early interaction of painting and photography. At its outset, photography often imitated the painted canvas in pictorial style and choice of subject matter, but it was quickly discovered that photography has its own inherent capabilities, and it soon evolved its own methods and approaches to pictorial content. Painting, in relation to photography, became critically aware of its particular expressive possibilities, and this new awareness contributed to the prolific development of new art styles in this century. The eventual result of this interaction was a tremendous increase in the creative possibilities of both forms of image-making.

Analogies to this type of process can be seen in certain developments presented at the conference. On the one hand, it is clear that video technology continues to approximate film materials and methods in terms of quality, versatility, and portability. For example, there is the development of a video camera with incorporated VTR, as well as a video camera with a picture quality said to equal 35-mm film images reproduced by telecine systems. On the other hand, video technology is pursuing lines of development that are specific to an electronic medium. The various image-creating manipulations created by digital effects, still store, and various interactive modes underscore video's unique capacity to process, index, and display information. Teletext and teleconferencing are further examples of the increasing capacity of video systems to interface with developing systems of information management.

Those from a film background have a certain regard for the status of film in the film/tape discussion. That is to say, for many people, film viewed in the theater is a shared experience with a dramatic and narrative intensity that assures its future use in endless variations. The demand for good films is unslacking, and advances in the technology's materials and methods will sustain film's matchless image quality and its trenchant capacity to communicate.—*David H. Phillips*

The Television Sessions

The Technical Sessions of the 123rd SMPTE Technical Conference again demonstrated that the SMPTE, by providing a forum, is helping the television industry to evolve into a mature and confident body. This forum for technical papers was both enlightening and entertaining.

The papers delivered were timely, thought-provoking, and well presented. The television sessions were divided into several areas of interest. Advances in Television Camera Technology, Parts I and II; Film-Tape-Film Interface, Parts I and II; Digital Video Tape Recording Technology; Digital Signal Processing and Transmission, Video Anthology, Parts I and II; Computer Graphics; and Microwave and Antenna Systems for TV Signal Transmission.

One of the sessions on Advances in Television Camera Technology was devoted to a discussion of the combination Video Camera/Tape Recorder. J. J. Clark and C. R. Thompson of RCA and Ichiro Segawai of Sony discussed their systems in some detail. Although aiming to satisfy the same goals, the two companies offered slightly different approaches.

RCA's Hawkeye System is based on a camera using three 13-mm Saticon tubes and a $\frac{1}{2}$ -in VHS format recorder. Emphasis was on the development of components to reduce size, weight, and power requirements. Examples include the reduction in size of the optical system by using 13-mm tubes, and the use of such advanced circuit technology as LSI (large-scale integration) circuits and flexible printed circuit interconnections. Also cited was essentially knobless operation employing newly developed automatic controls whenever possible. RCA has elected to use a modified VHS format videotape recorder. The camera will supply unencoded *Y*, *I*, and *Q* signals to the recorder for recording on three separate carriers. The recorder will run at 8 in/sec, providing 20 min of recording time on a 240-meter cassette. Two audio tracks plus a time-code channel are provided. Also discussed was a studio version of this VTR with three-channel time-base correction before encoding and all editing functions.

Sony's Betacam BVW-1 system is based on a camera similar to the already announced Sony BVP-110. This camera uses a high-band Saticon Tri-

nicon tube. Their VTR is a $\frac{1}{2}$ -in Beta format design. They pointed to the weight, size, and power economy of the one-tube design; also noted was the elimination of registration controls. Their camera will provide *Y* and encoded chroma to a Beta modified format recorder for recording on two separate carriers. An L-500 cassette will provide 20 min of recording time with two audio channels and a time-code track. Also discussed was a studio playback-only machine (BVW-10) that would be compatible with their existing editing systems and time-base correctors.

Both RCA and Sony stressed the need for VTR/camera combinations that will meet or exceed the specification of the existing ENG (electronic newsgathering) systems based on the U-matic format. It was stressed that this system would be used for more than ENG, and must be easily integrated into the EFP (electronic field production) and post-production environments.

This session was closed by a very interesting photo essay presented by Bebe McClain, on the Hitachi Denshi Tri-electrode Saticon Tube Manufacturing Plant in Japan.

The other session on Advances in Camera Technology examined various camera improvements and system techniques. R. Matchell, H. Schkolnick, and D. Poetseh all gave papers on advancements in telecine design. A. Keil discussed Triax camera cables. K. H. Grieshaber described the Ampex approach to an automatic digital camera set-up system for their BCC-20 portable camera. L. Adler gave a paper on the human factors that influence the look of an electronically generated picture compared to film, and how this may influence HDTV (high-definition television). The paper also outlined the development of the PanaCam version of the CEI 310 video camera.

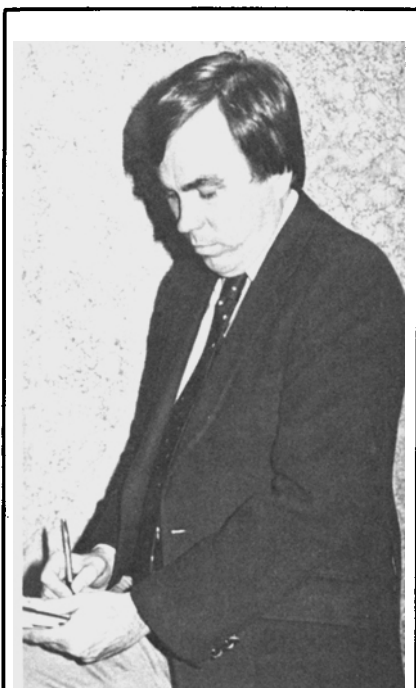
Of great interest to many were the pair of sessions entitled the Film-Tape-Film Interface, describing approaches to the marriage of film and tape.

Users and manufacturers alike were speaking of video-assisted film editing systems available today, each offering a different but relevant application of video hardware to the problem of interfacing video with film. A definite trend toward using the film "key" or

"edge" numbers to maintain the film relationships while editing on tape was noted, with four papers outlining procedures for shooting on film, editing on videotape work prints, and then cutting the film for release.

A paper by R. Duffey and J. Roizen described a system for editing film work prints. It uses a conventional flatbed film transport, adapted with a video camera, to feed a synchronized videotape recorder, thus allowing assembly of a work print without cutting the film. A print-out of selected film segments with frame count is provided.

P. McFadin and M. Kary gave papers on editing techniques using tape work prints of the original film with edge numbers and other pertinent data encoded in the vertical interval time



Gary E. Thompson was the special correspondent for the *SMPTE JOURNAL* at the 123rd Conference, reporting on the television sessions. As a private consultant in Hollywood, California, he specializes in television engineering services and allied fields. Much of his work is involved with the television and film interface. For seven years, prior to establishing his own office, he was Chief Engineer for CFI Video, and before that he was Engineering Manager for Vidtronics Company. He opened his office for Television Engineering Services two years ago, and has found the work of a consultant especially gratifying.

code (VITC) user bits. The work prints are used to make all editorial decisions. After a completed tape work print is approved, a film cutting list is generated using the information encoded in the VITC user bits. Both A. Schneider and A. Rynew gave papers on software and hardware systems they have developed for in-house use of existing post-production tools to assist the filmmaker in making editorial decisions as well as optical effects. Schneider stressed the use of software-based systems that were compatible with many existing editing systems.

For those interested in the applications of high-definition television, K. Holland of Image Transform demonstrated their HDTV system, ImageVision, as both a distribution system and as a source for producing high-quality film release prints. They projected a 1:85 theatrical print of a videotape master that had been transferred to a negative by an electron-beam recorder, and then transmitted a copy of the same videotape master by satellite to the theater to demonstrate this dual capability of their system. It was also stated that this system has had field testing and is available today. A. Sturm delivered a separate paper on one of the videotape recorders used in the ImageVision process. Bosch-Fernseh BCN-51 videotape recorders are being modified to record the wide-bandwidth signals required for systems such as ImageVision and other specialized video recording processes, i.e., ultra-high-quality mastering of film transfers. During these sessions several papers were also given on enhancing reproduction of film on modern telecine equipment.

There were two sessions devoted to digital topics.

During the session on Digital Video Tape Recording Technology, William Connolly, chairman of the SMPTE Study Group on Digital Television Tape Recording, gave a summary of the current status of digital standardization, emphasizing the importance of the CCIR AA/11 specifications. Many of the prospective digital recorder manufacturers, including Ampex, Bosch, RCA, and Sony, expressed their thoughts on the development of a digital recorder. R. Youngquist expressed the 3M view on editing digital audio signals in a digital audio/video system.

During the session on Digital Signal Processing, several papers were given outlining digital processing of televi-

sion signals for special effects and transmission. All these papers reflected the recommendation of the CCIR (International Radio Consultative Committee) for a digital system comprising component coding of Y , I (U), and Q (V) signals with a 4:2:2 sample at a 13.5-MHz rate, and a compatible horizontal sample for all television standards to insure international compatibility. Two papers (by Merrill Weiss of KPIX and by Richard Green of CBS) summed up the choices and cautions in making the transition from analog to digital from a system point of view. The views of both the networks and the large local broadcasters were expressed. Their concerns were much the same, centering as they did on the changeover period during which analog and possibly two digital (component and composite) systems will have to co-exist.

A fine illustrated glossary of computer graphics was presented by Glenn Entis and led off the Computer Graphics session. The other papers in this session described various computer graphics applications. All of the papers indicated the considerable potential of computer-generated graphics for both the television and the film communities.

In the two Video Anthology sessions, several papers were given outlining videodisc development and the Japanese television industry. A variety of other subjects were covered including automation in broadcasting and a comprehensive overview of recent developments in teletext systems in the U.S.

A special session was added to the program to explore recent developments in Microwave and Antenna Systems (papers # 140-146).—*Gary E. Thompson*

The Sound Sessions

The Sound Session was actually a combined morning and afternoon double session held at the Academy Theater — the Samuel Goldwyn Theater of the Academy of Motion Picture Arts and Sciences (in Los Angeles but *not* at the Century Plaza Hotel). The presentations were an informative mix of the past, the present, and a glimpse of the future. Historical papers on early sound recording and reproduction practices (both on film

and on disc) were well complemented by especially relevant opening films: *Mr. Bell* and *Listen to This*. The present state of the industry was emphasized in descriptions of existing facilities in which new state-of-the-art equipment is gradually being introduced. The sound process was described as a chain of steps culminating

in the final sound reproduction. An area of interest and on-going research is that of sound reproduction in the motion-picture theater. Another subject discussed, in which it was suggested that change may be needed, is the standard commonly known as the "Academy Curve."

The future can be glimpsed by de-

scriptions of the latest equipment: a computer-assisted mixing system, equipment for printing and utilizing time code for audio, a new design for magnetic film transport, a new system for sound tape-to-film transfers, and results of research on sound transmission through perforated screens.—*Arthur Biderman*

Synopses of Papers Presented at the 123rd Technical Conference

Techniques and Technology for the Eighties

1. Opening Address. By *Joseph A. Flaherty* (SMPTE Executive Vice-President; CBS, Inc., New York, N.Y.)

A presentation designed to welcome members of the Society and other registrants to the 123rd Technical Conference. The highlights of this speech include the important aspects of the week-long conference, the international importance of the conference, and the assistance given by various committees and officers to help bring the whole event together. Also mentioned are the additional technical sessions at the 1981 Conference in the way of new technologies, including the latest data on high-definition television and digital technology.

2. Engineering Standards Report. By *Roland J. Zavada* (SMPTE Engineering Vice-President; Eastman Kodak Co., Rochester, N.Y.)

Discussed in this presentation are the SMPTE Engineering Standards activities for 1981. Included in this discussion is a look at the SMPTE's standards activity in relation to the United States Government regulations. Also addressed are the questions concerning motion picture and television standards in the eighties, and the Society's commitment to the needs of television standardization.

3. Photonics. By *Lincoln L. Endelman* (SMPTE Vice-President for Photonic

Affairs; Aerospace Systems, Perkin-Elmer, Santa Clara, Calif.)

Described in this presentation is the state of photonics in the eighties. Computer and integrated circuit technology has allowed great strides to be made in the field of high-speed photography by eliminating human error in image recording. The advance of technology has created new equipment which has capabilities of recording images moving at incredibly high speeds. The future of photonics in the immediate future looks bright as the equipment grows in capability.

4. Education. By *Herbert E. Farmer* (SMPTE Vice-President for Education; University of Southern California, Los Angeles, Calif.)

See the February 1982 issue of the *SMPTE JOURNAL*.

5. Developments in Television Technology in 1981. By *Frederick M. Remley* (SMPTE Vice-President for Television Affairs; The University of Michigan, Media Resources Center, Ann Arbor, Mich.)

This report to the membership summarizes the many developments in television technology that have been announced or introduced during the first nine months of 1981. The paper, written as a supplement to the recently published "Progress 1980 — The World of Motion Pictures and Television," will include information on the following topics: (a) teletext developments; (b) high-definition television systems; (c) digital video and digital audio proposals; (d) self-contained

camera-videotape recorder systems; (e) videodisc systems; (f) television camera tube improvements; (g) other developments briefly summarized.

6. Motion Pictures By *Roderick T. Ryan* (SMPTE Vice-President for Motion-Picture Affairs; Eastman Kodak Co., Los Angeles, Calif.)

This presentation, profusely illustrated with slides, makes the point that there is presently considerable expansion in motion-picture facilities. Many studios and also laboratories are building new structures or enlarging those already built. The author feels this is a very encouraging sign concerning the present and future vitality of the motion-picture industry. The concluding section illustrates and describes various types of new equipment.

Laboratory Practices I

7. Considerations in the Illumination of Photographic Darkrooms. By *C. Bradley Hunt* (Eastman Kodak Co., Rochester, N.Y.)

An important aspect of improving laboratory safety, as well as productivity, is in determining and providing adequate levels of safelight illumination which will maximize visibility in darkroom work areas. Film laboratories must be able to assess the level of illumination needed, choose the proper safelight equipment, and implement that equipment effectively in the darkroom areas. This paper reviews the physiological phenomenon of adaptation to the dark, the methods for

measuring safelight illumination, the safelight equipment which is currently available, and its proper application.

8. A Longer Length 12,000-Foot Printing System. *By Colin F. Mossman* (Rank Film Laboratories, Uxbridge, England)

This paper provides a comprehensive outline of the development of the high-speed film cleaning machine, designed to make up or clean 12,000-foot copy reels. The paper also discusses microprocessor conversion of a panel printer capable of high-speed RF or FCC printing, and the importance of the ancillary modular winding equipment necessary to handle the 12,000-foot rolls of film. The high-speed frame line winding unit, with splicer, creates rolls of positive raw film stock with splices that will fall on the frame line. The transport and storage system also affords protection of negative and positive film in transit or storage. This system, which has been used at Rank Film Laboratories over the last two years, was first shown to overseas visitors during the BKSTS '81 convention.

9. Printing Techniques for Adjustment of Final Screen Contrast. *By Wendell V. Discher and Donald L. Strine* (Eastman Kodak Co., Rochester, N.Y.)

Negative and positive films which are manufactured for motion picture productions are designed to provide the most commonly desired screen contrasts. However, lower contrasts and subdued colors are sometimes desired for aesthetic reasons by film users. These effects can be achieved for high-volume release printing by selectively pre-flashing the intermediate films which are used in making full-length duplicate negatives. Slide prints shown during the presentation of this paper demonstrate the modification of highlight and shadow contrasts which are possible using this technique of customizing master positive and duplicate negative sensitometry. The effect of directly flashing the projection print film is shown for comparison.

10. Bi-Directional Printing with Total Immersion Wetprinters. *By W. D. Carter* (Carter Equipment Co., Inc., Lawndale, Calif.)

Though the author has personally been an advocate of "total immersion wet-

printing" for all phases of motion picture duplication for many years, certain commercial parameters and raw material considerations, such as solvent availability, purity, etc., have led to yet another evolutionary stage in the development of total immersion wetprinters. By adapting the "interchangeable format" configuration of continuous contact total immersion wetprinters, in conjunction with the superimposure module, a "total immersion" wetprinter may now be provided with dry picture and sound heads for bi-directional operation. Though the author feels that ultimately there are more economically practical printing techniques, it is also understood that the use of this option is at the discretion of the end user. This paper deals with the mechanical considerations and design pertaining to a bi-directional dry printer, and describes in detail how this capability is accomplished without sacrificing quality or ease of operation when used in a wetprinter mode.

11. Color-Correcting System — Two Years Later. *By W. D. Carter* (Carter Equipment Co., Inc., Lawndale, Calif.)

At the 121st SMPTE Conference two years ago, the author delivered a paper entitled "A New Video Color Analyzer." Detailed at that time was an entirely new concept of electronic video color analyzing of motion picture films. The previous systems, utilizing complex custom dedicated electronic systems and/or sequential field color displays, were well known within the industry. By attempting to duplicate the consistency and repeatability of a motion picture film raw stock by means of standard, commercially available, color television components, an opportunity was presented for designing hardware utilizing a variable additive light source to illuminate the film being analyzed, thereby effectively duplicating a printing machine.

Since its initial manufacture and as a result of subsequent field testing, modifications have been made in the method of matrixing to compensate for the discrepancies between the spectral characteristics of the color display tube phosphors and those of the film dyes. Initially, such matrixing was done using complicated mechanical interaction of cams within the manual additive lamp house. Now, by means of electronic truth tables (Programmable

Read-Only Memories or PROMs), not only is a greater reliability achieved while reducing the mechanical complexity of the light source, but there is the further advantage of being able to make rapid and accurate modifications of truth tables for new film types or for individual peculiarities in a given laboratory's print/process parameters. These modifications can now be easily programmed to give optimum results over the entire printing range encountered by virtually any printing stock, from any original or pre-print material.

In this paper, the substantially increased versatility and simplicity of the new matrixing approach are examined. Additionally detailed are steps and procedures, along with available hardware, to completely automate the process of generating printing machine control tapes by interfacing them to peripheral devices.

12. Easy To Operate Wetgate Contact Printer. *By Ch. Geyer* (Geyer-Werke GmbH, Hamburg, Germany)

In the course of the last few years, the speeds of the wetgate printers have increased. While ten years ago speeds of 180 feet per minute were normal for film printing, today there are speeds up to 720 feet per minute and faster. While this increase in film printing speed means increased printing output, total efficiency can only be considered if lacing-up time for the printers is disregarded. Consequently, if a hundred prints are made per negative, then the negative runs in a loop and the raw stock is connected continuously over an elevator. Therefore, it can be assumed that increased productivity due to faster printing speeds is true only when mass prints are made. The situation is quite different if single prints have to be made (that is, printing a few pieces for which the threading of a loop cabinet is not worthwhile), A/B prints have to be made, or section printing has to be done. With priorities such as these, the lacing-up time of a printer is becoming more and more significant as a part of the printing speed. It was with these priorities in mind that Geyer-Werke set out to design the wetgate contact printers discussed here. These printers are designed to be easily operated and to work largely automatically. These machines have been designed so they are particularly easy to maintain. An unskilled person can discover and repair a machinery breakdown in a short time.

13. Eastman Ektachrome High Speed Daylight Film 7251. *By B. O. Black, W. G. Doody, R. J. Guerin, and H. R. McNair* (Eastman Kodak Co., Rochester, N.Y.)

A new high-speed color reversal 16-mm camera film, compatible with either Process VNF-1 or Process RVNP, is now available. The film, Eastman Ektachrome High Speed Daylight Film 7251, has been developed to help further satisfy the need of cinematographers working in disciplines such as sports and motion analyses for more photographic speed. It is designed for daylight exposure and will produce acceptable results under a variety of metal halide and xenon arc discharge lamps without filtration.

14. Paper cancelled.

15. A Unique Challenge in Electro-mechanical Design — The GSMO Camera. *By Edmund M. DiGiulio* (Cinema Products Corp. Los Angeles, Calif.)

Designing a 16-mm film camera for the 1980's requires one to look at the latest technology available in acoustic and structural materials, motor drive systems, and the latest advances in microcircuit technology.

Size and weight are critical factors in the design of any hand-held camera. It was possible in the design of the GSMO to achieve size and weight reductions, on the one hand, by utilizing the largest scale of integrated circuits that could be hybridized to provide all the needed camera control functions and, on the other hand, by utilizing, wherever possible, recently developed carbon fiber materials which provide approximately three times the tensile strength of aluminum with half the weight. These savings in size and weight reduce the weight of the GSMO camera to less than 10 lb — fully equipped with plug-in battery and viewfinder, and including a 400-ft magazine. Also contributing to size and weight reduction is the unique motor used in the drive system; it has a samarium cobalt permanent magnet structure that provides the performance of substantially larger motors in a very compact package.

To achieve an acceptably quiet sound level without added-on excess size and weight presented a really difficult challenge to the design engineers of the GSMO. Here again, the latest technology in drive systems was utilized to achieve a sound level not exceeding 28 dB on the weighted A scale, one meter from the film plane while pulling film. There is only one gear mesh in the entire camera, with sophisticated toothed drive belts providing all other drive functions. Total isolation of the one gear pass and motor module from the rest of the camera is the key to achieving the low sound level.

The latest addition to the camera design is the 100-ft (30-m) magazine. With this magazine, the total camera weight (less lens and film) is less than 8 lb. The camera profile is exceedingly compact as well, measuring 12.9 cm wide by 11.8 cm high by 19.3 cm long (5.08 × 4.65 × 7.60 in). Also included in the camera design are the most advanced electronic features that modern cameramen require, such as through-the-lens indication, as well as the ability to write SMPTE time code in the camera in accordance with recommendations of the SMPTE Time Code Working Group.

16. The Design of a Total Studio Complex to Service Film and Video Production in the New York City Area. *By Milton Forman* (Consultant, Astoria Studios Inc., New York, N.Y.)

The New York City area is the second largest center for the production of feature films, films for television, and commercials in the United States. (The Hollywood-Los Angeles area is first.) New York is such an important center because it has a substantial supply of competent, skilled film and video technicians and is the center of very desirable and interesting locations. In addition, it has some stage facilities and excellent laboratory facilities and optical and other post-production capabilities.

For the out-of town producer, however, it leaves much to be desired. The production manager is on his own to find the proper people, the most reliable sources, the best equipment and the full complement of supplies. This results in inefficiency and excessive costs. Up to now, New York has been a wonderful center for location shooting. However, it has rarely been able to fulfill the complete needs of film production.

In 1980, George Kaufman, a real estate developer who had previous experience in the film industry, saw the potential of developing a viable project which could be financially justifiable as well as result in bringing a substantial amount of business to New York. Utilizing the support of the city, state, and federal government, Mr. Kaufman backed a plan to supply the New York area with the best, first-class support for the production of film, television, and commercials. The heart of the program was to utilize the Astoria Studios, which were built by the U.S. Government in the 1920's. These studios are only a 10-minute auto drive from the center of Manhattan, over the 59th Street/Queensboro Bridge. The studios had four stages and were used by the U.S. Army for the production of training films during the Second World War. Prior to that, they were used to produce feature films. Recently they have been used to produce such films as *The Wiz*, and other large productions. The studio has the largest stage outside of Hollywood itself — a 26,000 square ft stage with a height to the grid of 40 ft. In addition there are three stages of approximately 4000 square ft. The stages have not been improved much since their construction.

The design task was not only to modernize the existing facility but also to add two new stages so that the resultant facility could become a basic center for the production of film and independent television for the East Coast. The issue was not to "compete" with Hollywood, but to provide a capability for the film and television industry to produce its product on both coasts of the U.S. efficiently with high quality.

Historically, Hollywood developed its studios where there was an abundance of available land, so everything is spread out, and on a single level — ground level. This resulted in studios which expanded horizontally. As a result the distance from the center of production to the carpenter shop, paint shop, etc. is considerable (and the handling costs as well as the cost of time and labor escalated). This is reflected also in the location of the production offices, dressing rooms, etc., with respect to the center of production — the shooting stage. Therefore, the layout of the typical Hollywood studio left much to be desired from the point of view of easy "flow" of material and labor.

The design of a medium-sized

complex which would mitigate the deficiency of the "Hollywood" production system and optimize the method of production that was possible in the New York area was proposed, therefore, by Mr. Kaufman. The design objectives of the new studio complex were as follows:

1. To refurbish the existing four stages with proper soundproofing and with a simple efficient grid system. Also there should be a utilization of the ample space available so that the support facilities are immediately adjacent to the stage. This would apply especially to the carpenter shops, paint shops, electrical, grip, camera and sound, set dressing, production offices, etc.
2. To design two new 14,000 square ft stages with a grid height of 35 ft to include the latest state of the art improvements. These stages are to provide for the efficient access of all support requirements.
3. To organize as part of the studio system a service for the producers to be able to purchase all supplies, materials, and consumables. Also the studio will be able to expedite location searching, permits for shooting, etc.
4. To include space within the physical facilities for service companies to rent space in the complex — special effects, location video, location film production, etc.

17. The Mitchell Camera: The Machine and Its Makers. *By Laurence J. Roberts* (Portland, Oregon)

A concise history of one of the world's leading — and pioneering — professional motion picture camera makers is presented, including a review of their products from 1920 to the present. The presentation includes, in addition to the company's standard 35-mm and 16-mm models, specialized models in the wide-film gauges of 55 mm, 65 mm, and 70 mm, as well as horizontal-travel 35-mm and multiple-panel 35-mm models. Among the 35-mm models covered are the first model, Standard, Hi-Speed, NC, BNC, BNCR, 205-R, Mark I, Mark II (S35R), S35RB, S35RC, and Mark III models. Wide-film and specialized models include the "Grandeur," FC, BFC, Todd-AO, AP-65, 55-mm SCS Super Cinemascope, horizontal VistaVision, and three-panel Cinemiracle models. Also covered are 16-mm gauge models such as the Standard,

SSR16, and R-16-S. Process (front or rear screen) projectors and obscure Mitchell models such as the "Giant" 16-mm and 35-mm theater projectors, and 8-mm and 16-mm amateur projectors are mentioned.

The concept and uses of various types of Mitchell and Mitchell-designed movements are treated, including their use by other manufacturers of cine equipment. The presentation stresses the importance to the world film community of standardized types of 35-mm cameras and production equipment.

18. A New Ergonomic Approach in Film Editing Table Design. *By Karl Brey and Gerald Wilke* (Arnold & Richter, Munich, West Germany)

This paper presents a new generation of film editing tables in which up-to-the-minute technology is combined with ergonomic layout design. Prior to firming up any of the technological features of this new six-plate editing table for 16-mm film, a comprehensive ergonomic design study was carried out.

A computer study was made, analyzing all data relating to seat dimensions, height of eyes, size of working area, field of view, optimal arrangements of control elements, and much more. Each factor was weighted for its relative importance in the work process of film editing, along with considerations as to the physiological differences between female and male editors, tall and short persons, etc. Applying the results of this analysis, an editing table was created which, we feel, differs substantially from former, conventional ones in the areas of operator comfort and convenience.

The new BTM 616 Editing Table is equally significant from the point of view of technical features. The design completely eliminates synchromesh and differential gearing, magnetic clutches, as well as plates and other forms of electromechanical slaving of drive components. Quartz-controlled speed precision is maintained at all speeds up to ten times sync-sound speed. A 24-face glass polygon ring is installed as standard equipment to assure excellent image quality and smooth flicker-free projection, even at speeds substantially below 24 frames/sec.

The Arri BTM 616 Editing Table is equipped to handle both EBU/IRT and SMPTE time codes.

Laboratory Practices II

19. Liquids for Use in Full Immersion Printing Process. *By R. N. Haig* (Lipsner-Smith Co., Ltd., Uxbridge, England)

There are a number of factors to be considered in the selection of a suitable liquid for use in full immersion film printing processes. Primary among these are: (1) that the refraction index of the liquid approximate that of the film base, (2) the effect of the liquid on the film base and emulsion, (3) possible liquid mixtures (4) the effect of the liquid on the print film when used in contact printing, (5) the effect of the liquid on the printing machinery, (6) removal of the liquid from the film after printing, (7) liquid filtration, and finally, (8) toxicity. This paper examines and also evaluates the effects of these various factors in printing processes.

20. Persulfate Bleach for Process ECN-2. *By Julianne E. Crisante and Wayne A. Szafranski* (Photographic Technology Division, Eastman Kodak Co., Rochester, N.Y.)

This paper provides a detailed description of the use of sodium persulfate bleach in Process ECN-2. This bleaching system provides an attractive alternative to those motion picture laboratories seeking a means to assure compliance with local waste disposal codes governing the amount of ferricyanide in their effluent. The presentation also includes a review of the persulfate bleaching mechanism, a discussion of the advantages of persulfate bleach, and a detailed explanation of changes in the process specifications.

21. A New Eastman Color Print Film. *By John W. Erwin, Steven J. Powell, Franklin R. Reinking, Richard C. Sehlin, Stephen W. Spakowski, and Richard J. Wein* (Eastman Kodak Co., Rochester, N.Y.)

A paper which describes, in detail, a new color print film designated "Eastman Color Print Film 5384/7384." This film has a number of advantages, including a greatly improved cyan dye, dark-keeping stability, and reduced sensitivity to processing variations.

22. Film Is Not Dead. By Harry Teitelbaum (Hollywood Film Co., Los Angeles, Calif.)

Film has an impact on every person in the world in one way or another. Twenty-five years ago, with the invention of videotape, it was predicted that film was doomed. Today, film usage is greater than ever and the market has expanded through motion pictures, amateur productions, advertising films, defense usage, information storage, medical applications, microcircuitry, and other areas. Today, film and videotape have expanded and complement each other.

This paper deals with film usage throughout the world, the improvements made to date, and a discussion of research dollars being spent for future improvement.

23. Experiences with the Super-16 Format. By R. Ericson and A. Orring (Swedish Filminstitute/SFI, Stockholm, Sweden)

The originally scheduled paper was cancelled. The synopsis for this replacement paper was not available at press time.

24. Psycho-Physiology of Film and Video. By Dimitri Balochoff (Meuter-Titra Laboratories, Brussels, Belgium)

The same film sequence may have quite a different effect on the same viewer, depending on whether he sees that sequence on a normal cinema screen or on a television picture tube. This paper provides an analytical comparison of psycho-psychological responses to such visual stimuli offered by these two modes of presentation. Also surveyed are the different, and sometimes contradictory explanations, which have already been proposed about TV and cinematic viewing. Examples are also provided to highlight the areas where the language of film loses its consistency and strength when it passes to the video medium. A new theory emerges which explains the differences between these two media.

25. Production Procedures for High-Capacity Motion-Picture Printing. By Roland Chase (Colour Film Services, London, England)

Many users of continuous total immersion printers find that the output is below expectations. They also find

that operators object to the risk of contamination from the solvent by contact during rethreading and by vapor inhalation.

This presentation outlines the means by which these reservations or objections may be overcome. One method is the use of a system of film leaders which allows the equipment to be used without rethreading between one printing run and another. A second procedure is to enclose the submerged printing heads to contain the solvent vapor. By these means, not only is the risk of contamination removed, but also the output can be improved as much as threefold.

25A. Electrically Controlled Manual Additive Color Lamp House for Optical Printers. By M. Nishizawa (Hoei Sangyo Co., Tokyo, Japan)

This paper describes a newly developed lamp house for an optical printer, in which the quantity and quality of light are electrically controlled using three 500 W halogen lamps.

The ordinary additive lamp house separates white light into red, green, and blue by using dichroic mirrors, regulates the quantity of these lights with three light valves, and finally recombines them to obtain any required quantity of light. The drawback to this system is that the use of the dichroic mirrors tends to cause an uneven distribution of light due to the irregular reflection of light.

In this new system, the dichroic mirrors have been replaced by dichroic filters and glass fibers that provide nearly 100 percent even distribution of light. Since the dichroic filters have no problem with uneven color, the obtained red, green, and blue components are immediately collected at random by using each optical glass fiber. Thus a uniform surface brightness is obtained. The collected light-radiating points of the optical glass fibers form over a hundred thousand red, green, and blue light groupings. The light is printed on the required picture using a condenser, while the light obtained through the dichroic filter is collected at a given point through the optical glass fibers. A sensor is attached to the end points of the optical glass fibers so that it senses the same quality of light as that collected at the given point. The sensed light is transferred to a central processing unit (CPU), where additional processing is performed in conjunction with the data for film printing light control, which are supplied by an

external preset trimmer, and the calculated value is immediately fed back to each lamp.

The International Scene

26. Motion Pictures From Another Angle. By I. Ben Yehuda (Ben Film Productions, Tel-Aviv, Israel)

Commercial motion pictures are filmed and projected mainly in 35 mm either as Cinemascope or in wide-screen ratios from 1:1.5 to 1:1.85. Although there are producers who are using negatives larger than the 35-mm format, nevertheless even the use of "only" 35 mm is often considered quite expensive for low-budget film projects. Hence, more economical solutions are continually being sought.

The following three systems, known for their economical value, are briefly described.

1. *Techniscope.* A regular 35-mm camera is converted to pull down two perforations instead of four. Prints are made either by anamorphic or straight enlargements.
2. *16-mm Blowup.* A regular 16-mm camera is used both for Cinemascope as well as for flat wide-screen for later blowup of the picture to 35 mm.
3. *Super 16.* This is an improved version, proposed by Rune Ericson, which uses single perforated 16-mm film by extending the picture frame over the space used for the soundtrack, thus gaining 40 percent over the 16-mm wide-screen frame — also for the purpose of blowing up to 35-mm film.

All the above systems have one factor in common — the need for an optical printer to achieve a print suitable for 35-mm projection. Though appreciating the many advantages and savings achieved by the above three systems, the author considers a fourth alternative, comparing it with the existing systems and discussing its advantages for practical usage.

Since wide-screen productions have become popular, the 35-mm frame has been cropped, leaving less than half its height unused. The fourth alternative utilizes the free space by exposing an additional image. The Techniscope system used this same idea when it divided the 35-mm frame horizontally. The author proposes that the frame be divided vertically into two equal parts and that pictures be exposed on each

half separately, with the half that is not to be exposed being masked. Actually, by dividing the frame vertically, the width of the picture becomes smaller than its height. Therefore it has to be exposed after turning the frame by 90° optically or mechanically. This can be carried out in various ways depending on the type of camera. One light or graded rushes could be contact printed and later projected on any standard 35-mm projector fitted with an adapter outside the lens to turn the image by 90° and a mask in the gate to cover the other half of the frame. For editing purposes the print is split into two separate rolls and used like any other film with suitable equipment.

If we compare the four systems, by taking into consideration that the same emulsion has been used in each one, the use of split 35-mm film would be most economical while maintaining the highest quality.

Using the proposed system, the following types of prints can be released: (1) a contact print on one side of the 35-mm frame, with the regular soundtrack printed in its usual space on the other side; (2) both sides contact printed with the images, including their respective soundtracks in opposite directions; (3) a contact print of a split 35 mm (17½ mm); and (4) an image enlarged to 35 mm.

The author expects that there will be much interest in separate filming and screening of split 35 mm — either as a single or double 17½-mm film, photographed and projected by turning the image by 90°. The advantage of “Split 35” is not only economy and quality but also easier handling due to the weight reduction of 50 percent. Its further development will result in lighter cameras and projectors, cheaper release prints, and lower delivery costs.

27. Film Storage and Shipment: Square Solutions to Rolling Problems. *By Morten Jacobsen* (Morten Jacobsen Trading ApS, Gentofte, Copenhagen, Denmark)

Ever since the first theatrical releases early this century, the film industry has had to cope with some big rolling problems. The Americans, who generally set the trend, did something early to “ease the roll.” They at least store and ship prints on reels, three to the case, for features.

The same cannot be said for the Europeans. We neither shelve nor transport 35-mm film on a reel. There

are historical reasons for this situation, but they all seem to boil down to money. The Europeans, to put it bluntly, are penny-pinching to the point where many in the industry pinch the film to save the penny.

Otherwise, how do you account for the distributor who spends \$2000 for a release print and \$15 for a set of cardboard boxes to send it on its rounds? How do you explain the projectionist in some countries who knocks out the only support the film has — its plastic central core — and sends the print packing again with a gaping hole in the middle? Why else, when it comes down to it, are prints still stored in the same round metal cans in which raw film is supplied? And I am thinking both of the awkwardness of storing “in the round” instead of in standard square plastic boxes, as well as of the superb heat conduction of metal in the event of fire. Plastics which we use for film cans are rated class V2 according to the American test method UL 94 by Underwriters Laboratories. According to ASTM D 635-74, they are self-extinguishing. Class V2 is obtained with plastic thicker than 2 mm. Such plastics will not catch fire. Film has a better chance in plastic cans.

We are all aware of the trend towards distribution of 35-mm release prints in longer lengths. We know that two years ago the BKSTS Technical Advisory Committee recommended retaining a length of 2000 ft in Britain, appealing to laboratories to supply prints in 2000-ft metal cans to BS4615. Meanwhile other countries go on adopting automated projection systems and much larger and heavier reels.

My own country, Denmark, was the first in the world to move nationwide to the Italian-type 5000-ft reels. All projectors were converted in early 1978. Do not ask the aging cinema owner in the community where I live how he likes lugging 30-kilo cases of film up into the projection box.

Looking at the storage and shipment of 2000-ft prints today, I have seen no significant improvement whatsoever — and certainly no radical change — in the entire history of the motion-picture film in Europe. Nothing. As one of the few European manufacturers of film storage and transport hardware, I visit laboratories and libraries up and down the Continent; and almost everywhere I go I am struck with disbelief. Archives, especially, are a plain disgrace. I have seen some in uninsulated cellars where

there is flooding and water dripping from above. These archives are supposed to be preserving film for people to look at a hundred years from now! The most common container in current use for all types of film is a cardboard box. In most European countries they just use a stack of these “European” boxes strung together. A 35-mm print is laid inside. The fifth or sixth “reel” may be only 1000 ft, which means that there is a free space of 5 or 6 in around it for kicking about. The cardboard boxes do not close snugly, especially after they start to break down and handlers keep lifting them by one side of their lids. Film is increasingly exposed to dirt from without and cardboard debris from within.

Now that such a series of cans is available, we may hope to see a concerted move to replace cardboard with a simple, sturdy, square plastic box which costs very little more, yet affords much more protection and longer life.

The presentation includes an audiovisual tour of some Northern European film capitals to show how film is being handled right now. Coverage includes 16-mm short or sponsored-film libraries, 16-mm feature film services, and 35-mm archives. Most of these, in the author’s best judgment can be standardized at low expense in plastic, affording the film superior protection for generations to come.

28. The Tucson 35-mm Fisheye Projection Lens. *By R. A. Buchroeder* (Optical Design Service, Tucson, Arizona)

The Tucson lens is intended for hemispheric motion-picture projection systems used to produce filmed environments that surround the audience. Applications may be found in planetariums, the theater, the entertainment industry, and certain research areas.

The lens was designed in 1974 by R. A. Buchroeder and is covered by U.S. Patent 4,070,098, assigned to the University of Arizona Foundation. Two copies of the lens have been built. The first has been operating since 1975 at the Flandrau Planetarium, in Tucson, Arizona. The second opened in 1978 at the Russell C. Davis Planetarium, in Jackson, Mississippi.

The *f*/3 system, comprising 14 elements in two principal sections, projects a 23-mm fisheye image from four-perforation 35-mm film through a 180° angle onto a 30- to 60-ft concave theater screen. The lens corrects

the distorted film image and produces a surprisingly realistic full-sky image whose resolution is film-limited.

The optical system produces an image orientation rotated 180° by comparison with conventional lenses. There is a choice in how this may be corrected, but the use of a mirror cluster seems most practical. The projection system is flexible in that it contains a motorized focused iris that may be used to mask the image for special effect, and a motorized non-uniformly acting fader that can totally extinguish the image or affect the brightness of the image. The less expensive of the two optical sections, effectively a six-element relay lens, may be adjusted to vary the projected dome angle for different film formats, or it may be exchanged for an entirely different relay for conversion to a 70-mm format. Focusing is accomplished by moving the relay section.

Owing to the enormous magnification involved in hemispheric projection, special considerations apply to optimize resolution and screen illumination. This paper explains the practical as well as the theoretical development of the Tucson lens, and it also reports on experience and ongoing refinements.

29. Nordiska Film-och TV-Unionen (NFTU) — The Nordic Film and Television Society. By Otto E. Mikkelä (Oy. Yleisradio Ab. — Finnish Broadcasting Co., Helsinki, Finland)

The Nordic Film and Television Society (NFTU) was formed in 1962 as a forum for debate, advanced education, and exchange of technical and practical experience. The Society has sections in Denmark, Finland, Iceland, Norway, and Sweden. The members are organizations for film and TV workers, as well as institutions which are active in the production and distribution of films and television.

According to the regulations, the object of the Society is "to act as a Scandinavian contact organ on the ideal level for those who carry out artistic, technical, and administrative activities attached to film and sound. Within its field of activity the Society intends to (a) strengthen and develop Scandinavian cooperation, and (b) work for education, research, information, and other interests."

The general meeting of the Society is the supreme authority. Each section has one vote. The work of the Society is directed by a Board of Directors, to

which each section appoints two representatives, one of them being the President of the national section. A Programme Committee and a Technical Committee act as preparatory organs under the Board of Directors. The committees have a member from each national section. The presidency of the Society and the secretariat are placed with one of the national sections, according to a choice made at the general meeting.

The main work is done in the national sections, which prepare their activity within the objectives of the Society. The work of the national technical working groups is directed and controlled by the Nordic Technical Committee, which has two meetings yearly. In addition to the national activity, the Society arranges Nordic meetings, seminars, and conferences, the practical organization of which can be delegated to a national section. Among the arrangements of a technical nature carried out by the Nordic Film and Television Society, a few can be mentioned: study tour to Rome (1964); study tour to USSR (1965); color film and color television seminar (1966); study tours to London (1969 and 1970); picture cassette seminar (1971); idea-technique-creativity seminar (1973); film/video seminar (1976); symposium on ecological problems in film laboratories (1976 and 1981); and study tour to USA (1981).

Each national section has its own language (Finland has two languages: Finnish and Swedish). The NFTU has no official language. Each section writes in its own language (the Finnish section uses Swedish in Nordic connections). Though the languages are different, they belong to the same family of languages (except Finnish) and are fairly well understood by experienced members; there are language problems, however, on the normal working level. To help solve this problem, the Society has undertaken the publication of a dictionary about film and television terminology. The book contains about 1700 terms, with English definitions and corresponding words in all five Nordic languages. The manuscript of the book has been completed, and printing arrangements are being made.

The Society takes part in international standardization by unofficially coordinating Nordic views on the matters discussed in ISO TC 36. It also publishes technical recommendations for Nordic use in matters which need

standardization but are not yet internationally standardized, or in cases where several different standards exist.

For distributing information the Society uses *TM Journal* (Tidskriften TM, Teknik & Människa), which is the leading Scandinavian film, television, and video journal. It is published by the Swedish Film Institute in Stockholm and supported by the corresponding Danish, Finnish, and Norwegian institutes.

30. An International Organization: UNIATEC. By Claude Leon (UNIA-TEC, Paris, France)

Synopsis not available at press time.

31. Technical Control in the French Cinema Industry. By Claude Soulé (Commission Supérieure Technique du Cinema Français — CST, Paris, France)

In order to carry out technical control in the French cinema industry, the organization concerned should have (1) the *necessary technical facilities*: test films, definitions and color test charts, etc., and (2) *specialized equipment and testing laboratories*. But this is not enough; it is also necessary to fix the measurement methods and the optimal values and to be able to adapt both of them according to technological evolution.

In France, this technical control in the cinema industry is carried out by the Commission Supérieure Technique du Cinema Français (CST). Its control activities involve the following duties:

1. To undertake all tests and measurements concerning films, equipment, premises, recording, processing, and reproduction of picture and sound. These tests can be carried out either in our laboratories, which have all the necessary specialized departments to cover every technical activity, or in any place where such measurements are required.
2. To publish, produce, or manufacture the required testing means for equipment and processing procedures in the various fields of film activities—for example, test films, definition and color test charts, and so forth.
3. To establish specifications in order to define, rationalize, and improve,

whenever possible, methods and practical working conditions.

4. To offer a technical assistance service, that is, to act as adviser for technical matters, whether they concern the premises or equipment.

In this paper, the author describes the different control activities, and illustrates them with a number of slides.

The CST plays an important role at all levels in the field of technical control, acting as testing and checking laboratory, producer of technical facilities, and technical adviser for the working of the French film industry.

32. The Talking Walls of the ASC. By Harry Wolf, ASC (American Society of Cinematographers, Hollywood, Calif.)

Throughout the last 45 years, the American Society of Cinematographers (ASC) has been headquartered in the heart of Hollywood. The walls of the old Spanish mansion built in 1903 could tell some fascinating stories, but the first thing most people want to know is: What do the letters ASC mean? They could mean "a splendid cameraman," or in deference to the non-sexist language, "a splendoriferous cameraperson." The letters ASC really stand for the American Society of Cinematographers, and membership in this society is one of the highest honors that can be bestowed upon a professional cinematographer. It is a mark of distinction and prestige.

The Society, founded in 1913, is the oldest film industry organization on the West Coast. It was originally called the Static Club because of a problem which plagued early film makers: static electricity on the negative. The ASC is a cultural, professional, and educational society whose original purpose was to give cameramen the opportunity to exchange ideas and to encourage manufacturers to make better equipment. The patents on equipment and photographic techniques held by ASC members embrace every phase of motion picture photography. Informal contributions of members to the evolution and refinement of commercially manufactured equipment and materials are innumerable. There is hardly anything used today in cinematography which does not bear some trace of a contribution by ASC members.

The ASC serves the entire industry through its publications, *American*

Cinematographer Manual and the magazine *American Cinematographer*. The *American Cinematographer*, a technical trade magazine, began publishing in 1920. Subscribers in 102 foreign countries as well as all 50 states in the U.S. receive the latest technological news through the pages of this monthly publication.

Motion picture nostalgia fans can enjoy the clubhouse museum containing a great number and variety of equipment including early motion picture machines such as the Mutoscope and the Kinetoscope, the first motion picture machine to use 35-mm film. The patent on the Kinetoscope was applied for in 1891. Within the walls of the clubhouse the history of the film industry is unfolded, but the clubhouse itself has quite a colorful history. In the early days, the main ballroom was full of flora and fauna. Plants of all kinds gave the house a jungle look. Later, Conway Tearle, a leading man of the silent film era, occupied the house. From then on, it was destined to be affiliated with the film industry. The sad economy of the 1930's brought economic disaster, and foreclosure was carried out in 1935.

Subsequently, the ASC bought the property in 1936 and transformed it into their clubhouse. Here many happy hours have been spent at dinner meetings with some very talented and famous people. Originally there were four bedrooms, a parlor, and a study in the cupola. An ample dining room, butler's pantry, and large kitchen saw much use as the elite of the world of music and the arts gathered for frequent receptions. Changes in the interior have provided the 180 active club members with a comfortable meeting place. There are stringent membership qualifications. In addition to the regular membership, there are 90 associate members, and through the years several honorary members, among whom was Thomas Edison.

More than 84 Academy Awards, 25 Emmy Awards, and hundreds of nominations have been presented to ASC members of the American Society of Cinematographers. It is truly an honor to be able to place the letters ASC after one's name.

33. A High-Speed Eastman Color Negative Film. By Glenn L. Kennel, Frank R. Reinking, Stephen W. Spakowski, and Geoffrey Whittier (Eastman Kodak Co, Rochester, N.Y.)

A new film, to be designated Eastman Color High-Speed Negative Film 5293/7293, is described. This film, designed for processing in Process ECN-2, is a tungsten-balance camera film which provides good graininess characteristics and exposure latitude at an Exposure Index of 250.

34. The Role of the BKSTS. By John B. Aldred (BKSTS, London, England)

The British Kinematograph, Sound and Television Society (BKSTS), now in its 50th anniversary year, is the only technical society in the U.K. catering to motion picture, sound, and television engineers. It was founded in 1931 by a group of individuals who were formerly the London Branch of the SMPTE — then called the SMPE. At that time it was called the BKS and catered only to film interests, but the Society has now expanded its title and areas of influence to meet the requirements of its sound and television members.

The BKSTS is run by an elected President and Council, who appoint technical committees to execute the Society's affairs in their particular fields. From its very beginning the Society has been involved in promoting technical papers and has played an active part in standardization. It also organizes training courses for practicing technicians, with the current series covering laboratory, sound, and television subjects.

The BKSTS became well known on an international scale when it commenced a series of biennial Conferences and Exhibitions in 1969, culminating with the 1981 Summer conference. The Society also promotes International Symposia for Wild Life Filmmakers, which attract many delegates from all corners of the globe.

This paper describes in detail the many Society activities, as well as the monthly publication, *The BKSTS Journal*, which is sought after by members and nonmembers in many countries.

35. Commission on Film Equipment and Technology of the USSR Filmmaker's Association. By Prof. B. Konoplev (Chairman, Commission on Film Equipment and Technology, Moscow, USSR)

The USSR Filmmaker's Association, founded in 1965, is a non-governmental organization serving those engaged

in the film industry — the people who make an active contribution to the development of Soviet film art.

Since its foundation the Film Maker's Association has had within it a number of National Commissions dealing with the problems of various professions in the cinema, among them the Commission on Film Equipment and Technology, which comprises scientific and technical specialists working in the field of cinema who have been given membership in the Association in accordance with its regulations. To join the Association one must have made a personal contribution to the development and practical application of new equipment or technology, and have published a certain number of scientific works.

There are also Technical Commissions in the Republican Filmmakers' Associations in Moscow, Leningrad, Kiev, Tbilisi, Tashkent, Riga, and Tallinn, which coordinate their activities with the National Commission.

Besides Association members, many scientific and engineering personnel of film studios, distribution organizations, factories, and research and educational institutions of the film industry actively participate in the work of the central and local Technical Commissions.

The usual form of activities of these Commissions is plenary sessions which are held regularly (once a month as a rule) and are devoted to discussion of various problems of film equipment and technology, television equipment and processes, and electronics. More often than not, the participants in these meetings also hear reports on the latest developments in their field in other countries.

The participation at these meetings of leading specialists in the field and the opportunity to discuss with them various problems of the film industry attract to Commission sessions not only technicians, but also many artists.

Another major activity is the biannual sessions of the National Commission held in various republics, at which the participants, many of them specially invited, look at the state of affairs in their sphere of authority, at the local studios.

The Commission on Film Equipment and Technology often organizes trips by leading specialists to local studios for on-the-spot technical assistance and expert advice.

The National Commission main-

tains business relations with numerous scientific and technical organizations in the Soviet Union; it invites their cooperation in its own activities and itself participates in their undertakings.

Since its foundation the National Commission on Film Equipment and Technology has been a member of Uniatec in its capacity as the USSR National Association. As such, it maintains contacts with SMPTE, BKSTS, and ISO. It gives due attention to the development of international relations in the field of film science and technology, and its delegations participate in various international congresses, exhibitions, and other events.

Lighting and Projection Practices

36. Xenon Short Arc Lamps for Film Production: The State of the Art After Twenty Years. *By Kenneth Luttio and Glenn Berggren* (Optical Radiation Corp., Azusa, Calif.)

Xenon short arc lamps were developed in Europe over thirty years ago, but they were not used in the United States until twenty years ago. The first major applications of these lamps were with developments associated with the New York World's Fair, and later serious applications were found in studios and theaters in the mid-1960's. Since that time, growth in the use of xenon arc lamps has been rapid and widespread. Unfortunately, with only half a dozen factory sources, the various short arc bulbs were often introduced in noninterchangeable designs by manufacturers using a variety of lengths and pin fittings. This tends to complicate the various applications, but there are a limited number of lamp designs between 500 and 5000 watts which fit all studio and theater applications. The various types and sizes are outlined and reviewed here. Over the past thirty years, a number of cathode, anode, and arc space designs have been developed, with varying degrees of success and different lamp lives. Other material explored in this presentation include fill pressure and material purity and their effect on lamp life, the popular lamp types in North America, state-of-the-art lamp physics, future developments, unusual applications, and the need for standards in the manufacture of xenon short arc lamps.

37. Xenon Light Collection for Film Projection: The State of the Art After Twenty Years. *By Glenn Berggren and John Wilkinson* (Optical Radiation Corp., Azusa, Calif.)

The science of light collection for film projection originated in the field of carbon arc light sources, and early xenon lamp houses followed the theories and practices of carbon arc lamp house design. Over the thirty-year development of xenon short arc light collection, there were changes from single elliptical mirror design to dual mirror systems, some involving four or more optical sections, and others including prisms or light diffusion plates. In 1970 there was a major transition when the typical vertical xenon arcs were applied in the horizontal mode. At that time, deep-dish mirror designs were applied, but many designs still parallel the elliptical optics systems. Included in this discussion of the evolution of xenon lamp houses and the technology as it stands today is a review of vertical bulb types in two-part systems, horizontal designs, mirror design, magnification factors and their related effects on picture quality, and a comparison of the efficiency of the vertical and horizontal systems. Also discussed are heat removal techniques, one-piece console design which can be applied to either horizontal or vertical bulb systems, the state-of-the-art in efficiency and light distribution, specialized applications, and the need for industry standards for xenon lamp houses.

38. "Ruggedized" Double Seal for Daymax™ Lamps and Its Use In A 6000-W Daymax™ Lamp. *By William Bamberg* (ILC Technology, Inc., Sunnyvale, Calif.)

ILC Technology has produced the Daymax™ product line of metal halide discharge lamps, described in this paper presentation. In developing the Daymax line, ILC engineers were striving to create a lamp which provides greatly improved reliability in the field, thus answering a real need for the end user. Prior to development of the Daymax, the primary reason for lamp failure in the field was due to a cracked seal which causes arcing within the base or behind the electrode, and often results in an explosion. To answer the problem ILC engineers developed their patented "ruggedized seal," which provides a thicker side arm and seal of tempered glass. The use of a single lead

wire helps distribute strain radially in the side arm, and the addition of a Teflon interface between the base and the glass of the side arm eliminates thermal strain. This lamp has been tested at temperatures above 240° C, resulting in the melting of the lamp's electrodes, but the seal remained intact. Another test submitted the burning lamp to a spray of cold water. The result was only steam. This patented seal technology has been extended to other lamps up to 6000 W, and the performance results will make this an important asset to location production.

39. 3200° Kelvin Discharge Lamp Compatible With Existing HMI Equipment. *By William Bamberg* (ILC Technology, Inc., Sunnyvale, Calif.)

The Daymax™ lamps, discussed in paper 38, provide an efficient source of 5600° Kelvin daylight color lighting. Its primary use is as a daylight fill light. At the same time, a Daymax is three times more efficient than a 3200° K tungsten lamp, since a 3200° K lamp gelled for 5600° K operation has filter losses close to 50 percent, typically. This makes the Daymax lamp six times more efficient than a tungsten lamp. The economic advantages become obvious, since it would take one-third the number of luminaires and equipment to achieve the same light level. ILC also recently introduced a 1200-W Daymax lamp which produces well-balanced 3200° Kelvin light with the same efficiency as the standard Daymax produces 5600° K light. Plans are also being made to introduce a 575-W lamp in the near future. This lamp will provide a number of advantages to film production, particularly since the color temperature is consistent over a wide range, and filters are not necessary to achieve daylight illumination. This lighting system is ideally suited to indoor filming and can be mixed with tungsten lighting without consequence.

40. The Use of Single-Ended Discharge Lamps in Modified Tungsten Halogen Luminaires. *By R. Hall* (Thorn Lighting Ltd., Leicester, England)

Recent developments in single-ended discharge lamps have resulted in designs which exhibit improved stability and color uniformity, and which match the performance of tungsten halogen

lamps. With the rising cost of energy, the television and film industries have shown an increased interest in the use of such metal halide lamps, largely because of their high luminous efficiency and the lower operating costs which result, as compared with tungsten lighting. However, one of the major factors limiting the widespread usage of discharge lamps is the capital expenditure necessary to cover ancillary gear and custom-designed luminaires. To minimize these costs there has been a growing interest in efforts to convert existing studio halogen luminaires so they can house single-ended discharge lamps. This presentation provides a critical assessment of the possibilities and limitations of such conversions for lamps with ratings from 200 W to 2½ kW.

41. Flicker-Free Ballast for Higher Wattage Daylight Sources. *By Frank Marsico* (Strand Century, Elmwood Park, N.J.)

High-speed filming with the use of HMI lamps has suffered from the problem of flickering and unwanted stroboscopic lighting effects caused by the ripple in the power supply. There is now a power supply available that removes the ripple from the sine wave, thus eliminating flickering.

The availability of this power supply makes it possible to extend the use of efficient HMI sources into applications that extend beyond rates of 24 or 25 frames/sec. With the new three-phase flicker-free ballast, filming can now be carried out at rates as high as 4000 frames/sec and is not limited by the need to synchronize the speed of the camera with the angle of the shutter and the frequency of the supply to the lamp.

42. Cycscreen — A New Approach to Cyclorama for Television Stages. *By Peter Edwards and Richard B. Glickman* (CFTO-TV, Toronto, Canada)

The Cycscreen is a plastic film welded together to form a cyclorama surface for use in television stages. Because it has unique properties, it provides an excellent surface for either front or rear screen projection. This means that cyc lighting can be applied to either side with equal effectiveness. Due to the viewing characteristics of this material, an extraordinary range of viewing angles is possible without a noticeable shift in brightness in either

front or rear screen projected images. In general, cyc lighting for this surface tends to be simplified because of the material's diffusion characteristics. The Cycscreen permits a range of lighting options not available in conventional cloth cyclorama and scrim combinations. In practice, the cycscreen is a seamless cyclorama with essentially uniform dimensions. It is inherently non-flammable throughout its life, being a result of the inherent nature of the material rather than a flameproofing treatment. Cycscreens are also noted for having a proper video "whiteness" and a higher reflectance than cloth cycloramas, and its diffusion properties tend to "smooth out" lighting. At the same time, cycscreen gain characteristics permit essentially unlimited camera movement without brightness variations in the projected images. Cycscreens also permit rear lighting positions on the floor to cover the lower cyc areas without the need for a ground row or other masking device. The cycscreen represents a new tool for the television lighting or scenic designer. It opens a range of possibilities that have only been available previously to theatrical designers. The scope of design possibilities seems endless, and certainly many of the theatrical techniques employed over the past few years are now available to television designers.

43. Recent Developments in Studio Lighting Suspension Systems. *By Steve Futers* (Tele-Stage Associated Ltd., Suffolk, England)

Heavy demands are being placed on the modern production studio to achieve ever-shorter turnaround times between productions because of escalating costs. To aid this quick production turnaround, rigging and derigging of lighting equipment must be done in the shortest possible time with a minimal staff. At the same time, the larger TV studios which produce entertainment programming with audience participation need maximum lighting flexibility. To meet these demands, studio lighting suspension systems have been developed which allow maximum flexibility and minimal rigging and derigging times. This paper examines some of the possibilities provided by these systems, and examines European installations utilizing single point and barrel lighting suspension systems.

For many years, studios have utilized the single-point suspension sys-

tem which permits economical use of luminaires, requiring fewer luminaires that can be readily moved about the studio without disturbing sets or decor. The system is composed of an overhead slotted grid with telescoping lighting suspensions for raising and lowering the luminaires. Since all electrical connections are made at the grid, better use is made of available outlets and the studio floor is kept clear of power cables. Advances have recently been made in this type of grid design with the introduction of short slots at right angles. This system, known as a parking grid, allows telescopes to pass each other in a slot with little or no disturbance to existing set-ups. Single point suspension is also possible in studios where the ceiling cannot support a grid by mounting motorized telescope trollies and winches directly to the ceiling. Multipoint suspension systems using short barrels which can carry from two to four luminaires have been used in conjunction with the saturated lighting rig systems. These systems can be remotely controlled from the floor, allowing for easy maintenance, and safe and easy use.

Health, Safety, and Environmental Practices

44. The Keys to Effective Safety Management. *By Anthony F. Cantarella (E. I. Du Pont de Nemours & Co. Inc., Wilmington, Del.)*

The chemical industry is safer than most other industries. The Du Pont Company has been a leader in its field, winning the National Safety Council's Award of Honor 32 times out of the 36 years it has been offered. Du Pont U.S. experienced one lost-time injury per every 2500 employees in 1980, compared to one injury per 114 employees for the chemical industry and one per 37 for all industries. The communications industry experienced one lost-time injury per 65 employees (source: Accident Facts, National Safety Council, 1980 ed.).

In order to understand the concepts that have proven effective within Du Pont, it is necessary to review the company's safety history and analyze its injury performance. The company started in 1802 as a partnership to produce quality grade explosives. Mr. Du Pont took numerous precautions in building his plants, but in 1811 he realized the safe facilities were not suf-

ficient: adequate workrules were needed. These workrules introduced the concept of line management control and responsibility for safety. A corporate safety manual was issued in 1915 to better communicate safety to the workers. Significant regression in the safety performance was experienced in World War I and during further expansion in the mid-1920's. Having learned its lesson, the company's safety performance showed no significant deviation during World War II, even though it built 54 new plants and hired 75,000 new employees. Improvement has been consistently made over the last 30 years. By comparison, data from the Bureau of Labor Statistics shows that the all-industry average incident rate has actually increased since the formation of the Occupational Safety and Health Administration (OSHA).

Over 179 years of effective safety management, together with helping over 300 other organizations improve their performance, has shown that four primary steps are essential to any safety program regardless of industry or company history: (1) safety must become a management objective; (2) the goal needs to be communicated throughout the company from top to bottom; (3) a safety organization must be created to operate throughout the line organization; and (4) a safety program that fits the organization's concerns and needs must be established.

The cornerstone of any successful safety effort lies in the establishment of a written company safety philosophy. Du Pont's time-tested philosophy is given below in the form of five statements: (1) all injuries can be prevented; (2) management is responsible for the safety of all employees; (3) all equipment must be safeguarded; (4) prevention of injuries is good business; and (5) it is necessary to train all employees.

We have shown repeatedly that efforts to improve safety pays dividends in increased productivity, improved labor relations, and reduced government interference by meeting the intent of the OSHA regulations. With Du Pont's help in implementing the above concepts, immediate safety performance improvement experience has been 36 percent after the first year and 55 percent after two years. Individual cases of significantly greater improvement are not uncommon.

45. Analysis as Required: Why and What. *By Clark E. Lukens (Truesdail*

Laboratories, Inc., Los Angeles, Calif.)

In the U.S., every segment of society — from the common household to the film laboratory to the largest steel manufacturer — has been called upon to conserve water and to limit needless misuse of water. These new restrictions have been imposed for a variety of reasons. Some areas of the U.S. are experiencing drought conditions. Other areas, particularly the sunbelt, are experiencing rapid increases of population which strain water resources. In the U.S. Southwest, which has a combination of scarce resources and surging population, allocating each drop of water has become necessary. New economic requirements in terms of energy have also become of concern. It takes energy to transport water from one site to the next. It takes energy to condition the water for use, and after it is used, the water goes to the treatment plant where again energy is consumed in cleaning the water for reintroduction into the environment. Finally, nature has imposed the greatest burden on man. Nature does not have the quick capacity to keep up with man and his activities. Whether using the water for manufacturing aluminum or for taking a shower or for rinsing film, the water must be cleaned before being passed along. Thus, reducing consumption through conservation and limiting the load that nature must meet can only be beneficial economically and environmentally.

It has fallen on the shoulders of our national, state, and local governments to assess the quality of our water resources, whether the source is our oceans, lakes, rivers, or aquifers, and in some cases these governmental bodies are concerned with regenerating that quality from the wastewater we discharge. All these governmental bodies require information from users and dischargers. Modern analytical chemistry has evolved to tackle the massive task of supplying information about water quality. Twenty years ago, results called for analytical detection in the range of parts per million. Now analyses demanding ranges of parts per billion or lower are commonplace. Long-used analyses such as Biochemical Oxygen Demand (BOD) rest alongside instrumental methods involving gas chromatography/mass spectroscopy which detect and confirm trace organic contaminants. These analyses and others have given us a grasp of just how clean a glass of water

is and what we have to do to maintain that quality.

The analysis of any water or wastewater can be separated into three categories: organic content, inorganic content, and general physical parameters. Analysis for such parameters as BOD, COD, and TOC fall into the organic category. Analysis for pH, dissolved solids, cyanide, chloride, sulfate, thiosulfate, and metals such as silver, chromium, iron, cadmium, and mercury fall into the inorganic category. An item such as suspended solids might fall into either category. Finally, general physical parameters are odor, turbidity, color, and temperature. All these analyses and many others assess what has man or nature added to or subtracted from water and how much.

Once an analysis has been made, decisions must follow. For water, what must be done to condition it for use? For wastewater, how much is it going to cost at the treatment plant to recondition the water? Are there heavy metals that might inhibit treatment? Can the wastewater be discharged directly into the ocean, a lake, or a stream without treatment? Can the wastewater be recycled and recirculated instead of discarded without harmful effects to the natural biota? Can the wastewater be cleaned sufficiently for ground level discharge? In some cases, decisions are made that are costly, but any other choice might be harmful to a product, to man, or to the environment.

For the film industry, the analysis for purity of incoming water is especially important. Water must meet requirements for dissolved solids, particulate count and size, and hardness in order to yield an unblemished product. Water leaving the industry must meet standards for silver, thiosulfate, and total organic content, among others.

As mankind's utilization of water resources has increased, the role of the analytical laboratory has also become more important. The health of the environment has always been critical. But with growing apprehension over such items as carcinogens and the introduction of new synthetic chemicals into the environment, the public has begun to demand of science and government the certainty that water flowing from the tap is potable and will not cause any long-range health problems. We are making progress, but we need an understanding of problems and possible solutions.

46. Paper cancelled.

47. The Main Design Aspects of YLE's New Film Laboratory in Helsinki. *By Otto E. Mikkilä and Stig-Göran Bergholm (Oy. Yleisradio Ab. or YLE — Finnish Broadcasting Co., Helsinki, Finland)*

A new film laboratory with a capacity for developing three million meters of film per year began operating in 1979 in YLE's Helsinki Radio and Television Center. It is situated in the News Wing of the new Radio House. The wing contains all necessary facilities for both radio and television news services. The laboratory is designed for processing news films, but in addition it serves the whole YLE film production facility in Helsinki.

Because of the stringent occupational safety legislation in Finland, special care has been taken to ensure good working conditions. Daylight has been provided, if possible, in all working rooms; the noise level of the working areas has been kept as low as possible; and hazards caused by toxic chemicals have been minimized.

Proper architectural layout of the rooms solved the daylight problems. Although the laboratory was purpose-built, there were some difficulties in daylight questions and in arrangement of rooms because the form and dimensions of the building were determined by the television news studio and other news production facilities one floor above the laboratory. The laboratory is a closed area, with the "customers" being allowed only in the reception area. The total floor area is about 1600 m², and the laboratory consists of administration office, film storage, developing, grading, printing, and negative cutting, plus necessary auxiliary services. ECN-2, ECP 2, and VNF 1 processes are used for color film processing, and black-and-white negative, positive, and reversal films are processed. For speeding up the news film service there are Telelift transports from the reception area to the news film editing area and to the film library. All the main working rooms have a common floor level. To achieve this the floor of the developing hall is lowered 0.5 m, and a galvanized-steel working grid covered with rubber flooring is installed at the normal floor level.

Noise was reduced to 65 dBA by installing all noisy machines in a separate room below the developing hall.

In this room there are circulation pumps and compressors arranged in groups corresponding to the developing machines above. Also replenishment equipment, heat transfer units for temperature control, and silver recovery units are here.

To avoid the hazards of toxic chemicals, special care has been taken in the design of the air conditioning. The air of the developing hall is exchanged 18 times an hour through a perforated ceiling. There are side-by-side alternating inlets and outlets, and though the air is completely exchanged every 3 minutes, the ventilation is not drafty because there is such a large exchange area. Besides this the developing machines have three additional ventilating systems. Above the drying cabinets there are exhaust vents, the processing tanks have a slight under-pressure to avoid the leakage of vapors, and when the tanks must be opened a laminar air flow can be blown along their surface to direct the vapors into a special exhaust vent. In the chemical stores the chemicals are first unpacked in dust removing conditions from sacks into small transport trolleys —under conditions where the dust can be removed. The trolleys are then wheeled into the chemical handling area, where the weighing is done in suction cabinets into which the trolleys fit. All chemical mixing tanks have their own suction cabinets. There are emergency showers and eye douches in the chemical handling area, and each worker has his own protection mask.

The effluent guidelines of the local authorities are not yet too stringent. The effluents are led into a collecting tank where they are diluted by the other wastewater of the building and then discharged to the municipal sewage system. Only silver is recovered using a patch process by recovery units manufactured in Finland.

48. Introduction to the Labor/Management Safety Committee for the Motion Picture and Television Industry. *By T. McGee (Motion Picture and TV Safety Committee, MPAA)*

Synopsis not available at press time.

49. Chemical and Washwater Treatment in Photographic Processing. *By Dave Degenkolb (Drew Refining Co., Glendale, Calif.)*

In processing motion picture film, the efficiency of the chemical department

can significantly enhance the profitability of laboratory operations. The reuse of appropriate solutions, such as developing and fixing baths, combined with modern, automatic control and replenisher systems, can significantly decrease overall processing costs. In addition, reusing water will save costs in electricity, sewage, and gas, as well as water. The techniques and economics of chemical and water reuse are shown in detail. The results of these modifications can provide significant savings for your film laboratory.

50. A Slide-Tape Presentation of the Kodak Health, Safety, and Human Factors Laboratory. By Robert L. Raleigh, M.D. (Eastman Kodak Co., Rochester, N.Y.)

The Kodak Health, Safety, and Human Factors Laboratory slide-tape presentation describes how this facility helps the Eastman Kodak Company to provide safe, well-designed workplaces, as well as safe and efficient products. In many instances, the laboratory assists in minimizing the impact of manufacturing systems and products on the environment.

The Laboratory was established in January, 1972, by combining three older organizations — the Laboratory of Industrial Medicine (1936), the Human Factors Group (1960), and the Technical Safety Laboratory (1962). This created a single corporate facility to serve Kodak's worldwide operations.

The Laboratory staff is comprised of biologists, chemists, clinical chemists, biochemists, engineers, epidemiologists, industrial hygienists, microbiologists, pathologists, physicians, physiologists, psychologists, toxicologists, computer analysts, and technicians. The group includes librarians and data researchers, plus clerical, secretarial, and administrative staffs.

There are eight Laboratory sections: Toxicology, Biochemistry, Industrial Hygiene, Human Factors, Technical Safety, Clinical Chemistry, Occupational Health Services, and Epidemiology. They all contribute their expert knowledge to the company's manufacturing procedures and products.

51. The Photographic Laboratory: A Safe Place To Work. By Robert L. Raleigh, M.D. (Eastman Kodak Co. Rochester, N.Y.)

The Health, Safety, and Human Factors Laboratory of the Eastman Kodak Company has recently completed (May 7, 1981) the following study: An Epidemiological Study of Mortality, Cancer Incidence, and Sickness-Absence in Photographic Processors. The study was conducted by Dr. Barry Friedlander, M.D., Supervisor of the Laboratory's Epidemiology Section; Terry Hearne, M.S., Statistician; and Betty Newman, R.N., Epidemiologist.

Examined in the study was a 1964 cohort of 2085 employees in nine Eastman Kodak Color Print and Processing (CP&P) Laboratories in the continental United States. Analysis of pre-1965 environmental data indicated that chemical exposure was within the standards applicable at the time. The results showed no significant excess mortality, sickness-absence, or cancer incidence in 478 workers exposed to photographic chemicals (i.e., processors). The processing cohort's mortality experience after a 16-year follow-up compared favorably with that of the two industrial control populations as well as with that of nonexposed CP&P personnel. The present study represents the first published occupational epidemiology investigation which specifically examines the health of employees engaged in large-scale commercial photofinishing operations. The study has been submitted to the *Journal of Occupational Medicine*.

Dr. Raleigh discusses the Kodak study and relates its positive findings to practices in the wider commercial photographic processing industry. He stresses the importance of assuring that established processing safety procedures be strictly followed.

**Advances in Television
Camera Technology I**

52. Triax Cameras — A Decade of Experience. By Alan J. Keil (Central Dynamics Corp., Mahwah, N.J.)

The triax camera was introduced to the broadcast industry at the NAB convention in 1969. The Philips/Norelco PC-100 camera was designed to solve several problems associated with conventional multicore cable cameras. Included in these problem areas are a lack of reliability and maintainability of the multicore cables, as well as long and costly installation times especially noticeable in

field applications. In a remote sports application, the initial cable costs alone would justify a triax camera purchase. Additionally, automatic cable compensation utilizing RF multiplex techniques is realized. Digital control circuitry provides immunity from drift due to cable impedance fluctuation from temperature changes and connector contact problems. Eight PC-100 cameras were installed on the first network triax camera mobile unit, ABC-TV Phase 6.

A second generation triax camera, the LDK-5, was introduced in 1975. The LDK-5 was selected by ABC for three mobile units. Additional capabilities were offered with the LDK-5, including the incorporation of two high-quality program audio microphone channels. Also for remote announcing positions a return color video channel is provided to operate a remote color monitor. For microwave applications a narrow-bandwidth digital control channel is used. For applications such as the Indianapolis 500 motor race, the microwave configuration allows control and genlock of a distant camera from the A unit, removing the need for a single-camera B unit.

For the 1980 Winter Olympics the microwave configuration was ruled out due to severe weather conditions and the absence of power on Whiteface Mountain. For this purpose a Triax Repeater was designed. Operating with power from the triax cable, the repeater divides the various signals on the triax cable, amplifies them, and then recombines them. Utilizing 14-mm triax, cable lengths to 18,000 ft are possible. To cover the six alpine skiing events, ABC moved seventeen LDK-5 cameras to 73 different camera positions during the eight separate days of competition. A distance of over 60 miles of triax cable was run.

The compact, lightweight EFP LDK-14 camera was designed for easy conversion to triax. The initial design included digital control and automatic cable compensation by way of an RF multiplex system. Conversion at the head is achieved with a small clip-on adaptor; similarly an add-on unit is employed at the Remote Control Unit.

A major design consideration for a triax system is the choice of transmitting encoded video or RGB video from head to control unit. Encoded video transmission offers a lower bandwidth of signals on the triax cable, and subsequently less loss. The en-

coded signal is highly immune to chroma disturbance. This technique was selected for the LDK-5. The frequency spectrum of the signals on the triax cable of the LDK-5 shows an overall bandwidth requirement of 65 MHz. Within this spectrum, a number of channels are transmitted: power, control, four intercom, two audio, and three video channels.

The alternate technique of transmitting RGB video signals over the triax cable allows a conventional camera layout with video processing and encoding at the control unit. RGB signals are available for monitoring and chromakey. Although the majority of triax cameras are presently used for field applications, changes in camera design now offer the prospect of cost-effective triax studio cameras. Automatic set-up control by microprocessor requires a digital control system. Video multiplexing systems are now less complex than conventional cable compensation. Therefore, the advantage of triax can be achieved for a studio or field camera with negligible increase in electronic circuitry or cost to the customer.

53. High-Resolution Electronic Field Production: Human Factors. *By Leonard K. Adler* (Commercial Electronics Inc./CEI, Mountain View, Calif.)

High-resolution video is a euphemism for pictures which the viewer thinks are good. Such pictures are sometimes also referred to as being in "film style" or having the "film look." Such video, desirable by definition, is not only a result of advances in encoding systems, transducers, and circuitry, but is more a result of competent and creative directors and camera operators. The problem is to get this creative community — who, by and large, started out and spent much of their careers in the film world — to begin to originate their television productions on videotape. These TV productions might include TV commercials, situation comedies, and made-for-TV movies which are destined for distribution over network or cable TV rather than for theatrical release.

In order to determine the optimum configuration for a television camera for film-style production, CEI and Panavision have been conducting a year-long field test among the creative film community now producing for television. As a test bed they have utilized a video camera capable of being

operated by 35-mm camera crews which has been designated Panacam I. The test camera is a trial marriage of the Panaflex and CEI 310. Panaflex is prominent, even preeminent, in the 35-mm cinematography field. The CEI-310 is a matured reliable, $\frac{2}{3}$ -in camera configured so as to optimize its application to EFP rather than ENG and studio applications. It is widely used in the TV industry for EFP by production houses. Panacam-I utilizes the Panaflex prime and zoom lenses, mechanics, geared heads, and support systems integrated with the CEI-310 electronics. Minimum operational changes were instituted so that the normal three-man film crew could operate in the manner to which they were accustomed.

User feedback was utilized to generate a set of requirements for the next generation of "electronic cinematography" camera, which will shortly be made widely available to the industry. Some of the requirements which were used in establishing the configuration and necessary features are described.

54. Automatic Setup System for the BCC-20 Using Digital Video Techniques. *By Heinz Griesshaber* (Ampex Corp., Redwood City, Calif.)

The Ampex BCC-20 Digicam, a camera designed specifically for electronic field production (EFP), not only is equipped with state-of-the-art amplifier and video processing circuits, but it also takes a revolutionary approach in dealing with the registration errors of the 18-mm format. The conventional approach of adding combinations of sawtooth and parabolic signals to the normal scans has been replaced by a more powerful error-correction system — the Spatial Error Correction (SEC) System.

The heart of the SEC System is a set of 2048-bit random access memories (RAM) organized as a 16×16 array of 8-bit words. The value of the 8-bit word represents the magnitude of the displacement error in the horizontal or vertical direction at each crosspoint of a uniform 16×16 grid superimposed on the scanning raster. The memory content is recalled in synchronism with the scanning rate and converted to analog voltages by means of a two-dimensional interpolator. The RAM can be loaded by one of two means: either (1) manually through the Master Setup Panel (MSP); or (2) through the Automatic Set up Unit (ASU).

The microprocessor-controlled ASU will follow a predetermined program (menu) and evaluate the image of a diascope pattern by digital means. The selected camera signal is converted into an 8-bit data stream right after the input filter and fed to either the time-measure or level-measure block, depending upon the required function. In registration, the time-measure block will generate a value for each point in the 16×16 array in both the horizontal and vertical direction during the time period of one frame. These values are compared to a premeasured electronic test pattern in the processor, and the resulting error values are loaded into the SEC RAMs in the camera head by means of a serial data path. Similarly, the level-measure block generates values to be loaded into the shading SEC RAMs. The same hardware is also used to produce the necessary correction factors for the tube setup and the video alignment.

The combination of the SEC together with the ASU is a long-awaited solution to the problem of achieving excellent studio quality pictures using an 18-mm EFP camera.

55. The Marconi B3410 Line Array Telecine. *By Ray Matchell* (Marconi Communication Systems Ltd., Chelmsford, Essex, England)

The telecine described is a new totally solid state equipment using linear sensor charged coupled devices (line arrays) as the sensing elements. The signal processing is completely digital and is controlled by a microprocessor system. The equipment operates on 16-mm, 35-mm, and Super 8-mm film, by means of interchangeable plug-in film gates, and operates on 525-line or 625-line TV standards.

The design aims for this telecine were to provide the highest quality performance and at the same time remove the need for the routine set-up adjustments which are required by other telecines.

Second-generation line-array sensors are capable of producing high-quality pictures from film. They have a typical dynamic range of 2500:1, and the 1024-element version provides resolution which is more than adequate for current television systems. Furthermore, these sensors have virtually infinite life, and the only registration required is initial mechanical registration on installation.

As the line arrays sense only one picture line at a time, it is necessary to

use a continuous-motion film-transport servo, locked to the TV system. The output from the arrays corresponds to a sequentially scanned frame of information; this output is converted into two interlaced fields by means of a Sequential-to-Interlace converter. This consists of a storage system employing a full frame of storage for luminance and a full frame of storage for chroma with the necessary control circuitry. Lines of information from the arrays are written into the store in a sequential manner. Odd-numbered lines are then read out in succession during one TV field period to produce the odd-numbered TV field; then even-numbered lines are read out to produce the even-numbered or interlaced TV field.

The wait period between writing successive lines of information into storage is controlled to match the film format to the TV format. On 525-line systems a 3:2:3 utilization of stored TV fields is employed. Sequential-to-interlace conversion follows the main signal processing and is performed on Y , $R - Y$, and $B - Y$ signals.

Conventional telecine signal processing is performed as follows:

The signals from the line arrays, which are analog signals, spatially sampled, are filtered to remove components above 6 MHz. They are then converted to digital form in 11-bit A/D converters with a sampling frequency of 12.8 MHz. The digital signals are first operated on by digital logarithmic amplifiers operating on the look-up table principle. At the log stage, corrections for array nonuniformities and optical shading are introduced. Matrixing and variable gain following the log amplifier provide for film masking and continuously variable gamma correction. Exponential amplifiers follow the matrix circuits and the outputs from these are gamma-corrected, masked digital R , G , and B signals in sequential form. Digital matrix circuits and decimation filters are used to produce a Y signal at full video bandwidth and $R - Y$ and $B - Y$ signals which are multiplexed at half bandwidth. These signals are then subjected to sequential-to-interlace conversion by the means earlier described. A total of $480 \times 16K$ RAMs are used for this conversion.

Vertical and horizontal aperture correction are performed digitally following sequential to interlace conversion. The signals are now fully processed and in digital form and could be used directly in a digital studio

system. For convenience in monitoring and in using conventional coders, A/D converters are used to restore the signal to analog RGB form.

A microprocessor controls the whole of the video processing. The initial A/D converters convert to 11 bits. The number of bits rises to 13 to avoid rounding-off errors and is then reduced to 8 bits at the output of the exponential amplifier.

A continuous-motion capstan drive mechanism is used for the film transport. The capstan servo compares the number of clock pulses occurring between successive lines of the 5000-line tachometer disk fitted to the capstan against a preset number. Positional control information is obtained from a pulse generator driven by the film, and a microprocessor is used to modify the preset count number so that the capstan runs in the middle of the velocity control range even if the film is shrunk or stretched.

"Shuttle" which is continuously variable from $\frac{1}{2}$ speed to fast rewind is achieved by obtaining the preset number by A/D conversion of a variable dc voltage. Under variable speed conditions the sequential-to-interlace converter is provided with information on the film frame position, from the sprocket pulse generator and on the actual capstan velocity, provided by the capstan tachometer. On starting or stopping there is an instant switch from a still frame to normal speed running and vice versa. The light sources for sound and vision are conventional Q.I. lamps, and both are provided with automatic changeover in the event of lamp failure.

56. Automatic Setup Color Telecine Camera for Broadcast and Teleproduction. By *K. Inoue and H. Schkolnick* (Ikegami Electronics (USA), Inc., Maywood, N.J.)

The typical color telecine camera system in use today consists of a number of film projectors (i.e., 35-mm slide, super-8 motion picture, 16-mm motion picture, 35-mm motion picture) arranged physically to randomly select the output of one projector so that it can be picked up and transformed to a video signal by the television camera. The video signal generated can be used for direct viewing ("broadcast") or for transfer to videotape ("teleproduction").

For "broadcast" applications, the video signal generated can be trans-

parent (without inclusion of corrections for deficiencies in the film stock) or processed by automatic means to compensate for errors in white balance, gamma balance, and black balance. For "tele-production" applications, modern techniques permit more sophisticated correction of the deficiencies in the film stock errors and can program these corrections on a scene-by-scene basis. In addition to the film stock errors, each individual projector introduces problems (white shading, flare, color temperature variation), and it is the responsibility of the color camera to correct these problems. The color camera also electronically enhances the generated video signal.

This paper describes a new color telecine camera with the following features: (1) suitability for transparent operation, automatic correction of white balance, gamma balance, and black balance during on-air operation by electronic analysis and adjustment of the RGB video signals developed by the camera, or interface to a scene-by-scene color corrector; (2) automatic setup of camera operating parameters; (3) camera-to-camera uniformity of setting in multiple camera installation; (4) projector-to-projector uniformity of performance in multiple projector installations; (5) optimized performance in the areas of geometric distortion registration, and shading; (6) optimized performance in terms of resolution and S/N ratio; (7) multiple camera corrections to equalize results from randomly selected projectors; and (8) cost-effective operation.

57. Digital Techniques for Pan-Scan and Black Stretch in the FDL 60 Film Scanner. By *Dieter Poetsch* (Robert Bosch GmbH, Television Systems Division, Darmstadt, West Germany)

The era of wide screen projection began with the introduction of CinemaScope in 1953. Compromises in the scanning of these films for television began soon after. Scenes shot with the CinemaScope technique are compressed in the horizontal plane by a factor of 2:1, using an anamorphic lens, and the resultant image exposes 35-mm film. Projection produces an expanded wide screen image with a format of 2.35:1, whereas the television screen can only display a format of 1.33:1.

Today, three formats are used as compromises in the televising of CinemaScope films:

1. The letter-box format 2.35:1. The film is reproduced fully in the format 2.35:1, whereby 32 percent of the television screen is not used. With 525-line/60-Hz standards, this results in only 294 active lines.
2. The 1.85:1 format. This format is a compromise between the television screen area used and the loss of picture information. Eleven percent of the picture area is cut off at each side of the picture and not transmitted. The unused television screen area is reduced to 21 percent.
3. The Pan-Scan format 1.33:1. Using this method the film is reproduced in full height on the TV screen. Subjective disturbance due to unused borders therefore does not occur, but 22 percent of the picture area is now cut off at each side. As useful picture information could be contained in this area, it became necessary to shift or pan the scanned picture area horizontally. Panning can be achieved with mechanical, optical, or electronic methods.

The image can be shifted on the target of a camera-type telecine using rotatable mirrors or prisms, whereas in the flying-spot system the raster of the scanning tube can be electronically shifted. Opto-mechanical methods can be used in a telecine using semiconductor line sensors. However, they are complex, degrade the picture quality, and do not allow the fast change of position during vertical blanking. Using high-resolution line sensors the entire picture width can be projected onto the sensor and expanded electronically by a factor of 1.76.

To maintain the necessary bandwidth of 5 MHz at the output of the film scanner, the line sensor must have a bandwidth of 8.8 MHz and, therefore, a sampling rate of more than 18 MHz. If the sensor allows selective read-out of a part of the TV line, then the CinemaScope expansion can be carried out directly in the sensor. The video processing circuitry and the frame store need only process the normal video bandwidth.

The FDL 60 film scanner employs charge-coupled-device (CCD) sensors with 1024 picture elements per line at a sampling rate of 20 MHz. Optical aliasing effects are minimal because the resolution of an average 35-mm copy is only 20 percent at 10 MHz. The CCD sensor does not allow for partial read-out of the line, so the wideband 8.8 MHz signal is processed and digitized. The Pan-Scan format is

produced with digital expansion. A microcomputer controls the position addressing, getting information from the Pan-Scan control on the operation panel. For decision making, the two limit lines of the Pan-Scan format are superimposed on the letter-box format. One can thus choose the best pan position during reproduction of the full CinemaScope picture, and store that position in an external time code controlled computer.

A digital luminance black stretch technique has been developed for the FDL 60, which offers considerable advantages over circuits with diode characteristics. High stability and free choice of the transfer curve result, the latter being limited only by the number of quantization steps. After digitizing in a 9-bit A/D converter, the digitized video signal passes through various selectable PROM transfer curves, the output of which is an 8-bit word. Hyperbolic functions of the form

$$Y = a \cdot \sqrt{b \cdot (X + X_0)^2 - C} - Y_0$$

were calculated, with the gradient 2 and 3 at the zero point. They have the advantage over diode type curves of approximate linear characteristics at midtones and highlights.

Laboratory Quality Control

58. Cross-Mod: More Versatile Than Ever for Photographic Track Control.

By Frank E. Pontius (Westrex, Burbank, Calif.)

The cross-modulation test signal may be used in the film laboratory as well as in the recording studio as a very effective tool in the quality control of variable area soundtracks. The introduction of the Westrex RA-1717 Analyzer permits the use of extremely short burst test signals for the analysis of printer and recorder performances. This allows routine evaluation of equipment with minimum expenditure of time. This paper presents a study showing how the laboratory and the recording studio are now able to cooperatively establish a quality control program, which benefits them both technically and economically.

59. Quality Control in an Australian Laboratory: Some Steps Toward A Computer-Aided Sensitometric Control System. By Tom Nurse and Dominic Case (Colorfilm Pty. Ltd., Sydney, Australia)

Sensitometry is one area of film laboratory production that lends itself to computer assistance. This paper describes how Colorfilm has organized its control department to introduce computer assistance in various parts of the operation, including implementation of a computer program to calculate sensitometric parameters. In the case of Colorfilm, the laboratory is a major operation in its region and must offer all laboratory services, but its film output is relatively small. Therefore, a control system is required that offers reliability and accuracy for a range of operations, but on a scale and budget appropriate for the small film laboratory. The control department fulfills two primary functions, printer control (including product quality) and sensitometric process control.

At Colorfilm at present, computers have been applied to aid the sensitometric control function. To aid in maintaining quality control, Colorfilm has its Chinagirl, which has been designed and produced to tight tolerances, and which includes gray squares exactly corresponding to the black-and-white television image and to the 18 percent gray card. Chinagirl readings are recorded on every roll, providing a useful supplement to the routine printer tests. At present, this is a manual operation, but it would require only a simple computer operation to isolate each printer/stock/process/time combination to signal undue variation.

In the area of process control, it was determined that computer-assisted curve plotting would be less valuable than automatic computation of the parameters associated with curve analysis, along with a hard-copy print of data and results. The program accepts density readings from all 21 steps of the sensitometric strip, as well as descriptive data such as stock type, developing time, and so on, and then calculates contrast parameters. At present, information is input through a keyboard, but plans are being made to interface the computer directly to a densitometer, which would cut the lag time between computer and processing enormously. Routine control strips are plotted manually on "clothesline" plots to provide a permanent record of process control. The computed parameters are plotted weekly to provide a larger scale indication of overall consistency. A stock comparison facility has been recently added to the program, which displays differences between two sensitometric strips and calculates printer

trim correction. A control strip cross-over then compares results with aims and computes the aim densities for the new emulsion.

Despite the valuable assistance these computer systems offer with time-consuming calculations, the basic control remains independent of the computer. This allows the operators to remain in touch with their work and to gain a normal understanding that is often lost when using more complicated systems. The computer system presently employed by Colorfilm offers many of the advantages of the more sophisticated systems, but at only a fraction of the cost.

60. The Theory and Practice of Process Control. By Gary L. Borton, Patrick T. Kurtz, and Frederick C. Franzwa (Eastman Kodak Co., Rochester, N.Y.)

High costs, high quality demands, and the need for day-to-day and week-to-week repeatability place the motion picture laboratory in a very challenging position. Meeting these challenges requires that laboratory management constantly keep abreast of current and new quality control techniques. Well maintained and controlled processes throughout the lab are the key to excellence in any quality control system. The practical application of process control theory can save time, money, and headaches by assisting in the proper identification of problems before they become serious. One of the most effective process control tools is the process control chart. When properly used, process control charts not only provide an excellent means for monitoring the process level, but they can also act as early warning devices. In many cases, the process control chart will help point to potential problems that can be corrected before any significant loss is encountered.

61. Paper cancelled.

62. Diagnostic Procedures for the Eastman Color Processes. By Julianne E. Crisante, Frederick C. Franzwa, Paul T. Hahm, Steven J. Powell, and Richard C. Sehlín (Photographic Technology Division, Eastman Kodak Co., Rochester, N.Y.)

A perfectly designed and maintained film process will never go out of control, theoretically. In the real world, however, processing control problems do occur, and when they occur, there

is a natural desire and need to fix these problems fast. Solving the wrong problem or jumping to the wrong conclusion has probably caught many of us off guard in these situations. In the aftermath it is not unusual to find information that was not analyzed soon enough, or perhaps was not analyzed at all. The diagnostic procedures for the Eastman Color Processes outlined in this presentation should move us all one step closer to fast diagnosis and accurate corrective action when a process decides to step out of line. Beginning with a discussion of diagnostic logic, a methodical approach to analyzing process problems is outlined step-by-step. The basis of the technique is simply that accurate information is part of the answer, and erroneous information is part of the problem. The diagnostic procedures presented in this paper help determine the difference. Asking the right questions, double checking certain pieces of information, and running the right experiments will generate the accurate information and pinpoint the problem with a minimum expenditure of time and effort. Intuitive factors also have their place in the diagnostic procedure but must meet certain criteria in order to be considered part of the answer.

63. Printer Control. By Robert Boeykens (Agfa-Gevaert N.V., Mortsel, Belgium)

In additive printers, printing light changes are performed with 0.025 log E steps in each of the three primary color beams. A change in the printing light will accordingly change the density of the print. However, the density difference obtained from a 0.025 log E printing light change varies in the function of the film density of the resultant print. For visual grays, the density difference resulting from a 0.025 log E printing light change can be expressed as a function of the print density by relatively simple arithmetical formulas. Using these formulas considerably improves the accuracy of the calculation of the printing light changes required to obtain a desired change in print film density. With relatively inexpensive, programmable pocket calculators, printer trim corrections can be calculated to adapt for variations in processing or printing and differences between print batches.

64. Quality Control of Processing and Printing Using a Low-Cost Computer.

By Toshio Ishiguro, Susumu Naito, Kazutake Matsuo, and Shuichi Saeki (Yokohama Cinema Laboratories, Inc., Yokohama, Japan)

This is the result of labor-saving efforts by the Yokohama Cinema Laboratories, similar to those exerted by all the industries in Japan today. As a step in quality control in the processing of motion picture films, Yokohama Cinema measures a very large number of control strips every day, from which characteristic curves are drawn. Normally, this requires a dedicated operator to measure the density of the control strips and draw characteristic curves. The problem arises that current methods of film development are performed rapidly at high temperatures. At the same time, the capacities of the processors and printers have also been increased. Consequently, to maintain thorough quality control, the measurement of the density of control strips, the drawing of the characteristic curves, and the determination of the control data must be done quickly and accurately.

To achieve this end, the Yokohama Cinema Laboratory has automated the measurement of the control strip densities and the drawing of characteristic curves by using various devices, including a low-cost computer. The automatic density measurement of the control strips and the automatic drawing of the characteristic curves have already been performed in the United States, and many papers have already been written on these subjects. Yokohama Cinema, however, uses a microcomputer, not only to draw the characteristic curves automatically, but also to store the measured density values in the microcomputer. Microcomputers are also used to calculate the trimmer values of over ten additive color printers by type of film, check each type of raw stock upon receipt, and determine the optimum exposure conditions for the duplication cycle.

The equipment for this quality control system consists of a densitometer, a low-cost microcomputer for automatically operating and measuring the densitometer, a color monitor, a four-color graphic plotter, and a Serial Dot Printer. A manufacturer's agent supplied the automatic measuring device and assembled the equipment. Yokohama Cinema prepared the computer programs for the microcomputer. Although the continuous wedge is more convenient for the purpose of automatically drawing

characteristic curves, it cannot record and draw the density of any given point. Therefore, a 21-step optical wedge is applied that measures the dimensions of any density area and takes any number of measurements automatically. However, as a smooth characteristic curve cannot be obtained in this manner alone, Spline's interpolation is applied to the density between each step to determine four more points. Much purpose-oriented software has been prepared to operate the microcomputer, and Yokohama Cinema Laboratory is continuing to study further applications for the microcomputer system for the improvement of process control.

65. Chemical Safety Assurance/Control: The Importance of Engineering and Training for Minimum Risk. By *Ed H. A. E. Zwaneveld* (Metro-Goldwyn-Mayer Laboratories, Inc., Culver City, Calif.)

"Chemical Safety" is a new term which is still whispered, mostly within the confines of the office or the laboratory conference room. Laboratory engineers have long known chemical safety as "those complaints about fumes again," which were eliminated by removing the bottles lined up in front of the fume hood exhaust in the laboratory or by replacing the fan motor. Laboratory managers have seen this phenomena appear as "another reason to have grievances with the union" or even "a new way to have the plant shut down on a hot summer day," or a reason for "demonstrating at the front gate of non-union laboratories." Surprisingly, chemical safety has also appeared on the budget for laboratories around the world under variable costs. And insurance companies have used these words as a pretext for increasing workmen's compensation premiums.

This tutorial paper defines the terminology of chemical safety. It shows which of the more than 80 chemicals and solutions used in the laboratories are most likely to present problems if not controlled correctly. To add perspective, international exposure limits are compared to those of the United States and California. Also defined are the basic criteria for assuring a safe working environment in all laboratory departments where chemicals are used by employees. This paper asks the manufacturers and engineers to "think safety." It also shows how to isolate the

sources of chemical exposure, either in solid compound, liquid, vapor, or mist form, through preventive engineering, and where contributions will most likely be made. Monitoring equipment and tools which assure adequate maintenance and trouble-shooting as well as legal evidence of an effective Chemical Safety Assurance Program are reviewed. Also presented are the latest recommendations for controlling worker exposure to formaldehyde, which is considered a suspected carcinogen as of December 1980. Recommendations are given for a vital Employee Training Program, with rules and their strict enforcement, and protective gear to reduce respiratory, eye, skin, and hearing problems. The paper concludes with comments about recommended substitution of chemicals, the use of absorbents to reduce vapor concentrations in developing and wet printing areas, and the reduction in use of breakable film.

65A. A 21st-Century Crack at the 10/30% of Lab Sales Cost of Quality. By *Ed H. A. E. Zwaneveld* (MGM Labs. Inc., Culver City, Calif.)

Synopsis not available at press time.

Sound I

66. Mementos of Early Photographic Sound Recording. By *F. K. Harvey* (Bell Laboratories (Retired), New Providence, N.J.)

From a period ranging from 50 to 100 years ago, several organizations associated with Bell Laboratories conducted research into the recording of sound using photographic means. This presentation displays some of these surviving mementos of early experiments, and analyzes their importance in the development of the talking picture. The first of these mementos are copies of photographic plates currently in the custody of the Smithsonian Institution. These plates, glass disks varying in size from 13 to 14 inches, are the result of work conducted by Alexander Graham Bell and his associates.

In the years 1884 to 1885, Bell, Chichester Bell, Sumner Tainter, and photographer Harris Rogers experimented in making sound recordings in a spiral track on a rotating disk. A voice-actuated pulsating liquid jet was used to modulate a beam of sunlight

focused on the sensitized moving disk. Apparatus was then constructed to play back the sounds recorded on the disk (samples of which are presented here).

The next set of mementos are motion picture film clips from early experiments made at the Western Electric Engineering Department in New York. Following 1920, considerable work was done toward providing synchronous sound for a motion picture image. The obvious choice at that time seemed to be the use of the phonograph record for sound accompaniment. The first indications that an accompanying soundtrack provided on the film was possible came in 1923, with the invention of a light valve by E. C. Wente. Wente used his light valve in some experimental in-house productions, employing a double film system for recording. Only a few clips of the titles and credits from the playlets performed by staff members remain today, and the nitrate film soundtrack has been destroyed or lost.

The final mementos provided are newsreel film clips made in 1929. By this time, talking pictures were sweeping the country, and sound equipment suppliers were hard pressed to meet the demand. At this time, Bell Laboratories was still refining their sound recording system, and these film clips provide some examples of the early experimental single-film systems developed for newsreel purposes. To create this footage, an Akeley camera was fitted with a Wente light valve to provide an improvement in dynamic range over any device existing at that time. The soundtrack recording adjacent to the picture edge was of the variable density type, the form which Western Electric chose to use during its many years as supplier of sound equipment to the industry.

67. The Academy Curve from a Psycho-Acoustic Perspective. By *Charles Nairn* (Communications Technology, Inc., Detroit, Mich.)

One of the most durable standards in the motion picture field was first released in 1938 by the Theater Standardization Committee of the Research Council of the Academy of Motion Picture Arts and Sciences — the "Standard Electrical Reproducing Characteristic." Popularly known as the Academy Curve, this standard, often being modified slightly, was reaffirmed by the Research Council of 1948 and, after modification to show

an acoustical response, is now up for approval as ANSI Standard PH22.202.

Despite almost universal use of the Academy Curve, many perceive it as a significant limitation to progress. Indeed, the continuing development of motion picture sound has resulted in the need for a more complete understanding of the various elements and functions of the curve to permit the rational evolution of theater sound systems.

Careful analysis has shown the curve to be derived from two widely used electrical curves, each serving an independent psycho-acoustic function. One curve, based on acoustic perception in large rooms, makes up the far field section of the Academy Curve. The other electrical curve, used to control high frequency transmission, makes up the bandwidth limitation section of the Curve.

Research done in sound reinforcement has shown that sound is perceived differently in the near (direct) and far (reverberant) fields. In the near field, a reproducer with a linear response is judged as linear. In the far field, however, a gentle mid-through-high rolloff is needed for the reproducer to be judged linear. As most theater seats are in the far field, some response correction will be required for natural sound reproduction.

Various other psycho-acoustic research shows relationships between: (1) intelligibility and bandwidth, (2) "quality" and bandwidth, (3) acceptable distortion levels and bandwidth, and (4) noise annoyance and bandwidth. Analysis of these data shows the high frequency outoff contained in the Academy Curve to be a good choice for a typical motion picture sound chain. Further analysis points up useful modifications to the bandwidth limitation section, as further development results in reduced distortion and improved signal-to-noise ratios.

68. Recording Techniques for Phonograph Recordings as Applied to Audio for Television and Motion Pictures. *By Carson C. Taylor* (Consultant, Danville, Calif.; formerly, Senior Engineer, Capital Records Inc., Hollywood, Calif.)

In this presentation the author makes the point that technology today has reached a level where it is possible to obtain very good sound — even though some compromises must still be made.

Some of the limitations that still exist are described. One goal in the art of mixing for sound recording and reproduction — whether it be for phonograph records, motion pictures, or TV — is to make the sound startling enough to catch and hold the attention of even a nondedicated listener. Some techniques are described, and some of the pitfalls are mentioned.

The author concludes with a proposal to his colleagues: "Overcome limitations that we can, and live with those that we cannot do away with. . . . Bring to fruition and accomplish what has not yet been done — great visual images accompanied by equally great audio."

69. Feature Film Sound in the United Kingdom. *By Geoffrey F. Labram* (Pinewood Studios, London, England)

The paper opens with a brief review of production techniques, especially defining points of difference between British and American floor and location sound equipment.

In the field of post-production, reference is made to Britain's contribution to progress in that area, including the use of stereo surrounds. The range of hardware currently used in the United Kingdom is examined, with descriptions and illustrations of many items not commonly found in American dubbing rooms.

Particular attention is given to the mixing desk recently installed in Pinewood's No. 2 theater, which has automated panning with selectable laws and other custom features designed to save non-creative time.

The use of the separate, stereo, multi-film techniques is discussed, and the paper ends with an outline of maintenance and alignment methods.

70. Laboratory Sound in the United Kingdom. *By John Aldred* (Rank Film Laboratories, London, England)

Sound plays an important part in all film laboratories in the United Kingdom. Several laboratories even have their own recording departments so that sound negatives can be manufactured "in-house." Due to the various demands made by producers and distributors, sound negatives manufactured by one laboratory are frequently shipped to another laboratory for release printing. This is not too difficult in England since the geographical lo-

cations of all laboratories are within a 20-mile radius of London. But, this procedure does entail close cooperation in all areas involving sound control and printing procedures. Some divergence in these procedures became evident with the exchange of negative material between the United Kingdom and Hollywood laboratories. This paper describes some of the difficulties encountered, the probable reasons for them, and the steps taken to overcome them.

71. Necam B — An Advanced Computer-Assisted Sound Mixing System for Film and Audio Post-Production. *By Martin Jones, Derek Tilsley, and Barry Roche* (Rupert Neve Inc., Danbury, Conn.)

The Necam B system described in this presentation provides a powerful tool in the dubbing theater for the rapid artistic building of film and video soundtracks. Attention to human engineering has resulted in the creation of a control system of great flexibility. The operator can choose as little or as much computer assistance he needs at any time, thus maximizing versatility in dubbing. For example, the mixing desk and recording machine control can be operated entirely manually at any time. A fast autolocator facility can control the synchronized recording machines using simple numbered location points which can be named and moved by the operator, as required. Spot sound effects can be automatically triggered at specific SMPTE time code and frame count values. Mixing desk fader positions can be memorized and reproduced at any time with the touch of a button. At the same time, correct sound levels are reproduced and the fader controls automatically move to their correct positions since they are servo-motor driven. Fader movements can be recorded dynamically in exact sync with the soundtracks, and updates are made by simply moving the faders upon replay of the sequence, thus creating the desired mix. Up to 999 different attempts at a balance can be individually named, listed, recalled, and compared. Also, the best sections of two or more different balances can be combined using a "merge" facility to give optimum balance. With all these capabilities, this system enables the dubbing engineer to concentrate in the most critical creative aspects of his task, no matter whether he is laying down effects, optimizing a critical di-

alogue balance, or creating the final music/dialogue/effects mix.

72. New Sound Facilities at Universal City Studios. *By Richard J. Stumpf* (Universal Studios, Hollywood, Calif.)

In order to meet increasing demand for quality cinema sound, Universal City Studios has completed a major construction and renovation project. Four years in the making, the project resulted in one completely rebuilt re-recording room, plus a new building which contains an elaborate re-recording facility located in the 325-seat Alfred Hitchcock Theatre, an automated dialogue replacement (ADR) room, plus a smaller, but fully equipped, re-recording room.

In the design of the new facilities, emphasis is placed upon providing quick access to processing equipment; computer-aided mixing is also provided. Comfort and convenience of client and crew were also considered important, and the finished structure provides beautifully decorated rooms appointed with a view to giving creative surroundings for the intense effort of mixing sound for today's feature motion picture.

The Alfred Hitchcock Theatre re-recording console made by Quad/Eight is computer assisted, handles 72 inputs, and has 6-channel output. The operation uses three magnetic film recorders and 42 sound reproducers, many with multiple track heads. The system contains an advance-retard feature which allows a mixer at the console to advance or retard any reproducer in the system to correct for out-of-sync conditions. An added unique feature allows the mixer to speed up a soundtrack to twice normal speed or slow it down to zero speed in order to create new sounds from existing effects tracks.

An RCA FR-35 DP projector and SL recording equipment was used in the new construction. Shuttle speeds of six times normal are attained by this equipment.

The interior design of the Alfred Hitchcock Theatre features a 36-foot screen and sound diffusion panels along the side walls interleaved with six surround speakers. Behind the screen are six Altec Voice of the Theatre speakers specially positioned to reduce high- and low-frequency horn crossover phasing effects. The Theatre is therefore able to obtain exceptionally uniform sound quality over the

entire seating area. All five front speakers work against a continuous wall, extending from the floor to the top of the screen, for efficient low-frequency radiation. The Theatre additionally contains six Sensurround speakers hidden in the rear corners and below a stage platform for both screening and dubbing.

These facilities were designed with one purpose in mind: to provide the finest plant possible in which to create high-quality sound for feature motion pictures. This indicates the commitment of one major producer to making pictures for theatrical exhibition. Mixing sound for productions destined to be seen only on living-room screens would not require the scope or completeness of this project.

Sound II

73. Time Code for Audio in the Film Industry: Feasibility/Compatibility. *By Jean-Pierre Beauviala* (Aaton Cameras, Grenoble, France)

Although time code was developed and accepted in the video industry with relative ease and rapidity, in the cine film industry a real consensus as to requirements, standards, etc. has not yet evolved. There are several reasons for this: (1) there are many specific branches of the filmmaking industry: film cameras, sound recorders, processing equipment, dubbers, editing tables, projectors, etc.; (2) each sector has a great deal of equipment which is perfectly usable and will last for many years to come; and, most importantly, (3) the very nature of the filmmaking process, which is a double system. Video, by nature a single system, requires time code for labelling and for identification of each specific frame, whereas filmmaking requires time code first and foremost for synchronizing sound and image.

This paper describes a system developed for audio time code. It provides the necessary information once per second on $\frac{1}{4}$ -in tape to allow synchronization in double system film or video. (With the demand for high quality soundtracks, EFP is becoming more and more often a case of double system.)

The system described allows existing professional $\frac{1}{4}$ -in audio recorders to be adapted at low cost, retaining the pilotone function that sound recordists have grown to rely upon. Neither re-

ording nor playback head has to be changed. A small unit connected between playback recorder and transfer bay converts the quarter-inch time code into standardized video-compatible SMPTE code, (or other codes as required) and lays it down on the cue track of the fullcoat. For those synchronizing the soundtrack to film images, a rewriter/printer unit reads the time code on the fullcoat, and prints a full address onto the backing each second: production number, equipment number, year, month, day, hour, minute, second. With the naked eye, the film editor can conform to film on which the time address has been exposed once per second in clear figures.

This system provides a viable solution to the needs of double-system time recording for the film industry.

74. The MB 51 System — A New Design in Magnetic (Sound) Film Transport. *By Gunter Kiess* (Wilhelm Albrecht GmbH, Berlin, Germany)

After a short introduction of magnetic film technology, the author describes the "MB 51" magnetic film transport system. The unique feature of this new unit is the development of a micro-processor-controlled capstan drive which does not need any of the mechanical filter systems previously in use. Since the system contains no flywheels, its acceleration and braking characteristics are extremely good. A direct synchronization with telecines or video recording machines is possible at speeds of 0 to 750 fps (16 mm) or 300 fps (17.5 and 35 mm), both backwards and forwards.

75. A New System for Producing Highest Quality Sound Tape-to-Film Transfers. *By G. Quellet* (Stellavox, Hauterive, Switzerland)

For over a quarter of a century, the Swiss company Stellavox has regularly introduced new concepts in the field of magnetic tape sound recording. The basic goals have always been miniaturization, versatility, and improved sound quality.

Stellavox offers a coherent, modular system that embraces practically all sync and nonsync sound applications; the system is designed so that it will be possible to introduce future standards by means of new plug-in modules.

The long experience of the company has led to products having ergonomic designs. The design of the circuitry combined with careful processing of

the signals appears to impart a world recognized quality to the final product. In fact, many parts of Stellavox machines incorporate new technology. The motors have been designed, patented, and manufactured entirely by the company. Advanced microprocessors and pluggable optotensimeters are also new.

The Stellavox system consists of some basic elements that may be coupled in various combinations. These elements include the AMI 48 mixer, the battery-powered portable SP 8 recorder, and the TD 88 studio recorder. The presentation included a demonstration of the machines in operation.

76. Subjectively Perceived Frequency Response in Small and Medium-sized Rooms. By Erik Rasmussen and Henrik Staffeldt (Danish Filminstitute, Copenhagen, Denmark; Engineering Academy of Denmark, Copenhagen, Denmark)

A sound field produced by a loudspeaker system in a room will normally cause a listener to hear something, i.e., a hearing event is evoked. The essential characteristics of the hearing event are its distance, direction, spatial spread, spaciousness, loudness, and timbre. In the reproduction of sound it is especially important to ensure that a certain, reasonably well defined timbre or tonal balance is obtained, as timbre is the hearing event parameter in which changes are most easily perceived by ordinary listeners.

To ensure uniformity of sound reproduction in different rooms, in particular with regard to timbre or tonal balance, the usual practice is to measure the third octave frequency response of the integrated loudspeaker-room system and adjust it to a certain shape. It is typical that such a frequency response shows a marked high-frequency roll-off. However, two loudspeaker-room systems with the same third octave frequency response — e.g., measured according to ISO 2969 — will not of necessity have the same tonal balance. Perceptual differences remain which cannot be unveiled by a traditionally measured steady-state frequency response.

The objects of the research described have therefore been to try to find (1) an explanation of the apparently necessary high-frequency roll-off, (2) an improved measuring and adjusting method for the attainment of certain tonal balance, and (3) an ob-

jective way to measure/calculate and adequately display the subjectively perceived frequency response of a loudspeaker-room system.

Earlier researchers have called attention to some of the factors which should be taken into consideration when meaningful objective measurements are sought. A listening test technique, proposed earlier, that uses a reference loudspeaker close to the test subject has been applied in a series of listening tests consisting in matching the loudness of a distant loudspeaker to the reference loudspeaker with third octave band-pass noise as test signal. The tests have been carried out in an anechoic room, and in rooms with volumes ranging from about 100 to 1000 cubic meters and reverberation times at or below one second. The results of these tests, and further tests using broad-band noise, speech, and signals are presented.

The often demonstrated high-frequency roll-off may partly be due to the measuring microphone. To avoid this and to get measuring results which are in accordance with results computed from the acoustical data of the loudspeaker and the room, it is necessary to use a microphone with a flat free field and flat random incidence response and a constant directivity index of 0 dB.

The actual function of the reference loudspeaker is to act as a long time acoustical memory for the test subject, that is, it replaces the short time acoustical memory of man. As the perception of sound from the reference loudspeaker is not influenced by the room, it is possible to create a certain reference timbre, e.g., the timbre corresponding to a reference loudspeaker with a flat free field frequency response. Carried out in this way the listening tests have shown that in order to obtain the same timbre from the reference loudspeaker and the distant loudspeaker, the two loudspeakers must have the same third octave frequency response measured at the entrance to the ear canal of the listener.

Based on these results, measuring methods are discussed which make it possible to "transfer" the timbre experienced in, for instance, a small monitoring room to a cinema theater. A meaningful way of displaying the subjectively perceived frequency response of an integrated loudspeaker-room system is presented, and a subjective frequency domain description (loudness vs. pitch) is defined.

The preliminary conclusion is as follows. An accurate evaluation and comparison of the timbre of reproduced sound in small and medium-sized rooms with normal reverberation times is possible on the basis of steady state third-octave frequency-response measurements if the source-dependent diffraction around the human head is taken into account. Temporal effects, if any, will be investigated in some final supplementary experiments.

77. A Review of Requirements for Motion Picture Sound Systems. By John M. Eargle (James B. Lansing Sound, Inc., Northridge, Calif.)

The earliest motion picture sound systems consists of single-way exponential horns operating over a bandwidth of approximately 70 to 5000 Hz. These systems were 30–35 percent efficient, and with input power of about 10 watts they could deliver peak levels of 95–100 dB-SPL in a typical 1000-seat house. Average dialog levels were in the 85–90 dB-SPL range. While adequate for speech, these systems did not have the necessary bandwidth or output level for realistic music reproduction. In time, they were supplemented by horn-loaded 18-in low-frequency (LF) units as well as high-frequency (HF) horn-loaded devices.

Significant improvements were made during the thirties by Shearer, Lansing, and Hilliard, who developed a practical two-way system crossing over at 500 Hz with adequate output over the bandwidth of 40 to 10,000 Hz. The LF section made use of an open-back "W-horn," with its relatively short path length, while the HF section used a multicellular horn for reasonable pattern control. During the forties, Hilliard and Lansing improved this design further, employing for the first time a ported horn LF enclosure. This system, Altec's "Voice of the Theater," became the *de facto* standard in large houses and provided, up until only a few years ago, a level of performance generally exceeding the program input requirements.

The seventies witnessed two important developments in motion picture sound art: special high-level LF effects, as typified by Universal's "Sensurround," and the introduction of Dolby noise-reduction techniques. The special LF effects required supplementary transducers and amplifiers, and the noise-reduction program called for detailed equalization of both

monitor and theater playback channels. The equalization process underscored the power response limitations of existing systems and, in larger houses, pointed to multi-way amplification and more robust transducers as necessary requirements.

The moviegoer of today has been conditioned by the improved quality of music reproduction available for the home, and he is apt to find traditional theater systems lacking in both dynamic range and bandwidth. While older theater systems can usually be upgraded in performance, it seems clear that newly engineered theater systems should be based on vented LF systems and constant coverage HF horns. Bi-amplification is a necessity for response down to 40 Hz, and tri-amplification is a necessity for very-low-frequency (VLF) response down to 25 Hz. Sound-pressure-level requirements over the 40-15,000 Hz band are generally set in the 105-110 dB-SPL range for multichannel systems. Operation below 40 Hz is usually monophonic only, with enclosures located in a cluster to maximize mutual coupling. Level requirements in the VLF region are set in the 115-120 dB-SPL range for the required visceral impact.

The use of well-behaved LF and HF componentry simplifies the design of systems which exhibit flat power response in addition to flat axial response, and such systems normally require only screen loss equalization when used in houses exhibiting smooth absorption characteristics. In many cases, the specification of system componentry can be reduced to a simple choice of quantities of basic HF, LF, VLF, and electronic modules, based on the acoustical and physical characteristics of the house.

The ultimate realization of improved sound reproduction in the motion picture theater depends of course on the production of material with these requirements in mind. Two problems are encountered at the outset of any program to accomplish this. One has to do with the vast population of films tailored for older playback channel response. Optimum presentation of these films over newer systems would require some degree of response adjustment in the theater. A more difficult problem has to do with films optimized for the newer playback systems. This problem is the obverse of the first, and the difficulties are those encountered in theaters not equipped with the extended range systems. In

particular, the ratio between dialog levels and music/effects peak levels would have to be reconciled.

78. Sound Transmission through Perforated Screens. *By Michael Rettinger* (Consultant on Acoustics, Encino, Calif.)

There is a great dearth of information about the design of perforated motion picture screens. There is presently no U.S. standard for such screens: the subject was prepared as a standard in 1945 (252.44) and approved as an American National Standard in 1951 (PH 22.82), but it was withdrawn in 1963. There is a British Standard, BS 5382:1976, according to which the 6000-Hz sound pressure level shall not be attenuated by more than 3 dB and the 8000-Hz level by no more than 6 dB by the screen compared to the level at 500 Hz. The mathematics of the sound transmission of apertures has engaged the attention of many acousticians for many years — starting with Lord Rayleigh and continuing to investigators of the present time, like Ted Uzzle and Rex Sinclair, who presented a paper on the subject at the Spring 1981 Convention of the Audio Engineering Society. But none of these efforts have led to any specific design information on the subject. In the present paper, on the other hand, it is proven that for the same percent open area, the screen with smaller-diameter circular holes has less treble loss than one with larger-diameter holes. The paper is not all-conclusive, but should lead to farther efforts on the part of screen manufacturers.

79. A Modern, "Environmental," Stereophonic, Multichannel Recording Studio. *By Ted Gomillion, Bob Davis, and Michael Rettinger* (Gomillion Sound, Inc. and Altec Lansing, Hollywood, Calif.)

A new concept in re-recording is described. Not only does the studio have state-of-the-art equipment, but it was also designed for the pure comfort of the client.

The new studio consists of a 6 times speed sprocket, stereophonic, re-recording system, with a 96-input Quad 8 mixing console, with complete Dolby encoding and decoding studio. In addition, there are two 35/70-mm projectors that can convert the studio into a 250-seat theater available for private screenings or other functions.

Acoustically speaking, the room is

ideal. Much attention has been given to the design of the stage to make the client and personnel as comfortable as possible. A small gym with hot tub and stream room is available. Natural cedar and warm earth colors have been used extensively to give an earthy feeling. Motorized skylight visors are operated from the console to allow sunlight in on our dubbing stages.

In the rear of the studio are two personalized VIP areas, an office, and a lounge. These areas have convex 14-foot windows for visual and aural monitoring of films. These windows are of particular acoustical and visual uniqueness in that they provide the needed sound isolation between theater and lounges, with very little picture distortion. Each room has its own self-contained bar and motorized visored skylights and curtains for privacy.

In addition to the VIP areas, there is a fully equipped apartment available to talent or executive for "live-in" when lengthy dubbing is in progress.

The studio, with all of its technical sophistication, combined with its environmental treatment, should motivate the client and personnel to produce the most creative product.

79A. Basic Sound Recording and Reproducing Practice (1927-1940). *By J. K. Hilliard* (Hilliard and Bricken, Santa Ana, Calif.)

The presentation provided a brief yet informative history of these formative years of the sound-recording industry.

Advances in Television Camera Technology II

80. Paper cancelled.

81. A 13-Millimeter Saticon™ Television Camera Tube for Use in Portable Television Cameras. *By L. D. Miller and Al Month* (RCA Electro-Optics and Devices, Lancaster, Penn.)

A short 13-mm-diam. magnetically focused and deflected Saticon™ television camera tube has been developed for use in small portable high-performance ENG and EFP color television cameras, such as the RCA Broadcast System's Hawkeye. The tube (RCA BC4398) features new assembly

techniques that facilitate acquisition and maintenance of the high precision required for more accurate registration. The tube's unique glass envelope assures accurate alignment of the electron optical axis of the tube with the electron optical axis of the focus-deflection coil assembly; the electron-gun design reduces lag caused by target capacitance. Excellent resolution has been obtained by optimizing the diameter and location of the beam-lighting aperture. Beam landing error and beam bending have been minimized through careful design of the G3-G4 lens and accurate control of the G4 target spacing.

The BC4398 utilizes the amorphous selenium-arsenic-tellurium Saticon photoconductive layer; thus its spectral response is highly suited to three-color television cameras. The Saticon layer features high sensitivity with excellent resolution. The low reflectivity of this layer results in minimal flare in highly illuminated portions of a scene and makes the implementation of flare compensation circuitry less difficult. Since the Saticon layer can be produced in large lots, the process is particularly suited to high-production schedules. Each faceplate is individually inspected for defects before being sealed onto the tube; therefore, the BC4398 produces a picture that is free from spots and blemishes.

Resolution data taken using the RCA P300 test chart are presented as MTF versus TV line number, effective amplitude response versus TV line number, and resolving aperture geometry. Sensitivity and spectral response data are given along with decay lag and buildup lag curves, with and without bias light. Data illustrating the excellent geometry and registration achieved with the newly developed 13-mm Saticon tube are also included.

82. The Hawkeye Camera — Part I of "A Broadcast Quality Recording Camera." By L. J. Bazin, S. L. Bendell, and J. J. Clarke (RCA Broadcast Systems, Camden, N.J.)

A hand-held camera designed to be coupled to a VTR requires a new look at old problems, i.e., size, weight, and power. To a large extent, the size of current hand-held cameras is determined by the size of the optics, which is directly related to the image size. Broadcast-quality cameras are presently limited to an 11-mm image diagonal on the pickup tubes.

The decision to base a new camera design on an 8-mm diagonal was taken after intensive studies of the various parameters affected, including sensitivity, resolution, and mechanical stability.

The problem of maintaining registration stability required a new approach to the design of the yoke and pickup tubes. Substantial improvements have been made in performance in both of these areas, and it is expected that the resultant picture quality will extend the use of the camera well beyond the ENG field.

Integrating the VTR with the camera resulted in design emphasis being placed on reducing the number of adjustments to simplify the system, improve stability, and reduce size. This effort resulted in a "knobless" encoder which performs better than conventional designs employing many adjustments.

Similarly, a simplified digital memory is used to store the auto white and black balance settings.

Special attention has been given to the design of the mechanical assemblies. A modular concept has been used throughout the design, and the conventional cable harness has been eliminated. The design lends itself to high-quality production techniques in addition to improved serviceability offered to the customer.

The camera supplies special video signals to the VTR. A composite signal output is also available in any one of the four TV standard signal formats.

The combination of the camera and advanced $\frac{1}{2}$ -in cassette-loaded VTR has resulted in a substantial step forward in portable recording systems.

83. The Hawkeye Recorder — Part II of "A Broadcast Quality Recording Camera." By C. R. Thompson, R. E. Flory, and L. M. Chatman (RCA Broadcast Systems, Camden, N.J.)

The paper discusses the overall design considerations for a new ENG/EFP videotape recorder. One of the most important goals is the improvement in picture quality over the current generation of portable VTRs while decreasing the size, weight, and power consumption.

The paper is presented in three parts. The first focuses on the important human engineering which is required in a portable videotape recorder. It touches upon mechanical reliability in such a portable VTR. The second part focuses on the studio VTR

system. A new electromechanical design for the studio VTR is described, with the emphasis being on the new radical packaging concept for a VTR of this type. Such important items as accessibility and ease of maintenance are included. The studio VTR, while operating in a controlled environment, must be designed to withstand demanding service, and the key elements in designing a more rugged and reliable VTR are presented. The third part of the paper provides an overview of the new recording format which was used to improve the picture quality of the videotape recorder system. The results of this improvement are shown via a comparison with the current generation of ENG/EFP U-Matic VTRs.

84. Betacam — A VTR in Camera. By Masayuki Takano and Ichiro Segawa (Sony Corp., Atsugi-shi, Kanagawa-ken, Japan)

The early 1970's saw the beginning of a new era in the broadcast industry with the development of electronic newsgathering (ENG). The desire to pursue immediacy in news coverage led the broadcast industry to search for a new medium to supplement film coverage. Their endeavors were realized by the accessibility of field portable color cameras and recorders, as the first attempt in the form of rather institutional equipment which later provided a basic platform for the development of true broadcast-quality ENG equipment.

The paper describes what is being called 2nd-generation ENG (recognizing that the present ENG operation is the first generation of ENG).

The criteria of 2nd-generation ENG have been based on users' desires and the manufacturers' experience to date. Some of the key criteria are: film style mobility, improved picture quality, and system implications.

The technological analysis and achievements towards the best possible form of the equipment in order to meet every aspect of ENG criteria are described. These include: (1) the advantages and disadvantages of various color recording systems, such as direct, RGB, YUV, YIQ, Y/C, and color-under methods; (2) the best possible tape and cassette size among the following sizes: 2 in, 1 in, $\frac{3}{4}$ in, $\frac{1}{2}$ in, and $\frac{1}{4}$ in; and (3) the choice of recording format.

The present result has been the development of "Betacam — A VTR in

Camera," and its application in conjunction with the existing system such as switchers, VTRs, time-base correctors, and editing facilities with a minimum amount of additions and changes.

85. The Development and Manufacturing Process of the Unique Hitachi Tri-Electrode Saticon Broadcast Camera Tube. *By Bebe F. McClain* (B. F. McClain Productions, Inc., Asheville, North Carolina)

The new tri-electrode Saticon broadcast tube was originally developed years ago by RCA, but was never successfully manufactured until Hitachi Denshi built a special plant in Kobuchizawa, two hours outside of Tokyo, for the express purpose of manufacturing this tube under the extremely rigid conditions that are required. This presentation describes the manufacturing process, using photographs to illustrate the major steps.

Six years were spent developing and testing the processes needed to successfully manufacture this tube, which is used in the new single-tube color broadcast cameras. (The R., G, and B are combined on the target of this tube.)

The difficult part of this manufacturing process lies in the production and assembly of the target. Many delicate steps must be performed under exacting "clean" conditions more stringent than almost any that have ever been required for manufacturing any item in the world. Aside from the unbelievably clean conditions needed, the target, which is no bigger than a quarter, has a complex wiring system with over 1000 contact points, including three-dimensional contact points.

The first stage of production involves a piece of polished glass upon which a thin layer of photoconductive material (SnO_2) is deposited. This is for the face of the target. A stripe is then made by exposing some parts to light. Next, a second glass square is added upon which chrome and gold are evaporated (on the surface), making special patterns.

After that, wiring is placed around the surface, a glass is placed on this, and all are ground down to one plate. Another glass plate with the color striped filter is put onto the plate and the two existing plates are pressed together.

The most difficult part of the process is considered to be the next two stages. Some of the glass is removed,

leaving the filter. Cutting this glass off and boring the holes for the R, G, and B solder connections are considered highly proprietary. Next the target and gun are assembled, then aged, and tested.

The entire plant is a "closed system" and does not discharge any water into the local town's water system.

The manufacturing process and the testing procedures are explained, using numerous support slides.

Also explained are the differences between the tri-electrode tube that has been manufactured since 1979 and used in the low-cost single-tube color industrial video cameras, and the new tri-electrode tube that will be used in the new single-tube broadcast cameras.

New Applications of Technology to the Film Industry

86. Microcomputers in the Film Laboratory (How Film Processing Laboratories Take Advantage of the Third Industrial Revolution). *By Dr. Yngvar Cramer* (Schwarz Filmtechnik, Ostermundigen, Switzerland)

More and more film laboratory equipment today is designed using microprocessors. If you read the manufacturer's advertisements, microprocessors are sometimes treated like jewels in a watch — the more you have in the equipment, the better it is. Although the first microprocessors only appeared in the second half of the 1970's, probably no other technical innovation has ever caught on so fast. This creates some problems for the laboratory engineer. Most engineers went to college before 1976 and had to learn about microprocessors on the job. Many didn't have the time to do even that, so that in many small laboratories today the new, sophisticated equipment is treated as a black box. It would be too demanding to give a 30-minute crash course in microprocessor technology, but all the same, this paper gives some of the basic facts regarding what a microprocessor is; how it works; some microprocessor jargon explaining interfacing, input and output, memory, software, hardware, digital codes, and languages; the nature of microprocessor networks; the current state of microprocessor-controlled laboratory equipment; and a peek into the future of microprocessor technology and applications.

87. Application of Standard Microcomputers in Negative Preparation. *By Nigel S. Varian* (Cine Lab Services Ltd., Hertfordshire, England)

This paper covers the use of standard Apple microcomputers in the preparation of negatives for printing. Several Apples are used in cueing the film, in timing the film, in automatic generation of printer control tapes, and in efficient regrading. In both the cueing and timing applications, the Apples are interfaced directly to the relevant film handling/timing equipment so that all data is read by the computer with no intermediate manual operations. This eliminates many operator transcription errors. The paper continues to describe some further developments of the system. These include a fully-automatic negative cueing system for A & B checkerboard cut negatives, which derives the cue positions from the detection of black spacer as the film is transported continuously over suitable detectors. The geometry of the film also enables dissolves and fades to be detected and all cues positioned accordingly. An efficient print inspection and regrading system provides a simple means of electronically placing "flags" opposite bad scenes so that subsequent bench inspection can go directly and automatically to the scenes in question. An integrated laboratory print control system integrates cueing, timing, densitometry, and color control with the administrative requirements of orders, progress, and dispatch of work from the lab. The aims of the system described in this paper are continually directed at the ongoing laboratory requirements of better negative handling, fewer reject prints, and faster and more productive throughput.

88. New Microprocessor Systems for the Automated Collection and Use of FCC/Timing Data. *By Michael V. Chewey, III* (Lab Methods Corp., Woodland Hills, Calif.)

The efficient gathering and use of FCC data is becoming essential for increasing productivity within the film laboratory. Several systems have been developed for Lab Methods Corp. for the rapid and economical utilization of this cueing method. In this paper, an advanced and versatile stand-alone programmer employing a CRT terminal, high-speed reader-punch, and optional hard-copy printer is described. Powerful electronic data editing and

high-speed punching of tapes make this system an important tool for production of paper tapes. An FCC data collection is used at the film synchronizer. This system automatically gathers FCC data and provides a paper tape at the negative write-up area. The system is configured to allow up to six synchronizers to share a common reader-punch and hard-copy printer. The system can also handle up to six reels (A-F) simultaneously. Also described is the most advanced analyzer system available to gather FCC/timing data at a film analyzer. This system uses a CRT for unprecedented versatility and ease of operation. All analyzer data are automatically gathered and processed with minimum operator intervention. Optional scene descriptions may be provided, and the system is designed to allow up to six analyzers to share a common reader-punch and hard-copy printer. All three systems described above are capable of storing data on cartridges, disks, cards, and other formats, as well as paper tape.

A microprocessor-based system is also presented for use with a Model C-type printer. This inexpensive reader/computer replaces the high-maintenance electromechanical reader head in the printer's high speed reader. Installation takes less than an hour, and all tape data is stored in computer memory. The system provides automatic heads-tails printing, automatic loops printing, and all cueing modes (FCC/tab/notch/frames only). All film formats — 8-mm, Super 8, 16-mm, and 35-mm — are accommodated, and single, double, or custom tapes may be used. A panel and optical printer FCC system are also described. These systems are self-contained and provide the capability of firing all light valves — Bell & Howell, Peterson, and Debie — by a simple interchange of a program chip and driver board. The development of these products represents a major step forward in microprocessor systems using FCC to enhance productivity in today's film laboratories.

89. Film Metering Devices. *By Robert P. Gyori, Fred J. Scobey, and Imre O. Fodor* (Deluxe Laboratories, Inc., Hollywood, Calif.)

Two major areas where film metering is relevant are in the processing machine through tachometry, and in the theater using a counter with a large display. Through the years, Deluxe

Laboratories has played a major role in the design, development, and manufacture of such devices.

During the 1950's, the implementation of the Burroughs electronic counter with large nixie-tube displays for theatrical use was significant. As the state of the art in electronics progressed, integrated circuit chips became available. A fully solid-state system using incandescent, back-illuminated, large displays became a reality in the 1960's.

With the introduction of the microprocessor in the world of electronics, a number of possibilities in film metering techniques became available. It became possible to develop the "PiTak" (programmable integrating tachometer). Large-size light-emitting-diode displays can now be used in projection room counters.

These state-of-the-art devices are now superseding their original functions, and are extremely useful in laboratory practices.

90. A Cost-Effective Approach to the Long Term Preservation of Color Motion Pictures. *By Henry Wilhelm* (Consultant to Iron Mountain Group, Inc., Grinnell, Iowa)

There has been a great increase in concern recently about the preservation of color motion pictures. Film director Martin Scorsese and others have expressed the fear that much of our color motion picture heritage will eventually become seriously deteriorated, and possibly lost completely. Not only are major worldwide theatrical releases at stake, but also untold thousands of color films made for television, documentary programming, and educational and scientific use. Emerging markets for color films, such as videodisk and cable television, have greatly increased the potential for future revenue from films. However, the promise of long-term market value can only be realized if these films are preserved in a usable condition.

At present, there are only two viable approaches to long-term color film preservation. Black-and-white separations can be made from the camera original for reconstruction in the future. The other approach is to store the color original, intermediates, and release prints at temperatures of -18°C (0°F) or lower with a controlled relative humidity of about 30 percent. In fact, available information indicates that color originals stored under these conditions will last far longer than

silver separations kept in normal air-conditioned room storage.

This presentation compares these two approaches to color film preservation, with particular emphasis placed on the initial and future costs per foot of film preserved. It demonstrates that the low-temperature storage of original color footage is much less expensive, both in the short and the long term, than the separation approach. There are also a number of important advantages to the cold storage approach, not the least of which is that, along with the camera color original, release prints can be preserved in an essentially unchanged state for many hundreds of years while remaining readily accessible for videodisk production, television broadcast, future forms of electronic theatrical release, and other applications where a top-quality release print is required.

Also included is a brief discussion of the film storage facility at the John F. Kennedy Presidential Library, which opened in Boston in 1979. The Library has the world's first operational large scale humidity-controlled -18°C (0°F) storage facility for its collection of color still photographs and motion pictures, most of which are color negative originals. Later this year, Time, Inc. will begin operating a similar low-temperature storage facility on the 28th floor of the Time-Life Building in New York City, to preserve its large collection of color still photographs. The Art Institute of Chicago is currently constructing a low-temperature facility for its expanding collection of still color prints, and is scheduled to go into operation in early 1982.

When it is important to protect major productions and other valuable footage from catastrophic loss as a result of earthquakes, equipment failure, fire, theft, or damage during transportation or laboratory handling, the various film elements made during the course of a production should be divided between low-temperature, humidity-controlled storage facilities at two different geographic locations. For example, one facility should be used to store the original conformed color negative, a duplicate color negative or CRI, a sound cut negative and/or magnetic master, and two mint condition release prints (including a copy of each foreign-version release print). Another low-temperature facility at a different geographic location should be used to store a color master positive, a duplicate negative or CRI,

a sound release negative and/or magnetic master, and two mint condition release prints (including a copy of each foreign release print). It may also be desirable to store important outtakes in one of the low-temperature facilities. The second storage facility should be close to production and laboratory facilities, and it is the film elements in this facility that would normally be accessed for distribution copies. The other storage facility would be used as a high-security dead storage area, which would not normally need to be accessed.

It should be noted that, other than the two to four release prints made for storage, all of the film elements mentioned would be made during the normal course of film production and are available for preservation without additional expenditure. The release prints can be made at low cost as part of the initial release print order. Black-and-white separations are not necessary if this general procedure is followed, which will save considerable amounts of money. The low-temperature storage of color films also permits long-term preservation of television features and other moderate budget productions at reasonable costs.

The availability of color release prints in perfect condition will probably prove to be the most valuable aspect of long-term preservation. A print can be readily accessed for videodisk production or television transmission with no laboratory costs for color correcting faded prints or attempting to make a new print from separations. As current film stocks become obsolete and are replaced with new materials or different sensitometric characteristics, it may be a difficult and costly process to properly print existing negatives or separations without significant image quality losses. In the long run, a well-preserved release print may prove to be the only usable element from current film productions. As high-resolution and digital television systems evolve in coming years, it will always be desirable to go back to the photographic original in order to obtain maximum image quality.

91. A Commercial Service for Low-Temperature Color Film. *By Jack B. Goldman* (Iron Mountain Group, Inc., Boston, Mass.)

Preservation of color photographic material has become an increasingly important issue in the motion picture industry. After-market value of color

motion picture film and ownership issues have focused attention on the use of cold storage as a viable option for the archival preservation of color films. At the present time, few cold storage facilities exist that deep-freeze color film. The Kennedy Library in Boston has operated at 0° F for more than a year. Also, Boston's Peabody Museum has operated its facility at 38° F for the past year, and plans to operate at 0° F soon. Other 0° F facilities are being constructed or planned for the preservation of museum photographic collections, but no *commercial* facility presently offers temperatures below 32° F with 30 percent relative humidity (RH).

The Iron Mountain Group has studied the viability of constructing a commercial cold storage archive, and presents here its facility, services, and the management support activity required to insure the best possible preservation of color photographic materials.

In a statement issued at last year's SMPTE Conference, Dr. Charleton Bard of Eastman Kodak Co. recommended low-temperature, low-humidity storage of valuable color film. This includes negative intermediates and black-and-white separations. The release states, "The storage temperature should be as low as possible — the lower the temperature, the greater the dye stability. The ideal relative humidity should be 25 to 30 percent. . . . Store your valuable negatives and intermediates in an environmentally-controlled vault or similar storage facility. If you don't have such a vault, consider one of the 500 underground storage facilities located throughout the United States." Unfortunately, there are less than 25 commercial underground storage facilities in this country. The program to be introduced to the film industry by Iron Mountain will be the first to be totally dedicated to the storage of material at 0° F and 25 percent RH. It will be offered to all collections of photographic material, regardless of the size of the collection. For the first time, these collections will have an economically viable alternative to black-and-white separations or building their own cold storage archives.

The cold storage archives will be contained within a building in Iron Mountain's underground facility near Kingston, New York. This facility presently stores and services large film and audio collections in twelve environmentally-controlled buildings. The

film archives will consist of a 0° F cold storage vault which is expandable in modules, an outer storage area maintained at 50° F and 40 percent RH for the staging and storage of black-and-white photographic materials, and a support service area in which technicians will inspect, package, identify, and index all incoming and outgoing materials. A computerized locator system will automatically assign a location code and up to three unique identifiers for each item received. The system will schedule future dates for film servicing and report on any films that have been logged out, but have not been returned within a specific time frame. Inventory reports will be prepared on a scheduled basis for each client's collection. In addition to motion picture films, the archives will house and manage collections of still photographic material, including 4 × 5 and 8 × 10 transparencies, 35-mm slides, and color prints.

92. An Inexpensive Archive Storage for Color Film. *By Roland S. Gooes* (The Swedish Filminstitute, Stockholm, Sweden)

The Filminstitute has started an operation to store all Swedish color films made from the 1950's to the present, and into the future. All of these films are ordinary motion picture safety films. First, the film is conditioned in a specially constructed cabinet to bring down the relative humidity to 20 percent using a constant temperature of 68° F. Thereafter, each film roll is packed into a bag, the air is expelled, and the bag is immediately heat sealed. This bag is then placed into one more bag of the same quality, the air is evacuated, and that bag heat sealed. The film is then placed in a tin case and stored in a freezing chamber maintained at a minimum of minus 15° F. It is very important that the plastic lining in the bag is not harmful to the film, since potentially harmful gases can occur during heat sealing.

93. Paper cancelled.

The Film-Tape-Film Interface I

94. Improved Integration of Film and Television. *By Karel Staes* (Agfa-Gevaert N.V., Mortsel, Belgium)

When looking back into the history of

photographic and electronic image recording and reproduction, it is plain to see that both reproduction systems were developed independently and result from totally different technological approaches and principles. It is therefore quite understandable that both techniques do not match completely when they interface, namely when film is scanned and converted for broadcast.

This paper discusses some suggestions that could lead to an improved interface between film and television. Special attention is given to image steadiness and automatic color correction.

95. The Interface of Color Negative Film and Telecine. *By Karel Staes and W. Markie (Agfa-Gevaert N.V., Mortsel, Belgium)*

Color negative film has been designed to be used as the primary image recording element of the color film production system. Consequently, its characteristics, such as sensitometry, dyes, and photochemical masking, are chosen to yield optimum transfer of the recorded information from the color negative onto the color print film or intermediate materials.

Recently, color negative film has also been used as the primary recording element of the film-telecine reproduction system. In this system, color negative film is used instead of the traditionally-used color reversal film, and it is scanned without intermediate transfer onto color print films. In this paper, the discussion surrounds the interface between color negative film and the telecine, and a proposal for an adapted signal handling procedure that will lead to optimum reproduction.

96. The Marriage of Film and Tape: New Tools for Filmmakers. *By Humberto R. Rivera (Cinetronics, Inc., Los Angeles, Calif.)*

As the motion picture industry developed during the era of silent movies, so did the visual language which we take for granted today. Sound became an adjunct to the movies. Similarly, the broadcast industry began with the development of radio, and, in the early days of television, images became the broadcaster's adjunct.

To this day, film remains the primary production medium for dramatic works, and video is the primary medium for event coverage, variety shows,

news coverage, and other non-dramatic works. However, the tide is turning. Recently we have begun to see the evolution of a new, hybrid, film/video production technique. We only need to look at the increase in the video presence at the traditionally film-oriented SMPTE Conference to see the writing on the wall.

The creation of a film or video production utilizes converging technical systems of diversified interests. For example, motion picture professionals have been using many things that must have been somebody's problems decades ago, e.g., latent edge numbers on the original, standardized perforation sizes, film stock qualities that flow from the original photographic image to internegative and on to release prints, and many more.

We are now beginning to see the marriage of film and tape through a combination of experimentation, equipment design, and the continuing evolution of the visual language. In the process, new tools are being created for filmmakers.

The producer's perspective of the image path in the film/video production is typically perceived through a series of post-production stages. In the outline which follows, there is an assumption that most of the work has been done on one-inch Type C equipment:

(a) **Location Photography:** Usually shot on 16-mm or 35-mm color negative stock using a double-system sound recording.

(b) **Developing the Original:** The original is developed and prepared for videotape transfer. At this point, the producer has two options on how he can deal with the synchronized sound. He can transfer all of the $\frac{1}{4}$ -in sound to magnetic film and make a work print of the original. The soundtrack is then synced without cutting the picture print. During the interlock transfer to videotape, the original film is substituted for the workprint, making sure that all sync marks are exactly the same. The other option is to transfer the film to videotape without sound, and then transfer the $\frac{1}{4}$ -in synced soundtrack to another videotape. Both videotapes are then synchronized on a video editing system making audio-only edits on the picture master. This system can be slightly modified using the $\frac{1}{4}$ -in audiotape original to edit directly to the picture master.

(c) **Transferring Original to Videotape:** We have found that a color negative, normally processed and ex-

posed $\frac{1}{4}$ to $\frac{1}{2}$ stop over, exhibits a certain quality that is very difficult to achieve on videotape. It is this subjective perception of the image quality when transferred to videotape using a flying spot scanner that is one of the primary reasons for the continued acquisition of images on film.

(d) **Off-line Editing:** This is an optional step that depends on the time required to complete a production and the size of the budget. Generally, a $\frac{3}{4}$ -in videocassette duplicate is made of the original videotape, including the original time code numbers burned in over the picture. This procedure allows the editor to concentrate on the images and forget about the numbers since they will always be on the picture (similar to original film edge numbers printed through a work print).

(e) **On-line Editing:** Simply stated, on-line editing is going directly from the videotape original to an edited master videotape. This procedure can take a number of different forms — 1-in tape to 1-in tape, $\frac{3}{4}$ -in to 1-in, and so on.

(f) **Sound Mixing (Sweetening):** One of the major problems for filmmakers dealing with videotape is sound and how to sync it, edit separate tracks, dub soundtracks, and so on.

Using film images today makes good sense. Not only can these images be transferred to any videotape format around the world, but more importantly, they can be made compatible with future technologies, such as high-definition television and digital processing. It is usually a careful and calculated move when a filmmaker ventures from pure film editing to the world of video post-production. It is a move that is often viewed with a certain amount of distrust and uncertainty. Video editing should facilitate the image-making process without compromising the film editing techniques which have evolved since the early days of silent pictures. The time to move into the twentieth century with regard to image editing is here, particularly as we can see the possibility of high-definition television, digital, and other modern image-making systems taking shape on the horizon.

97. Electronic Film Editing. *By Robert Duffy and Joseph Roizen (CMX/Orrox, Santa Clara, Calif.; Telegen, Palo Alto, Calif.)*

In a world of microprocessors and machine controls, film editing is still

essentially being done using mechanical techniques developed decades ago. However, physical handling and cataloging of film for re-editing has always proved to be one of the most time-consuming aspects of film production, because of the need to store, search, and assemble random scene segments. A solution to this growing problem is in combining the primary film medium and advanced electronic technology, which permits the assembly and real-time preview of various segment versions without subjecting the film to actual cutting. The device which has been developed to satisfy this need in modern, fast-paced film production, for either cinematic or television program production, is an electronic control system, applicable to any servo-driven film editing or sound transport. Through the use of EBU or SMPTE time and address codes so prevalent in video operations, very precise frame-by-frame control can be maintained through total synchronism between the film source and the videotape recorder. The editor can then select only those film shots that are needed, preview them, and re-edit them before making a final commitment. The valid edit decisions are stored in a memory and used to print out a negative and sound cutter's list.

One of the problems in 60-field TV countries is the difference between the television image rate and the 24-frame film rate. This can be overcome by using a sophisticated software program which tracks the film and VTR image sequencing and decides on the correct film edit point by selecting the appropriate video field on which the edit is being performed. Also, a continuously variable film/VTR interlock is provided. This allows for the European requirement of motion-picture-style soundtrack editing and mixing for productions originated on videotape.

System compatibility with a wide range of existing tape machines has been made possible by taking advantage of the existing 340X control Intelligence Interface (I²) unit. The same philosophy used with film transports has been applied to a universal film control. The main design goal was to give film editors a relatively inexpensive add-on to existing equipment, which would move them toward new technology while retaining familiar tactile and visual approaches to editing.

This paper describes a working system which has been developed for

the purposes indicated, and which received its first exposure at the Photokina Show in Cologne in September 1980.

98. Data Encoding for Video-Assisted Film Editing. By Phillip G. McFadin (Gray Engineering Laboratories, Inc., Orange, Calif.)

This presentation provides a discussion of a method of establishing an accurate decision list of film edits using a visual representation on videotape. This decision list can then be used by a film editor to cut a film negative. To facilitate this editing process, a Vertical Interval Time Code (VITC) is employed, in conjunction with a field rate longitudinal code. Data encoding in the user bit section of the code contains multiplexed versions of the film frame count, as well as scene number, reel number, and other identification information. Information from the edited videotape can then be automatically transferred to a decision list for film editing.

Since the frame rates for television and film are different, the 3/2 pull-down method has been used for years to make the two formats compatible: alternating between three TV fields for one film frame, and two TV fields for the next film frame. The inability to edit the videotape where the film frame changes results in some gross accumulative errors. Two out of every five TV frames have a film picture change in the middle of the frame, making them unusable for frame editing. A more useful approach would be for the tape machine to be able to servo-lock and edit on either field of every frame. The editing system would then be able to recognize mid-frame film changes and control the edit machine to use every film frame in its entirety as it was transferred. But this solution obviously poses new problems: (1) how does the editing system recognize that a TV frame was split by a film frame, and (2) how is the TV field interlace relationship maintained throughout the editing process?

The first problem is solved by encoding the tapes during the transfer process with an edit code similar to the SMPTE Edit Code. The code is then transmitted at a field rate, rather than a frame rate, and the user bits are encoded with the film frame count, using signals from the telecine system. This method, known as the "Gray Field Code," provides sufficient information to allow the editing system to perform

the edit based on the time portion of the code and the film frame information in the user bits. Each TV field is identified in the time portion by using the 80-second bit to identify the fields. At the same time the data is being encoded and recorded on the cue track, it is also inserted into the vertical interval using the proposed SMPTE Vertical Interval Time Code format. The purposes of using VITCs are: (1) to provide an accurate edit code when the tapes are viewed at very slow speeds or still frame, and (2) to provide a data format preserved in the edited master without disturbing the cue track.

The problem of maintaining proper TV field interlace during the process can be handled much as color framing is done now. After the editor has viewed the tapes and entered his chosen numbers into the editing system, the system then searches and parks the tapes at some place before the actual edit point. It then rolls the machines and synchronizes the "record" VTR so that its playback video field interlace matched that of the system sync. At this point, it synchronizes the "play" VTR to make the edit code numbers correspond to the numbers of the "record" VTR; i.e., if the "record" VTR is 117 fields away from the edit point, then the "play" VTR is moved to 117 fields away from its edit point. Now that both tapes are synchronized to one another, the editing system can command the "record" VTR to record on a specific field to perform the desired edit.

The editing process will probably take at least two forms: one is a simple two VTR cuts-only system, the other is a computer-aided system with a full video effects switcher. The first system requires no additional equipment. The editor simply makes cuts-only edits to assemble a master, and, after getting the picture the way he wants it, goes on to the logging process. While he has been assembling video from the play reels to his master reel, the data recorded in the vertical interval identifying every TV and film frame was also transferred. The data in the vertical interval of the master reel now reflects the origin of all source material. The more complex system using the SMPTE Edit Code and having the ability to do video dissolves and wipes from two or more "play" VTRs, must in itself be equipped with time base correctors (TBCs) in order to synchronize and stabilize the video from the machines prior to mixing at the video switcher.

99. A Video-Assisted Film Editing System. *By Michael Loran Kary* (Harris Video Systems, Sunnyvale, Calif.)

There are several major advantages to editing videotape as opposed to film stock. Videotape, as a medium, is more compact and more convenient for shipping and storing than film, and multiple copies can be generated more easily for viewing purposes. Since videotape is reusable, there are cost savings as well. Computerized electronic editing eliminates most of the manual tasks required in film editing. The computerized system can make frame-accurate edits and generate a list that records each edit decision. Since there is no physical splicing, previewing and re-editing are greatly simplified. Minor changes involving one or a few frames are handled easily, but, most importantly, effects and transitions can be generated electronically as part of the editing process.

If film producers are to be able to participate in the advantages of electronic editing, there must be a method of transferring the original film footage to videotape for editing, and then conforming the negative to the edited videotape. Until recently, no satisfactory system has been designed to accomplish this, because of the difficulty of relating the standard 24 frame-per-second film rate to the 30 frame-per-second video rate. Since the film frame frequently changes in the middle of the video frame, it becomes ambiguous as to which film frame corresponds to a particular frame of videotape. One solution that has been proposed involves the extensive modification of the film chain to prohibit edits on certain frames. A different approach has been taken by Harris Video Systems, which has developed a software-modified version of the EPIC computer-assisted videotape editing system that overcomes the problem of ambiguity. The solution is to record the film edge numbers in the user bits of the time code when the film is transferred to tape. The time code itself is doubled in frequency so that it occurs at a field rate. The video frame number updates once per frame, as always, but the film frame number updates simultaneously as the film is pulled down in the gate. If the film frame updates in the middle of the video frame, so do the time code user bits. The time code is recorded in the vertical interval of the video signal, as well as on the longitudinal audio track.

The editing of the videotape is no different than usual, except that the EPIC operates in a field-accurate mode. Each time an edit or preview is performed, EPIC identifies the time code field corresponding to the edit point and reads in the film footage and frame information, which is stored along with the scene, reel, and take number in the edit list. When the edit session is complete, this data is accessed and printed out in the form of a film cut list, which contains all the information necessary to conform the negative. In addition, the vertical interval time code from the source tapes is re-encoded in the vertical interval of the master tape, and the user-bit information can be displayed as characters in the picture. In this way, the edited master tape also contains all the information necessary to conform the negative, and the videotape looks just like an edited film workprint.

100. High Definition Television Distribution Systems. *By Kenneth F. Holland* (Compact Video Systems, Inc., Burbank, Calif.)

Over the years, television has progressed as a powerful production and distribution medium. With the advent of color videotape, large-screen displays, and satellite transmission, the original standards set forth by the 1953 National Television Standards Committee (NTSC) have become inadequate to meet the quality level required for today's entertainment distribution. For example, although television camera resolution has improved over the years, usable resolution has remained basically the same, limited by the color coding and decoding of the NTSC system. Satellite and cable systems are now capable of transmitting much greater resolution, as long as a new spectrum-compatible color coding and decoding system is used.

This paper describes a new color coding and decoding system utilizing a 7.16 megacycle subcarrier, including appropriate noise reduction. The system is called PALAF (Phase Alternate Line Alternate Frame), which is designed to be spectrum-compatible with studio and satellite transmission equipment. The system eliminates quadrature cross talk, cross color, and cross-luminance components, while a 150 percent usable resolution increase is achieved in both luminance and chroma.

The paper concentrates on four

areas: satellite systems for television distribution, high definition tape recording equipment, high definition monitors and projectors, and high definition cameras.

In the case of high definition tape recorders, the development of high quality formats, such as the 1-in Fernseh B equipment redesigned to run at twice the normal writing speed, and new frequency modulation signal systems, have achieved an increase in video bandwidth to 10 megacycles. Ten megacycle machines can record in both 655 and 525 vertical line scan modes, and in PALAF using the color system to create a high-definition recording and playback system.

With regard to current camera technology, high-definition camera design utilizes special 30-mm pickup tubes to achieve a 70 percent increase in resolution over current small-format cameras. Up to 800 lines of horizontal resolution can be achieved and encoded in the PALAF color encoder to generate a composite signal, which can then be distributed via satellite and VTR.

This paper further suggests the acceptance of a 655-line, 24-frame distribution format because it will accommodate film-to-tape and tape-to-film transfers. Such a facility allows film to be transferred to videotape for post-production and still retain substantially high resolution and motion rendition.

Additional applications of a high definition television system include increased videodisk density, archival film storage, improved teleconferencing, and high resolution film distribution played from video to large screen projectors.

The Film-Tape-Film Interface II

101. The Urgency of HDTV Standards for Electronic Cinematography. *By Kerns H. Powers* (RCA Laboratories, Princeton, N.J.)

In the production of motion pictures for both theater and television media, substantial flexibility and cost savings in the editing (post-production) process can result from the use of television-like cameras for shooting, and videotape rather than film for interim "daily" storage. This process, called electronic cinematography, is a fast-growing art and is expected to partially displace film, at least in the editing

phase, where film-to-tape conversions are already used widely in post-production. However, current television equipment, based on 525- and 625-line transmission standards, is not adequate to reproduce either the vertical or horizontal resolution limits of 35- and 70-mm film. The 4:3 (1.33) aspect ratio of television is also undesirable for cinema use, where aspect ratios of 1.67, 1.85, and greater are common. Thus interest has intensified in high-definition television (HDTV) systems based on scanning standards in the range of 1100 lines per frame with aspect ratios larger than 1.33.

The maximum benefits from an HDTV system are expected to be achieved ultimately with digital implementation of equipment, although such implementations are not yet cost-effective as compared to current analog experimental systems. In the specification of a digital TV system, it is most important to specify not just the line-scanning rate and the video bandwidth or horizontal sampling rate, but rather to specify the image sampling *grid* in terms of the number of the horizontal and vertical samples constituting the active portion of the frame (the image) exclusive of horizontal and vertical blanking intervals.

We have just achieved the possibility of a worldwide digital TV standard with a common sampling rate of 13.5 MHz and a common number of active horizontal sampling elements in both 525- and 625-line systems. It is clear that the first HDTV system level for teleproduction should be maximally compatible with that standard, and should contain double the common number of active horizontal samples modified by any increase in aspect ratio. This choice will permit the simple selection of alternate samples (after digital filtering and cropping each side of the image to a 4:3 aspect ratio) for transcoding to both 525- and 625-line scanning standards.

The vertical dimension of the sampling grid should be a number that lends itself to simple interpolation to both 485 and 575, the approximate numbers of active lines in the 525- and 625-line systems, respectively. The frame rate standard for the worldwide HDTV system could be based upon either 25, 30 (29.97), or 24 frames/sec, but it is important that a *single common number* be specified.

We simply cannot afford to miss this rare opportunity to achieve television system equipment that is absolutely

identical worldwide. The need to commence worldwide discussions on an HDTV standard that will be maximally compatible with the recently achieved digital television standard is *urgent*; otherwise, existing analog experimental equipment scanning parameters might become an incompatible ad hoc standard before digital TV technology becomes widespread.

102. Development of an Ultra Wide Band Videotape Recorder. *By John H. Streets and Al Sturm* (Merlin Engineering Works, Inc., Palo Alto, Calif.)

In February 1981, at the 15th Annual SMPTE Television Conference, Merlin Engineering Works demonstrated a prototype of a new ultra wide band videotape recorder, the ME-248. This has now been developed into a product, and first shipments are being sent to customers.

The Merlin ME-248 is based on the Fernseh BCN series VTRs. The BCN-51 or BCN-20 format is modified so that the head-to-tape speed is doubled. This allows higher carrier frequencies to be used and video bandwidths of up to 14 MHz to be recorded and played back with excellent signal-to-noise and transient response. Details of the new signal system characteristics are discussed.

The ME-248 can be configured to suit a variety of different applications. It can operate on a wide range of standards including 525/30, 625/25, or 655/24. It is capable of filling the needs of a wide range of users — including electronic film production, high-quality master recording, and some military uses.

Future developments aimed at meeting the requirements for the new era of high-definition television are also discussed.

103. New Thresholds: The Electronic Optical House and Its Application to Film and Television Post-Production. *By Arden Rynew* (Compact Video Services, Burbank, Calif.)

This presentation provides a brief history of the continuing involvement of Compact Video and Image Transform in the developing concept of an electronic optical house. It starts with their first excursion into this area eight years ago and traces their progress up to the present, including an overview of the entire concept and a look at future developments, with an emphasis

on Image Transform's flying-spot scanners and the new added importance of Imagevision. Visual examples on film and on videotape are displayed, and information concerning Image Transform's process of interfacing Eastman Kodak edge numbers with the SMPTE time code are included. This last step enables Image Transform to conform video pictures derived from uncut negative to cut film workprint.

104. An Efficient Off-Line Videotape System for Film Post-Production. *By Arthur Schneider* (Consolidated Film Co., Hollywood, Calif.)

Since the advent of videotape in 1956, the film industry has been considering the idea of using videotape as a work print medium to edit motion picture films for television and theatrical release. Until recently, no practical method had been devised that would accurately compute the 24 to 30 frame difference encountered when using videotape as the work print device. One measurable advantage of this application of videotape is increased efficiency and speed during off-line videotape editing.

When editing motion picture film by conventional means, the editor must add or delete film trims in order to modify the length of an edit. This means laborious cutting and splicing each time a change is made. In the event that a piece of film is torn or damaged beyond further use, a reprint must be made in order to maintain visual continuity of the work print. This may take a day or two and cause some inconvenience.

On the other hand, videotape editing creates continuity in work print form by transferring material from one VTR to another by electronic means. Therefore, edits may be modified easily by changing time code numbers, which alter the existing edit points. The editor then remakes that edit until he is satisfied. This procedure may be performed as many times as necessary in order to achieve the desired results quickly and efficiently.

Over the years, systems have been developed that include methods of relating film edge numbers to videotape time codes. However, most of these systems required complex software and/or hardware to achieve less than accurate results. In some cases the footage conversions were within one or two frames, adequate for some applications but not accurate enough for the

exacting consistency required by the film industry on a large scale.

Consolidated Film Industries has developed a sophisticated editing system operating at 30 frames per second, utilizing standard hardware and time code software designed to make this complex conversion procedure invisible to the editor during the post-production process. This conversion does not require the use of user bits or vertical interval time code. With only a few minor changes to already established laboratory procedures, either color positive or negative film material may be transferred to a videocassette work print. This software is designed to edit directly to two-inch or one-inch videotape for a television release or to conform the film directly after completion of the off-line editing process or both. In addition, this process has been designed to work with 16-mm or 35-mm film in any screen format.

With a minimum amount of preparation prior to the start of off-line editing, nearly any CMX or Mach One time-code edit list may be converted to the CFI film program even though it may have been edited outside of our facility.

Presently, CFI offers the option of transferring film dailies silent for those that wish to minimize the amount of negative handling that the film may encounter during the film transfer. The soundtrack is then added by transferring the corresponding sound takes from the $\frac{1}{4}$ -in production originals to the videocassette. An efficient transfer method has been developed by Glen Glenn Sound to add sync sound to the transferred silent film dailies. We also offer the service of interlock transfers to cassette, either positive or negative.

Once the editor receives the composite $\frac{3}{4}$ -in work print cassette, the creative editing process begins in the quiet of an offline editing room until the final version of the work print has been approved. The resulting edit list must be cleaned and traced in order to remove unwanted data and to reorder the edits so that the CFI film program can format the edit list in the same way that the negative cutter assembles the negative.

The CFI film program requires two reference numbers in order to generate the film footage list. The first number is the code or key start mark, and the second is an SMPTE time code number that relates to that film edge number. All these offsets are stored on a magnetic floppy disk and may be

recalled by the editor at any time. Since the film program is an integral part of our Mach One software, it is only a matter of pressing a single key to initiate the film operation.

Because Consolidated Film Industries offers film processing, videotape, and sound facilities under one roof, this organization has the ability to devote the time and resources necessary to develop this unique and versatile editing tool, which CFI feels will increase the efficiency in post-production throughout the television and motion picture industries.

105. A Film and Procedure to Assess Dynamic Luminance Reproduction of Film by Television. *By Robert C. Lovick* (Eastman Kodak Co., Rochester, N.Y.)

A film has been prepared and evaluated for assessment of luminance reproduction of films by television. The film is based on photography of matte white, gray, and black targets on three different backgrounds. Reflectances of the targets bear known relationships to all other targets used in this film.

The target format and backgrounds were chosen to permit tone-reproduction analysis at high average picture level, normal average picture level, and low average picture level. Control white and black targets are included at all times so that evaluation is possible in any combination of manual, automatic white, or automatic black modes. The three average picture levels (APLs) permit good analysis of dynamic operating characteristics.

Luminance reproduction of film is highly affected by the flare of the original taking lens and any additional lenses used to derive the display. Luminance reproduction may be further modified by the telecine transfer characteristic and/or monitor set-up. This paper does not attempt to answer the question of how the display should compare with the original scene luminances. It does provide a photographically valid procedure for those who might wish to explore luminance reproduction of direct projection or television.

Some examples of measurements of two different telecine cameras are discussed to illustrate the information that can be obtained through the use of this film.

105A. SMPTE Time Code Interface and Its Application to Film-Tape

Editing. *By Ludwig Schneider* (Kem Electronic/Mechanik GmbH, Hamburg, Germany)

An editing table that can be used for film and for videotape is described. It was designed to interface between the media of film and tape. The problem of synchronization is solved by making use of the SMPTE time code, either in the form of user bits or the full time code. The editing table design is similar to that of a standard editing table except that the picture is displayed on a TV monitor. There is pushbutton control for a U-Matic VTR and an interlock system to control the drive mechanism. The VTR can be run in forward and reverse at various speeds. The goal has been to provide equipment that can be operated simply so that the user can concentrate on the creative aspects of editing. Several of the manufacturer's editing tables have been in use in the German television industry for about a year.

105B. Film-to-Tape Transfer Technology. *By Bengt Modin* (Swedish Television, Stockholm, Sweden)

The technique of using direct 16-mm negatives in checkerboard cutting is described. Two telecines are used to transfer film to tape, maintaining compatibility with conventional laboratory technique. This unit (A/B-roll telecine) is preprogrammed in a converted synchronizer called CL 500, which is located in the film laboratory.

Cuts, mixes, fades, and superimpositions are made fully automatically using computer technology. Slides and captions are automatically mixed into the film, using a video camera and a slide scanner.

The set-up procedure and color matrixing for negatives are described. Masking matrixes for negatives can be made by using color bar test films and a multiple resistor unit. Film grading in telecine gives good television pictures, and color and contrast can be handled as well as in an electronic TV studio.

Stability has been a problem; the old settings have to be recalled with the same contrast and color as when the film was transferred the first time. Heating of the cellbox is necessary to maintain this stability.

Dirt and scratches on negatives are white and will be enhanced in telecine due to the whitestretch. Much effort has been made to introduce the envi-

ronment of the film laboratory into the telecine area. Negatives are coated before transferring to tape. Grain on 16-mm negatives is disturbing if the film is underexposed, but is significantly reduced if it is slightly overexposed, i.e., 80 ASA instead of 100.

Trends in the area of direct film-to-tape transfer in Scandinavia are discussed.

Digital Video Tape Recording Technology

106. Digital Video Standardization: A Summary Report. By William G. Connolly (CBS Television Network, New York, N.Y.; Chairman of SMPTE Study Group on Digital Television Tape Recording)

The International Radio Consultative Committee (CCIR) is in the last year of the present four-year study cycle. Accordingly, recommendations approved during the meetings held in Geneva from September 19 through October 1981 will be forwarded to the XVth Plenary Session to be held in February, 1982 in Geneva for approval. CCIR recommendation, not approved at this time, will wait for the next plenary session in 1986.

This report summarizes the results of the September meetings of the CCIR as they pertain to digital committee work at the SMPTE. Also, a review of the activities of the SMPTE Study Group on Digital Television Tape Recording is presented.

107. Digital Video Recording: Composite Versus Component Coding. By E. Frasier Morrison (Ampex Corp., Redwood City, Calif.)

A digital composite television signal is one in which the current analog color signal, either NTSC or PAL, is sampled by a clock that is a multiple of the color subcarrier frequency (f_{sc}). A sample frequency of four times f_{sc} is considered because it allows each sample to be defined in terms of its pre-encoded luminance and chrominance values.

A digital component television signal is one in which the original RGB source signals are matrixed to a wide-band luminance and two narrower-band color-difference signals. The luminance signal is usually sampled by a horizontally related clock, and the color-difference signals by a lower-

frequency clock derived from the luminance clock. The clock rates, and thus the signal bandwidths, are high enough to result in the system appearing transparent when the signal is encoded into the final analog transmission format (NTSC, PAL, or SECAM). The color-difference bandwidths are sufficiently high to enable post-production downstream chromakeying with minimal degradation.

The analog composite signal makes use of frequency interleaving of the color subcarrier and its sidebands with the luminance so that the two signals may share the same frequency spectrum with minimum interference. This is an extremely efficient system in terms of bandwidths, and requires a lower total digital data rate than the same information when digitized from the three component signals.

The tape consumption of a digital VTR is expected to be comparable to current high-performance analog machines. Higher data rates would therefore require narrower tracks and shorter recorded wavelengths on tape for constant tape consumption.

For the NTSC system the signal is sampled at 4 times the subcarrier frequency with 9-bit linear quantization, resulting in a user bit rate of 129 Mbit/sec. Under the same conditions for PAL, the user bit rate is 160 Mbit/sec. For a component system in the 4:2:2 hierarchy with, for example, 13.5 MHz as the basic luminance sampling frequency and 6.75 MHz as the sampling frequencies for each of the color-difference signals and 8-bit linear quantization, then the user bit rate would be 216 Mbit/sec. A digital video recorder designed for optimum performance will have a constant area packing density. For unit tape consumption of an NTSC machine, the tape consumption of a PAL machine will be 24 percent greater and the tape consumption of a component machine will be 67 percent greater. Therefore, for a given digital tape transport the tape cost will be considerably lower for the composite system.

In variable-speed broadcast-quality picture operations, such as stop motion, slow motion, and an increase of speed up to, say, two times normal rate, it will be necessary for the digital video recorder to randomly access, in real time, the nearest good field that is at a particular position on the tape irrespective of the longitudinal tape speed. From this one particular field all the other fields of the required televi-

sion system need to be reconstituted. In the case of NTSC a four-field sequence must be reproduced; in the case of PAL an eight-field sequence must be reproduced; and for the component system only two fields need be reproduced. The processing necessary for producing two fields from one is relatively simple and will produce acceptable results. The processing required to produce 4- and 8-field sequences of composite color becomes complicated and can introduce some distortions. Normally these distortions may be unnoticeable, but at the time when the machine is in a slow motion mode and going toward a play mode, a decision must be made to switch to the normal playback processing circuitry, i.e., normal playback. During this transition period the change of quality will be markedly noticeable on the composite signals and barely noticeable on the component signals, making the component system with its higher bit rate more flexible as a production tool in the production of stop and slow motion pictures.

Multiple generation performance in the digital domain will be dependent somewhat on the final error concealment system used. The requirements differ for component and composite systems. Data may be scrambled between channels on a multichannel digital video recorder in such a manner that adjacent samples, both horizontally and vertically, are on separate channels that are spatially separated on the tape. The worst form of uncorrected error is a tape dropout which destroys long strings of the narrow wavelength data. In the case of a composite signal, in order to replace a damaged sample an assortment of samples, either horizontally, vertically, or diagonally, are required to compute the true luminance and chrominance value of the damaged sample.

For the component signal, a damaged luminance sample may be replaced by the two adjacent luminance samples horizontally, or the two adjacent luminance samples vertically, or a combination of both, yielding the minimum loss in luminance spatial resolution for a luminance dropout. If the dropout causes a loss of chroma samples, then averaging the chroma sample from adjacent horizontal samples will produce a signal which has a bandwidth comparable to the color-difference signal bandwidth of the NTSC or the PAL system. Thus, a dropout in chroma will not produce any visible distortion when observed

through the window of the NTSC or the PAL system.

A digital composite television system is the most efficient in terms of tape consumption, as the analog composite television system is the most efficient in terms of a signal bandwidth. A digital component system, because the data is kept as three separate independent signals, is extremely rugged. There is no interaction of luminance and chrominance, and the picture repeats on a two-field basis — the same rate as the scanning frequency of the television system. Where any form of electronic picture processing is performed, such as in the case of stop motion, slow motion, and slightly faster than normal speed, the processing operations are simpler to perform on a component signal, and produce superior results. As a production tool, a variable speed videotape recorder operating on encoded component digital television signals would provide greater flexibility than the same type of machine operating on digital composite television signals.

108. Considerations for the Choice of Digital VTR Format. *By H. Yoshida and T. Eguchi (Sony Corp., Atsugishi, Kanagawa-ken, Japan)*

During the past few years, the standard for the future digital video system has been discussed intensively at the SMPTE. The basic concept of the standard has almost reached consensus, as may be seen in the literature.

Research on digital video recording at Sony was started as an engineering project to see how feasible it would be. However, at the present time it seems appropriate to carry the objective one step further towards practical development.

The paper qualitatively analyzes various options and trade-offs concerning the following subjects from the viewpoint of digital high-density magnetic recording: (1) factors deciding the tape consumption, (2) relations among the factors which limit the tape format, and (3) possible formats and some comments.

Despite all of the present engineering efforts, however, our research may lead to the view that the "C" format analog VTR is still evolutionally improved and is able to offer quite convenient facilities. Bearing this in mind, if more facilities or functions are expected compared with that of present analog VTRs while seeking a good

justification for the DVTR to be introduced in the future, the development time may be longer than was estimated earlier because the problem may be regarded as one of shooting at a moving target.

109. The (Correct) Approach to Digital Video Recording. *By J. Heitmann (Robert Bosch GmbH, Darmstadt, Federal Republic of Germany)*

Following the agreement between EBU and SMPTE concerning coding parameters for digital television studios, it is now possible to speed up the standardization of a digital videotape recorder.

Standardization in digital recording has two main factors:

1. Compatibility for 525 lines/60 Hz and 625 lines/50 Hz. This does not mean that every DVTR will be a dual-standard machine; the manufacturer should, however, use the same tape deck and largely the same electronics. This compatibility can only be achieved if the number of segments per field and/or the recorded wavelength are varied. As the recorded wavelength (linear packing density) has a direct effect upon error rate and tape consumption, it should be identical for both TV standards: 525/60 and 625/50. The smallest whole number ratio that represents the differing field frequencies is 5:6, i.e., 5 segments for 525/60 and 6 segments for 625/50 result in the smallest number of segments for identical wavelengths with both standards.

2. Compatibility between recorders from different manufacturers. Discussions about a standardized recording format must begin with the definition of which parameters have to be common and which need not be. Most often discussed are mechanical parameters, such as wrap angle, scanner diameter, and head configuration. Time compression techniques using buffer stores, however, make it possible to achieve the same track format with, for example, 270° wrap angle as is achievable with 360° wrap angle without compression. Scanner diameter and wrap angle are similarly exchangeable parameters. A 10-cm diameter results in the same track format at 270° as 15 cm at 180°.

The arrangement of heads — cluster heads versus equispaced heads — should similarly not be a problem for standardization. The use of buffer stores allows both solutions to achieve the same track format.

It is therefore of primary importance to standardize the track configuration on the tape, i.e., the length l of the individual helical tracks; the mechanical design of the tape deck should be left to the individual manufacturers. Competitive solutions would be feasible.

Every prototype digital video recorder is designed around the two basic parameters, linear packing density d and bit rate to be recorded D . The path leading to a digital recording standard therefore requires agreement concerning these parameters.

The length l of the helical track is given in terms of five parameters: the data rate, linear packing density, vertical frequency, number of segments, and number of channels.

Possible values are given for the track length l for two- and four-channel recorders. Also given are the scanner diameters for 180° wrap angle. The track angle results from the length of the helical track and the width of the magnetic tape.

A further section of this paper shows that the number of channels in the format does not determine the number of video recording heads. Finally, an account is given of recent developments and test results on channel codes and error protection methods.

110. Channel Coding for a Low-Cost 216-Mbit/sec Videotape Recorder. *By C. Robert Thompson (RCA Corp., Camden, N.J.)*

Cost of ownership has become of increasing importance for users of television equipment. Videotape recorders have not been immune to the need for cost reduction. A 1980 model C-format VTR is less costly to own and operate than was a 1970 model quadruplex VTR. In terms of constant dollars, can the 1990 model Digital VTR offer a similar reduction in cost of ownership?

Reduced complexity is the key ingredient for a low-cost VTR. The achievement of reduced complexity, while maintaining or increasing performance capabilities, requires the application of advanced technology. For example, a digital VTR operating with the SMPTE recommended input data format with luminance sampling at 13.5 MHz and each of the two chrominance channels sampled at 6.75 MHz results in an overall bit rate of 216 Mbit/sec, when picture elements are quantized at 8 bits per sample. One very attractive choice for a low-cost

configuration at 216 Mbit/sec employs two parallel channels, each operating at 108 Mbit/sec. Maintaining solid operating margins at this high bit rate and in the harsh environment of VTR field operations demands the most advanced technology available. This paper describes the results of channel coding studies conducted on an advanced technology program at RCA. This program is directed toward achievement of the objective of reduced cost of ownership.

111. Editing Digital Audio Signals in a Digital Audio and Video System. By Robert J. Youngquist (3M, St. Paul, Minn.)

Editing of video signals is usually performed based on the visual content of the video signal. This means the associated audio signal editing must be done in such a fashion as to match the required final visual product. Since the visual editing is restricted to, at least, integral fields and more generally to every other frame, these same time restrictions will apply to the audio editing. When the video and audio signals are digitally encoded, their sampling rates should be related to each other in an exact relationship. This relationship can be in the form of an integral number of audio words per frame or per n frames, where n is reasonably small. Further, if the digital audio signal is to be compatible with both NTSC and PAL standards, there exists a small number of digital audio sample rates to satisfy the requirement. In fact, if an integral number of words per frame is desired, 60 kHz is the only practical frequency possible (30 kHz was not considered because a bandwidth less than 15 kHz results, which is felt to be unacceptable). However, 60 kHz is higher than the sampling rates currently used in the professional digital audio recording.

This paper shows how video systems may use a 50-kHz audio sample rate, how this rate is locked to the video system, and methods of performing the actual digital audio edits to acceptably coincide with the associated edited digital video signal.

A Video Anthology I

112. Frame-by-Frame Long Recording with a TV Camera. By Akira Yonekura (NHK — Japan Broadcasting Corp., Tokyo, Japan)

This new system has been developed by NHK to record picture signals, frame by frame, for a certain period.

The time-shortening method is necessary when we want to see phenomena like the efflorescence, or blossoming, of a flower, or motions of cells, in a short time. Generally, a film camera is used for such purposes.

We can find some video equipment to record picture signals frame by frame on a magnetic disk. But, the recording period of this equipment is very short, and complex operations by an operator are necessary.

This system can record picture signals frame by frame on a 60-min videotape automatically by setting the period of recording with thumb-wheel switches on a controller. High-quality pictures are available and real-time observation is possible as a feature by using a live TV camera. A magnetic disk video recorder and a 1-in helical VTR are used to record frame by frame. These are controlled by the controller, which was newly developed by NHK. A 320-mm diameter magnetic disk which has 200 tracks and is able to record 200 frames is used. One frame of a picture is recorded when a record command is sent to the disk recorder. The period of recording is between 13 and 255 sec. When the 200 tracks are filled, the controller detects it and sends a command signal to the disk recorder to move its head to the first track. In this sequence, the controller commands the VTR to start playback. A timing signal is recorded on an audio track of the videotape. At the moment this signal is detected in the playback sequence, the disk recorder starts playback at a speed of 30 frames/sec. Pictures are edited automatically at this moment. This transfer of pictures from the disk recorder to the VTR is completed in 6.6 sec. When the transfer is finished, the disk recorder moves its head to the first track, and the VTR records the timing signal and rewinds the tape for 5 sec for the next sequence.

This system was used for the first time last summer to record cancer cells when an NHK Special Program, which introduced new drugs against cancer, was produced. This frame-by-frame recording system and a high-sensitivity color camera using interval beam scanning were used in this program. Very strong light is necessary to observe cells with a normal camera attached to a microscope because of light losses within the microscope. In this case, the cells will be

heated to a high temperature, which could lead to serious problems, including ultimately the death of the cells. So, a sensitivity of more than 100 times that of a normal camera is necessary. The interval beam scanning method was used to obtain an increase in sensitivity of a factor of more than 100. This is well known as a method to enhance sensitivity. If you want a sensitivity 30 times higher than the normal scanning, one field scanning should be done every second. The necessary interval, controlled by the controller, was determined by the sensitivity needed. The camera used was a $3\frac{2}{3}$ -in Saticon color camera. A deterioration of picture quality was *not* observed. One frame picture was stored in a frame synchronizer using its freeze function and was refreshed every scanning period. This picture signal stored in the frame synchronizer was transferred to the disk recorder by the controller.

We could record complete and clear pictures of the motion of cancer cells using this system. The system is movable and will be adaptable to observe phenomena in many fields, such as natural science, physics, meteorology, and astronomy.

When a compact digital frame memory which can store high-quality pictures of more than 200 frames is developed, the system will become even more useful.

113. Overview of a Visit to Various Japanese Broadcast Facilities, Manufacturing Plants, and Research Laboratories. By Bebe Ferrell McClain (B. F. McClain Productions, Inc., Asheville, N.C.)

In May of 1981, the author made a 10-day tour of various Japanese broadcast-related facilities including Tokyo Broadcast System's new broadcast studios, NHK's major broadcast studios, Hitachi's Central Research Laboratory, Hitachi's Koganei Works where broadcast cameras and recorders are manufactured, and other plants where items such as Saticon tubes, tri-electrode Saticon tubes, ICs, and LSIs are manufactured. This presentation gives a review of what was seen and utilizes many support slides.

The brand new facilities of TBS (Tokyo Broadcasting System) are located 20 miles outside Tokyo in Yokohama. This facility consists of four of the most up-to-date broadcasting studios utilizing all state-of-the-art

equipment and construction features including: 1-in Type C remote video recording, modern control rooms overlooking gigantic studios, studio floors that elevate, and outdoor studios.

NHK's major video broadcast facility, primarily using 2-in format, was toured. Points of interest were the central video recording room where all videotape is recorded from all the various studios located throughout the facility. Also seen were the telecine area, central air control, and the new computer editing facilities.

At Hitachi Central Research Laboratory, a number of departments were visited where the following work was under development: new chip color cameras; new $\frac{2}{3}$ -in double aperture diode-gun tubes with up to 1800 lines of resolution and less lag; new molecular beam epitaxy for crystal growing where a special ultra-high vacuum is used for depositing various materials onto substances for semiconductors (10^{-5} m barometric pressure); new polysilicon thin film transistors for possible application in development of linear screens and thin viewfinders; new materials for pickup tubes that will increase sensitivity and will have more stability and less "blooming"; and new high-quality semiconductor lasers in the shorter wavelengths for use in optical recording of videodisks and in the longer wavelengths for use in optical communication systems involving optical fibers.

At Hitachi Denshi's Koganei Works, a complete tour was made following broadcast cameras and 1-in Type C video recorders through the entire manufacturing and testing processes. Also visited were the production engineering areas and the plant research facilities. The main processes and areas are shown by slides.

The tri-electrode Saticon camera tube is manufactured at Hitachi Denshi's Kobachizawa Plant (located two hours outside of Tokyo) under extremely exacting conditions. Slides are used to explain how these conditions are attained — especially for "clean" room operations. This is the only place in the world that has been able to manufacture this special tube because of the critical manufacturing conditions.

Also visited were the Mobarra Works where Saticon tubes and TV tubes, including special test equipment tubes such as small 1-in CRTs are produced. The technical problems in-

volving the mesh used in the Saticon tube between the target and the electron gun will be detailed here.

Points of interest concerning the Musashi Plant, where ICs and LSIs are manufactured, involved computer assistance for circuit layout and stringent "clean" manufacturing conditions.

A summary is given of the overall impressions the author has concerning the rate of technological growth and the dedication to quality control given during the integration of these new ideas into the manufacturing process.

113A. A Review of Projects at Hitachi Central Research Laboratories. *By Dr. C. Hirano* (Hitachi Denshi, Tokyo, Japan)

Synopsis not available at press time.

114. Securing the Satellite Signals. *By William Riker* (Showtime Entertainment, New York, N.Y.)

In the four years that Showtime Entertainment has been distributing its programming via satellite, questions concerning the securing of this signal from unauthorized reception have periodically arisen. During the past two years, Showtime's Engineering Department has taken an active role in monitoring the rapidly expanding technology of satellite security.

This paper expands on the need for securing satellite delivered signals, not only as it applies to pay television but also for telecine, network production distribution, and the increasingly popular area of teleconferencing. Explanations of methods proposed by manufacturers presently involved in the development of scrambling systems are offered, along with evaluations performed by this department, and predictions for the future implementation of such systems.

115. Paper cancelled.

116. Standardization of the Television Raster for Nonbroadcast Applications. *By John H. Harshbarger* (Visual Information Institute, Inc., Xenia, Ohio)

The raster format appears to be the preferred method of CRT (cathode-ray tube) display, yet confusion abounds in scanning rates and pulse parameters, especially in computer

applications, leading to inefficient and costly designs as well as to equipment which is not interchangeable. While certain EIA Standards have been developed, they have not been adhered to in the design of much present-day equipment. This paper examines the applicability of existing standards to modern circumstances and proposes a further standardization of horizontal pulse proportion beyond what is now in use.

There is not a consensus on the methods most appropriate for television display performance, although it is commonly accepted that evaluation by visual observation is inadequate. This paper examines the patterns commonly available and relates the ways in which they can be used most effectively.

Nonbroadcast television has developed indiscriminately, without obligatory standards such as have been imposed upon broadcast systems. Some voluntary standards have been published by the Electronic Industries Association, but have not been universally adhered to in recent times. This paper examines the applicability of existing standards to present application demands, particularly in view of the rapidly growing computer display area. The precedent established by the 525-line NTSC broadcast system is examined, and the impact it has had on subsequent system developments is summarized.

Deviation from the broadcast system ideally would have followed other established standards such as EIA RS-330 and RS-343. However, this was not the case universally, and areas of possible technical limitation in these standards are examined. A change in approach to raster standardization is outlined; it is applicable to all scan rates—past, present, and forthcoming.

The proposed raster standardization reaches back to the precedent established by the NTSC 525-line system, observing that precedent rather than ignoring it as was done by EIA Standard RS-343. A description of horizontal pulse proportion by the percentages used in the earlier system appears to be technically feasible for scan rates in use at this time, and this is shown in a tabular display.

With definition of the raster accomplished, it is appropriate to view in depth the means by which performance in that raster may be fully evaluated. As there is confusion in scan rate and equipment interchangeability,

there is an abundant lack of knowledge, much less consensus, on the means of establishing what performance is obtained.

The ball chart/electronic grid method detailed by IEEE Standard 202 is quite effective for linearity and geometry testing, as developed for the 525-line system. Complication in application of that technique to the scan rates of EIA Standard RS-343 is detailed, and a guideline is offered for selection of scan rates in the future to allow most efficient use of the technique.

Each performance area considered important in overall display quality is examined, including black level, uniformity, gray scale, contrast ratio, brightness, and interlace. Test patterns found suitable for analysis in each area are outlined with suggested standardized proportions. Separate consideration is given to horizontal and vertical resolution, with a method of measurement defined for each. A historical perspective is given for the Kell factor, which is often quoted in reference to vertical resolution. It is pointed out that the factor was developed for the 525-line system only, and it is not believed to apply to other scan rates. The debate of square wave versus sine wave horizontal resolution is fully addressed, and a specific technique for resolution measurement is outlined.

The impact of the precision of interlace on the display is considered, and the technique for method of measurement as outlined in EIA Standards RS-375-A and RS-412-A, little known to date, is detailed.

Inasmuch as RGB color displays are being used in greater numbers, particularly in computer graphics, attention is given to color analysis. This centers about evaluation of white field purity using the Flat Field signal. The makeup of the common Color Bar signal is examined, and it is concluded that visual analysis of the color display is the most practical and affordable means known due to the complexity and cost of more sophisticated color measurement equipment.

Attention is given to the point that many qualities interact in the televised display. For instance, gray scale may be optimized at the expense of resolution and vice versa. Representative combination signals are illustrated; advantages and disadvantages of such an approach are outlined.

It is hoped that the information provided will help in the selection of television scanning rates from some

basis of judgment, rather than the decision having to be made in a completely arbitrary manner. The summary of test patterns and techniques should allow one to fully evaluate the results with confidence in the data obtained in the course of display testing.

117. An Automatic Insert Edit Cut-Out Design for the Sony RM 430 Automatic Editing Controller. By *W. D. Murphy and C. T. Fleming* (South Carolina Office of the Governor, Columbia, S.C.)

The Sony RM 430 Controller was marketed as a controller for the Sony industrial-educational line of $\frac{3}{4}$ -in videocassette editors. As a low-price controller the unit is efficient and reliable; it has one design weakness, however, which makes it less than a complete controller. Exit from the insert edit mode must be manually made. Anyone who has attempted to lay in precise inserts knows the problems created by this deficiency.

The Automatic Insert Edit Cut-Out Unit which this paper discusses uses CMOS technology to make it compatible with the 430's main board. Program logic is wired to the keyboard so that selection of the cut-out point is as simple as depressing the End button on the 430 at the time when the cut-out is desired.

The unit has four storage registers which hold the information selected to be the time for automatic cut-out to occur. When the machines are in the insert edit mode and the editor time domain is positive, four digits of display time are clocked into comparison registers and their contents are compared with the data in the storage registers. When an exact match occurs, the editors are put into the automatic end mode.

The Automatic Insert Edit Cut-Out Unit was designed around industrially available components in the Columbia, S.C. area. Usage of the 40085 should reduce the number of chips, but this component is not readily available in South Carolina. As designed, twenty integrated circuits comprise the unit. Thus, the fabricated cost of this function is a reason that it is not found on a low-cost controller. More of a problem with this design than any other, however, has been the incorporation of the boards into the RM 430 frame. The unit is presently fitted into four narrow boards and fixed to the CE-2 main board. While it is an integral part

of the RM 430, long-term effects of heat and physical handling are unknown at this time.

The Automatic Insert Edit Cut-Out Unit has an accuracy compatible with the accuracy of the Sony 2800 edit system. Precision inserts, especially audio dubs, can now be made reliably and efficiently.

118. The 19th Hole Framer for the VO 2850-A. By *W. D. Murphy and C. Fleming* (South Carolina Office of the Governor, Columbia, S.C.)

In the evolution of the $\frac{3}{4}$ -in videocassette player-recorder system the Sony Corp. 2800 series machines were produced without framer capability in the edit mode. Several thousand machines were sold in the United States and Canada before Sony included an edit framer in the VO 2860 A series. A large number of these early non-framer editors are still in use and the option of framer action for many owners lies in modification rather than the purchase of later model machines.

The 19th Hole Framer is one such modification. It uses TTL technology to be compatible with the Sony design. Both the player and the recorder are modified with the same design which differentiates it from some of the other modifiers on the market.

Operationally the 19th Hole Framer compares the presence of the extra H/2 pulse in the vertical blanking interval with the machine's field (head) signal. As the extra H/2 pulse may be considered to be the 19th pulse in the series which comprise the equalization-vertical sync series of pulses, the design has been named for this pulse as a sort of acronym. A particular head-video field arrangement was predetermined, and in the sample or servo phase of the design's function, the head signal and the video field on the tape during playback are compared. If the head and the field agree, no action is taken by the framer. However, if the two disagree, the 30-Hz reference field is inverted and the servo drum is slipped one half revolution. This brings the head and video field into agreement. Both the player and the editor share a common reference signal; thus, when they have been brought into agreement they are in exact video field synchronization. At edit, field synchronization will obviate the whip or glitch associated with non-framed edits.

The accuracy of the 19th Hole Framer has been tested at more than 80 percent. Each machine's stand-by light has been utilized to indicate when the video-head field are in agreement; thus the operator has a visual indication at the edit point to tell him of each machine's state. The 19th Hole Framer does not correct problems with variations in horizontal and vertical time base between the two machines. Modification costs for both units of an edit system are reasonable, and physical modification is not difficult.

Computer Graphics

119. An Illustrated Guide To Computer Graphics. By Glenn Entis (Ampex Corp., Redwood City, Calif.)

With the growing use and acceptance of computer-generated graphics for video and film production, it is useful to be able to describe and discuss these computer-generated images. This paper provides a glossary of computer graphic terms, and each word is illustrated with a high-quality image. Therefore, this glossary does not cover theory, algorithms, or even equipment, but focuses on the terminology required to recognize and describe computer-generated images.

This particular glossary is organized in order of increasing complexity. As more computing power, more sophisticated software, and more processing time are used, the graphic possibilities, realism, and of course, expense of the images grow.

The glossary is divided into two sections: vector and raster graphics. In vector graphics the nature of three-dimensional images, plotters, real-time vector graphics, and key-frame animation is covered. Raster graphic terms described include anti-aliasing, paint systems, color-map animation, three-dimensional images, shading, texture mapping, shadows, and lighting environments.

120. A New Method of Producing Animation for Television. By Gary Beydler (Lyon Lamb Video Animation System, Inc., Los Angeles, Calif.)

Here is a succinct analysis of the current explosion in video technology. This particular paper focuses on advances in the areas of broadcast tele-

vision, computer graphics, and the animation industries.

121. Animation Techniques in Digital Videographics. By Richard G. Shoup (Aurora Imaging Systems, San Francisco, Calif.)

Even a small amount of animation can greatly enhance graphic communication, particularly when it is necessary to show change, movement, or a complex idea or relationship. This paper discusses several ways in which real-time animation may be produced using digital frame buffers, disk memories, and small amounts of special purpose hardware.

122. Graphics V: A New Approach to the Electronic Generation of Quality Graphics for Television. By Renville H. McCann, Jr., Altaf Rahman, and Arthur Smith (Thomson-CSF Broadcast Inc., Stamford, Conn.)

The Vidifont Mark I was introduced in 1970. Since that time, TV character generators have divided the television raster into discrete rows of sequential characters. As memory costs decreased, an alternative approach which treats the screen as a matrix of pixels became economically feasible. By using multiple cooperating processors to create an entire display in a frame store, the operational restrictions of the row-oriented structure are removed, thus creating a new system. This system has three major sections: Font Storage and Control (FCU), Operator Interface and Peripheral Control (PCU), and Video Generation/Graphics Processing (GPU) all using a Motorola 6809-based microcomputer.

Fonts are maintained in separate memories, accessed by both the FCU and the GPU as independent pixel maps, two bits deep. A simple encoding scheme is used to compress the full pixel map into a more access- and memory-efficient form. This encoding scheme allows three separate levels of chrominance, plus luminance and key variations, to be incorporated into each character. The three chrominance values may be assigned to different colors, thus allowing a single keystroke to produce a three-color character. One of the three values may be treated as the border or edge, so that a character can have borders or drop shadows in any direction. Two of the three values may even be related, such as pale and bright blue. This final option

enables the transitions between a black background and a bright blue character to be smoothed by inserting a few pixels of pale blue. This process, called "edge polishing," is actually a multi-dimensional spatial filter, which can be used not only to overcome the jaggedness of diagonal lines inherent in a raster scanned image, but also to increase the effective resolution of the system to 12 nanoseconds. It can also be used to reduce dot crawl effects inherent in the NTSC system.

The use of a microcomputer as the controlling element of the GPU permits real-time animation and other effects without the need for specialized hardware. This makes it possible to create dynamic effects, such as multi-directional rolls and crawls, independent motions of characters or groups of characters, alteration of the position and size of a background, or alteration of the size of the portion of the frame store which is actually displayed. These effects can be performed in real time with no effect on the Operator Interface.

Display processing is implemented by employing a hierarchy of parallel processors. The visible display rows are selected by the page control processor, which passes the row parameters to the Entity (Row) Buffer Processor. The Entity Buffer Processor fetches the various entity parameters (ASCII, font, X-Y position, attribute index, etc.). The ASCII/font codes are sent to the Font Control Processor, while the position and attribute information is sent to the Display Frame Processor (DFP). The DFP processes encoded video descriptors from up to eight on-line fonts and writes each entity, line by line, into one of the four double buffered frame stores.

The use of a frame store (1088 horizontal pixels by 483 vertical lines by 6 bits) permits characters to overlay one another. When the frame store is scanned out, each pixel assumes the last value written into the frame store. This permits the operator to create multiple visual planes which can be moved independently, as well as permitting characters on a single plane to partially or totally overlap. The existence of up to four frame stores in the hardware permits additional overlaying of planes or separating into "channels," while minimizing the processing requirements. All of the planar capabilities described above are still possible with the use of only a single frame store. Up to four background planes, with up to 16 entities

per plane, can be incorporated into different configurations in conjunction with the character planes described above.

Nine different hardware edge treatments can be added to the video from any of the four character frame stores. Edge color can be assigned and turned on or off on a character-by-character basis.

The PCU manages the Operator Interface, the disk units (either floppy or Winchester disks), and any other peripheral devices. In addition to editing, recording and retrieving messages, and providing commands to the GPU to produce displays, the PCU ensures that the fonts required for a stored message are in the FCU. Additionally, the PCU provides security so that unauthorized users cannot access the system, and enables off-line changing of displays. Up to six low-resolution keyboard/display units can be used, along with the two high-resolution operating stations, to modify displays already in the system. For example, sports scores and weather forecasts can be modified by entering information into predefined areas of existing messages. These messages can be subsequently played back for display over the high-resolution channels. The entered values will automatically appear in the correct color and font style. The reporting of election returns can be handled in a similar fashion.

123. A High Quality Television Graphic System for Automatic Presentation of Weather Information. By *A. Marvin McInnis, Jr.* (McInnis-Skinner & Assoc., Oklahoma City, Okla.)

Synopsis not available at press time.

124. Graphics Go Electronic: The CBS Experience. By *Rupert L. Stow* (CBS Television Network, New York, N.Y.)

Over the past decade, the need to improve the techniques used in preparing still pictures for broadcast has become increasingly evident. The traditional 35-mm slide and its television projection suffer from high cost and unacceptable time lag in preparation. Storage and retrieval are labor-intensive and time-consuming. These considerations, together with increases in news programming and its corresponding demand for immediacy, led

to the joint development by Ampex Corporation and CBS of the electronic still store (ESS).

In this paper, the operation of ESS systems at the CBS Television Network and WBBM-TV in Chicago is described. The volume of news stills generated daily, the total number of stills broadcast, and the preparation of additive stills is also presented.

The AVA computer graphics system is now in working use by CBS News. Among the advantages demonstrated by this system are a great improvement in the creative scope afforded to the artist, the speed with which graphics are created, and the ability to modify or build upon an existing graphic held in an electronic still store. The concept of an off-line creative graphics facility combining the ESS and the AVA systems is also discussed.

125. Computer Graphics in Film-making. By *Alvy Ray Smith* (Lucasfilm Ltd., San Rafael, Calif.)

This presentation provides a short history of the use of computers in the production of films for theatrical release. Included is a brief description of some of the intended uses of the computer, or digital techniques in general, in all parts of the filmmaking process at Lucasfilm. Special emphasis is given to computer graphics, software, and hardware. Image synthesizing and matting are two examples of powerful graphic techniques associated with computers. The "optimal mix" of conventional and digital techniques is to be illustrated.

125A. The E & S System: A Production Pre-Viewing Tool for the Future. By *William Kovacs* (Abel and Associates, Hollywood, Calif.)

Synopsis not available at press time.

125B. Computer Graphics at Independent Television News. By *Christopher Long* (Independent Television News, London)

Synopsis not available at press time.

125C. Special Effects Through Digital Scene Simulation. By *Richard Taylor* (Information International Inc., Culver City, Calif.)

Synopsis not available at press time.

A Video Anthology II

126. The First Optical Videodisk—A Joint SRI/3M Development. By *Philip Rice and Richard F. Dubbe* (SRI International, Menlo Park, Calif.; 3M Co., St. Paul, Minn.)

The idea of recording television signals on a disk originated with John Logie Baird in 1928, when he built a device for recording low-resolution signals on a wax disk. Baird's idea was to provide disks to the few owners of television receivers then in existence, to allow them to adjust their sets prior to BBC broadcasts.

In 1961, several engineers at the 3M Company became convinced that standard television signals could be recorded on a disk that could be reproduced and distributed to viewers for home use. They felt that a refined version of the process for producing long-playing audio records would have sufficient resolution to permit recording and reproduction of from ten to fifteen minutes of television. 3M asked SRI International to prove the feasibility of the concept, and the project began in July 1961.

After considering a number of possibilities, SRI decided to concentrate on optical recording on high-resolution photographic plates. This decision was based on the fact that ordinary, inexpensive, microscope objectives are capable of resolving one-micrometer picture elements, thus opening the possibility of recording one half-hour of television signals on a twelve-inch disk.

Before launching a full-scale effort to make an optical videodisk, SRI engineers conducted a number of preliminary experiments to determine if one-micrometer bits could be detected reliably and with a sufficiently high signal-to-noise ratio to provide an adequate TV signal. Since gas lasers were not available, high-pressure mercury arc lamps were used to both record and read the optical image, with a specially-designed Kerr cell modulating and recording them. SRI chose baseband analog recording as the method best suited to the equipment available. The format on the disk was the same as that used today for constant angular velocity recording, one frame per revolution. Because of the low light output of the mercury arc source and the low sensitivity of the emulsion, recordings were made at $\frac{1}{16}$ real time. A fast pull-down motion picture film transport

equipped with a flying spot scanner provided the video input. Playback was in real time. Several disks with excerpts from a 16-mm movie were made and demonstrated by May 1963.

Working parallel to efforts at SRI, 3M built an electron beam recorder capable of recording one-micrometer bits on Lippmann emulsion in real time. They also designed and built portable disk players that were simple enough to be used in the home. These early players were designed so that the asymmetrical reading beam spanned at least two tracks, thus improving the signal-to-noise ratio. Each alignment of corresponding picture elements on adjacent tracks eliminated the need for track-following servos. Later, these servos were added in order to accommodate sound and color. A focus servo was also added.

By late 1965, 3M was developing techniques for reproducing TV signals on flexible photosensitive disks by contact printing from a silver halide master. Tracks on two-micrometer centers were recorded and 20-MHz signals were reproduced.

In 1976, 3M's Central Research Laboratories demonstrated an extremely durable plastic coating that could be cast and rapidly cured on a master disk's surface, rather than being hot pressed or injection molded.

In 1981, 3M arranged with Thomson-CSF and Philips to offer disk recording and replicating services using 3M's materials and processes.

Today, work is continuing at both organizations on new applications for optical videodisk recording.

127. The VHD/AHD Videodisk System. *By Tsuneyoshi Hidaka* (Victor Company of Japan, Kanagawa, Japan)

The VHD/AHD (video high density/audio high density) disk system plays 10.2-inch grooveless plastic disks. Each disk contains one hour of color programming per side with stereo sound for a total of two hours of information per disk. The system also plays digitally-recorded, super high-fidelity, pulse-code modulated audio high-density disks (AHD), a JVC development.

The concepts behind the development of this system were that both the videodisk and the player have to be compact, that the playing time should be long enough to accommodate a feature film, that two soundtracks

should be available so that stereo sound or bilingual soundtracks could be reproduced, that operation should be simple and flexible, that a variety of playback modes are available, and that a wide variety of software should be made available. Another important consideration was to design the system so that digital audio disks could be played on the same unit as VHD videodisks.

The playback principle of the VHD system is based on a grooveless capacitance pick-up system. The video and two audio signals are recorded on a surface in the form of micropits. An electrode is attached on a rear edge of the stylus which can pick up capacitance variations between a stylus electrode and the conductive disk. Since there are no actual grooves on the disk surface to guide the stylus, the pick-up stylus is controlled by an electro-tracking servo system. The tracking signal is placed between the micropits of the audio and video signals. During playback, the stylus electrode picks up video and audio signals, as well as two tracking signals, as capacitance variation occurs simultaneously. Even if dust particles are spread on the disk surface, the VHD stylus easily traces the desired track, essentially dusting the surface automatically as it plays. This stylus has been estimated to have 30 times the tracking ability of groove-guided systems.

The VHD disk can be manufactured through conventional audio recording processes. A master disk is made from a glass substratum, which is coated with photo-resisters. A minute laser beam is irradiated onto the master disk to form the micropits in spiral tracks. The video and two audio signals modulate the main carrier in frequency modulation (FM). This FM signal is used to modulate the intensity of a laser beam at the optical modulator in the mastering machine. The recorded glass disk is then developed, and the glass master is then coated with an extremely thin layer of silver (800 Angstroms), which is sprayed onto the surface of the glass. The silvered glass master is preplated at low temperature and current density before being transferred to a plating tank for deposition at the normal speed. After plating, the separated metal portion will become the metal master. The metal master is nickel-plated again for mother forming. The metal stamper is produced from the mother in the same manner. The metal

stamper is then mounted to the compression molding machine that is used for converting VHD disks from the conventional audio record pressing machine. The pressing process for videodisks is very much the same as that for an audio record, but a VHD disk is made of conductive plastics. There is no additional processing after pressing, thus, through the use of mass production techniques, the cost of the disk can be lowered. Replication of the AHD disk is exactly the same as for the VHD disk, except that the signal format is different.

128. Recent Developments in the SECAM Color TV System. *By R. Melwig* (Telediffusion de France, Paris, France)

The SECAM system is currently used in twenty-seven countries as the national color broadcasting standard. Since its introduction in 1965, it has been the subject of continuous research and development by various laboratories in France and elsewhere, to both upgrade the signal parameters and provide precise measurement equipment. These improvements have included the elimination of the need for vertical interval color identification lines (known as "bottles") in modern SECAM receiver decoders. Current decoders can synchronize the R - Y, B - Y sequences from burst information on the back porch.

New SECAM encoders now meet more stringent time base requirements of at least 10^{-6} , so as to facilitate standards conversion to either PAL or NTSC; and new precise measurement equipment, such as the Vecamscope, give very accurate visual analysis of the SECAM color signal characteristics.

Other areas of improvement covered in this paper include the evolution of SECAM switching systems, miniaturization through the use of CCD technology, and the use of the SECAM signal for data multiplexing.

129. Teletext in the USA: An Update. *By Joseph Roizen* (Telegen, Palo Alto, Calif.)

Current efforts by broadcasting organizations and other technical groups to define and implement a teletext service in the United States have created an expectancy that the FCC will, indeed, ratify a domestic teletext standard in the future.

To support the deliberations of the EIA Teletext Committee, a variety of FCC-sanctioned on-air teletext experiments are currently being conducted in various cities around the country. St. Louis, Los Angeles, Chicago, and Washington, D.C. are among those cities where local stations are using the various proposed systems.

Detailed technical petitions have also been presented to the FCC by various teletext proponents, requesting that a ruling be made to create a uniform teletext system with technical parameters that would permit reception of teletext signals using the same hardware all over the country.

This paper describes some of the technical aspects of the current teletext experiments, and some of the equipment being used to transmit and evaluate teletext transmissions.

130. Electronic Magazines via Teletext: The Services Which Sell the Technology. *By R. Gingras* (KCET-Los Angeles, Los Angeles, Calif.)

Teletext is used to create an electronic magazine called NOW. Examples of pages generated are shown, including new reviews and quizzes for children.

131. The Need for a Video-Compatible Future. *By Martin Polon* (UCLA, Video Magazine, Los Angeles, Calif.)

The success of the so-called video revolution will depend on the ease of movement of video software out of studios and into the home. The ability of video programming to compete with other forms of electronic entertainment is going to be a function of how accessible consumer video will be in terms of cost, ease of use, pricing and software, and, most important, the compatibility of various video systems in using common software and delivering a common service in the home.

Digital Signal Processing and Transmission

132. Spatial Manipulation of Digital Images for Television Special Effects. *By Glenn A. Reitmeier and Christopher H. Strolle* (RCA Laboratories, Princeton, N.J.)

This paper provides a detailed examination of the signal processing techniques which are required to perform spatial manipulation of digital televi-

sion pictures, while maintaining the highest possible picture quality. The theoretical requirements for image compression, expansion, and rotation are first presented, followed by an explanation of how these manipulations may be viewed as coordinate transformations. Since the theoretical requirements for picture manipulation include the need for digital pre-filtering and interpolation, the effects of various methods of interpolation on picture quality are shown, as are the trade-offs that exist between two-dimensional filter complexity and picture quality. Results from computer simulations are used to illustrate these effects on the picture quality of a monoscope test pattern. Finally, conclusions are drawn telling which techniques produce optimal picture quality and which produce the best compromise of complexity and picture quality for current technology.

133. A Flexible Approach to Digital Special Effects and Still Storage Using a Bidirectional Video Data Bus. *By Chuck Aronson and Tom Lyon* (Adda Corp., Campbell, Calif.)

Both digital special effects and digital still storage have become a fact of life in the modern television broadcast/production facility. However, up to now, such devices have been stand-alone black boxes with analog input and output. Once the video has been digitized, it is preferable that it remain in digital form. Moreover, the total system should be modular and expandable so that the customer can select both the appropriate amount of storage and the number of input/output channels, with and without special effects. These desirable features are made possible by the Addabus, which provides an integrated digital video system by means of non-real-time video data transfer. With this bidirectional video data bus, up to 16 devices may communicate and share a large video data base. These devices may be any combination of framestores, special effects units (which are also framestores), and disk drive controllers. Video data rates on the bus allow transfer of stills at less than one-half second per still from framestore to framestore, framestore to disk, and disk to framestore. The Addabus system and its components are discussed.

134. A New Approach to Component Digital Processing Equipment. *By*

John D. Lowry (Digital Video Systems Inc., Toronto, Canada)

A new family of digital processing systems designated as the DPS-100 series is described. The initial range of equipment includes plug-in modules for encoding, decoding, time-base correction, synchronization, test-signal generation, and both analog and digital interfaces. Y , $R - Y$, $B - Y$, digital signal generation and processing is employed in such a manner as to provide commonality of equipment for all television standards. I-O interface modules are provided for NTSC, PAL, SECAM, RGB, and digital Y , $R - Y$, $B - Y$.

Internal calibration and self-diagnostics provide a television display of system status, including fault analysis, to the board, circuit, or IC level. Intermittent faults generate an interrupt which logs the nature of the problem, its location, and priority level related to the degree of signal degradation when the fault was present. Continuous "on air" diagnostics of the main memory in the frame store system confirms the integrity of every bit at least four times per minute.

The time-base correction system for heterodyne VTRs employs a six-line window with an optional plug-in circuit board module providing a field store and its microprocessor control, for an infinite correction window, or freeze frame.

The test signal generator uses a high-speed microprocessor for digital component signal generation and control, providing a complete range of high-precision standard test signals, and the zone plate with its three-dimensional, horizontal, vertical, and temporal frequency sweeps.

Decoding, encoding, and component signal processing are also discussed.

135. Programmable Test Bed for Composite Television Coding. *By R. C. Brainard* (Bell Laboratories, Holmdel, N.J.)

We are interested in bandwidth reduction schemes for television signals. This operation introduces noise into the resultant received picture. Though much has been accomplished to generate objective measures that enable comparison or classification of the visibility of noise in a television signal, we must still build hardware to demonstrate the feasibility and actual performance of a coding system. We have constructed a test bed to enable

study of systems for processing of composite color television for bandwidth reduction. The test bed is a research tool intended to demonstrate various new algorithms and new ways of using and connecting DPCM (differential pulse code modulation), and adaptive DPCM systems.

Video signal processing is accomplished in special hardware circuits including memories, arithmetic units, selectors, and registers. These circuits are set for the desired experiment by a microcomputer in order to enable rapid switching between various sets of parameters. Transistor-transistor logic (TTL) chips are used in the circuits for flexibility and ease of design and construction.

The system operates at a clock frequency of four times color carrier (14.318 MHz). Three times color carrier can also be used.

136. Composite Television Coding at 45 Mbit/sec. *By R. C. Brainard and A. N. Netravali* (Bell Laboratories, Holmdel, N.J.)

A continuing study is reported of predictive coding of composite NTSC television signals sampled at four times color subcarrier frequency (14.3 MHz). Our goal is to demonstrate a coding system for a transmission rate of 45 Mbit/sec with full broadcast quality. Constraints on the choice of the predictor and a design procedure for the quantizer have been described earlier.

Variable word length coding is used to reduce the bit rate for the channel, but this requires a buffer to smooth the data output. Buffer overflow is prevented by quantizer selection and by subsampling. We report on 4:3 and 2:1 subsampling ratios. Various subsampling patterns and corresponding interpolation algorithms and their effects on the quality of the coded picture are evaluated. Simple motion indication circuits for interpolation mode selection are described. The effects on picture quality and limitations are discussed.

Adaptive prediction is used to minimize the necessity of the use of subsampling. Prediction errors for previous samples are compared and used to make the predictor selection for the current sample.

Picture quality judgments are based on observations of specially selected worst-case conditions on real-time processing using a mixed hardware/software experimental facility. A tape

recording of the coded picture is shown to demonstrate the results.

137. Systems Aspects of Digital Transmission of Television Signals. *By Ernest J. Tarnai* (Bell-Northern Research, Ottawa, Canada)

In Canada, as in other countries, transmission of various communication signals is rapidly changing from analog to digital technology; concurrently, television production studios are evolving into all-digital environments. This bifurcated analog-to-digital (A/D) conversion may jeopardize the future of video signal transmission, because the interface requirement between the broadcasters and the common carriers could become too complex to be either economically or technically viable. Important systems issues to ensure compatibility between the television studios and the telephone companies' transmission facilities must be resolved. Moreover, the ultimate all-digital, studio-transmission interface should evolve smoothly from the hybrid situation associated with the transitional period.

The various transmission scenarios envisaged divide into two groups: (1) communication between two analog or an analog and a digital studio via a facility which is digital or hybrid; and (2) communication between digital studios via digital or hybrid facilities. Some of the potential problems associated with these situations include multiple A/D conversion, transcoding, maintenance and surveillance, etc.

In the near future, lack of analog channels may necessitate the digitization of analog television signals. To implement a successful system capable of accomplishing this task, careful assignment of all signal components (video, audio, VIT, etc.) to the available capacity of the carriers' channel is necessary.

Future television studio facilities will enable the program producer to take full advantage of the enhanced utility offered by digital technology. A direct consequence of this may be a requirement for very high bit rate, high quality channels interconnecting production studios. On the other hand, economic constraints will dictate the employment of bandwidth compression techniques for signal distribution. Thus the final studio-carrier interface will likely be defined for a number of different grades of service (at various rates of tariff). For a number of these services, issues such as transcoding,

encoding, transmission requirements, available bit rates, and other systems considerations are involved.

The underlying theme for all the transmission issues is the unresolved question of digital television quality. For the context of this paper, however, an orderly evolution of standards and test methods necessary to guarantee adequate quality is assumed so that the systems issues may be addressed.

138. Transition from the Analog Studio to the Digital—A Scenario. *By S. Merrill Weiss* (KPIX Television, San Francisco, Calif.)

The conversion of any major broadcasting and/or teleproduction facility from entirely analog to wholly digital will be an intricate process. The plant must be taken from some current analog state when the process begins, through a number of intermediate, hybrid steps, to the final condition when all major signal paths are digital. Unless one has the luxury of building a new facility or of going off-line for an extended period, this must all take place while the plant remains operational.

Before the conversion can take place, the known beginning and the desired ending points must be carefully defined. Then, the intermediate steps when the plant is in a hybrid state must be extremely carefully planned. Each conversion increment must be examined in light of the new equipment which must be obtained and whether it will be useful only in the hybrid state or in the final configuration, which of the old equipment will be displaced, where the transitions from analog to digital will be located, what equipment is and is not yet available in digital form, what interconnection methods will be used, and the like.

This presentation follows the planning process for one typical, intermediate-size television broadcast facility. The current, analog state is defined. A proposed final digital configuration is outlined. Then a scenario is presented for the transition from one to the other through a sequence of hybrid states. How that transition will be impacted by the timing of equipment availability and by a number of industry decisions yet to be taken is studied along the way.

139. Transition from Analog to Digital Television: Choices and Cautions. *By William G. Connolly and Richard R.*

Green (CBS Television Network, New York, N.Y.)

The NTSC color transmission system has served us well during the past 28 years. However, it was adopted before the advent of videotape recording, and at a time when compatibility with the existing black-and-white NTSC System was the most important engineering criterion. As a signal format for production of programs, it falls short of the ideal. Artifacts due to the interleaving of color information with the NTSC monochrome signal, including color frame ambiguity, chroma-crawl, and limited chrominance resolution limit our production capability. Production effects using NTSC encoded signals are often unsatisfactory and pose a severe restriction to post-production processing of programs.

Digital television is now on the horizon and offers the solution to these problems. A milestone agreement, which specifies a worldwide compatible format for digitally encoding television signals at the component level, is now before the CCIR. Therefore, we have just entered the transition period which begins with our current analog production plants and ends with the all-digital studios of the future. The first and primary beneficiaries of the new digital capability will likely be the post-production and production segments of television operations. Thus it is important to plan the transition so that the advantages of the new format are not lost or compromised.

This paper reviews the requirements of an orderly, efficient transition to the all-digital studio, which will simultaneously expedite the benefits of digital television to program production operations. Choices in the evolution of digital studio complexes and consideration for studio interface selection during the interim are discussed.

Microwave and Antenna Systems for TV Signal Transmission

140. A Look at Airborne Microwave Technology. *By Eric Stromstead* (MACOM, Burlington, Mass.)

New microwave equipment that can be used on helicopters and other vehicles is described.

141. Interferometer — A New Family

SMPTE JOURNAL

of Microwave Antennas. *By Thomas Vaughan* (Micro Communications, Inc./MCI, Manchester, N.H.)

The presentation treats the use of interferometers in the case of highly congested interference environments.

142. OSHA Power Density Standards. *By David Hudson* (Hammett & Edison, Consultant Engineers, San Francisco, Calif.)

In this presentation there is a discussion of present and new power density standards of the Occupational Safety and Health Administration (OSHA). Questions considered include what these standards mean and how they apply to television and radio antennas.

143. LPTV/TVRO — A New Type of TV Distribution. *By George Townsend* (Townsend Associates, Inc., West Springfield, Mass.)

Information is presented on low-power television (LPTV). The likely configuration of a LPTV system is explained,

with coverage of power amplifiers and antenna systems.

144. A New Remote Control and Monitoring System with Color Graphics. *By Joseph Soll* (CAT Systems, Inc., New York, N.Y.)

A new microprocessor-based remote-control system that utilizes color graphics and is designed for transmitter, satellite terminals, or microwave systems is described.

145. Communication Vans. *By Rich Wolf* (Wolf, Coach, North Boro, Mass.)

This presentation describes the latest concepts in the design of communication and ENG vans, including masts, power plants, and other accessories.

146. Major Market ENG Operations. *By Al Topping* (KGO-TV, San Francisco, Calif.)

The use of vans, news cars, and portable microwave systems for the routing of television news is discussed.



Honors and Awards general reception at the Beverly Hilton Hotel.