
Conference Opening: Commitment to Tomorrow's Technologies

Introduction: *Gary L. Borton*, Program Chairman, 124th SMPTE Conference

Conference Opening Address: *Leonard F. Coleman*, Financial Vice-President, SMPTE

For the text of Mr. Coleman's Opening Address, see p. 5.

1. Guest Speaker: *Dr. Judith A. Schwan*, Asst. Director, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

2. Guest Speaker: *Dr. Kerns H. Powers*, Staff Vice-President, Commercial Research, RCA, Princeton, N.J.

3. SMPTE Commitment to Tomorrow's Technologies: *Roland J. Zavada*, SMPTE Engineering Vice-President

Laboratory Practices I

4. Raw Stock Automatic Feed Unit for Printer. *By André Robin*, Eclair Laboratories, Epinay/Seine, France

Because the length of raw stock reels increased from 2000 to 4000 ft, and will soon reach 6000 ft or more in the future, Eclair began to manufacture a raw stock automatic feed unit for a Printer.

The printing equipment of Eclair Labs consists of two types of printers; eight unidirectional Bell and Howell Model C printers, and two automatic continuous line printers, with loop cabinets for picture and sound negatives and magazines for both the feed and take-up sides.

Raw Stock Consumption — in peak

output, the eight Bell and Howell Model C printers, with a speed of 280 ft/mn, use per hr about 8000 ft of raw stock each, that is to say, 64,000 ft/hr. This raw stock is threaded to the printer in ready-cut reels, corresponding to the length of the negative. The automatic continuous line printers use 16,000 ft/hr each.

Packaging — the packaging used at present by the various film makers consists of 1 pile of 2000-4000-ft reels; each reel is enclosed in a black paper bag and the whole pile is covered with a cardboard box. This packaging has an important disadvantage — it prevents automation of the functions, mainly because of the black paper bag; therefore, all manipulations must be done by hand. Moreover, the weight makes the use of the largest reels impossible, particularly in France, where printer operators are women. Taking those drawbacks into account, Eclair designed a new type of packaging, suitable for complete automation. A first prototype was made in co-operation with Eastman Kodak Co. soon followed by Agfa-Gevaert and Fuji.

The principle of this packaging consists of piling up on a palette raw stock reels, separated from each other by a semi-rigid plastic disc and held together by an upright hub passing through the cores. The whole device is covered by black soft plastic bag and the outside protection is, as usual, made of cardboard. Such type of packaging has been delivered to Eclair by Kodak since last July.

Automatic Feeder — the feed unit consists of a stand supporting a horizontal winder plate, equipped with a retractable hub. The special box bin is taken from the raw stock store on a forked elevator truck and brought into the feeder. The elevator truck is locked and electrically connected to the machine by a plug. The hydraulic engine lifts up the box bin until the upper reel comes to the same level as the winder plate.

At this moment, the hub of the winder retracts and a chain-conveyor brings the upper reel onto the winder plate, and the hub comes back up in place, entering the core of the reel, which is ready to be used.

During the unwinding of the reel, the separating disc is taken away by a holder. The box bin rises 35 mm to be ready for the next operation.

In case of automatic-line printing, the operation cycle is started by the tail of the finishing reel passing through a contactor.

The feeding cycle lasts about 15 sec; the operator removes the piece of sticker on the reel, throws away the first two turns, and makes the splice with the Rank Solvit Splicer. This operation lasts about 45 sec, which leaves a good security as the run inside the feed reserve of the machine lasts about two min. Should the occasion arise, it also allows time to make two splices without stopping the line.

In the case of raw stock preparation and measuring stands for classical machines, the operator preselects the length of raw stock to be cut and the machine stops the reel at the given index. When the raw stock reel is finished, the same cycle takes place: splicing the tail of the finishing reel with the head of the next one with the Rank Solvit Splicer and manual re-start.

The advantages of this system are very important. Raw stock makers should, with similar automation, lower their production costs. The labs obtain a greater cleanliness, by avoiding manual operations, and effect an important economy in labour costs, as it takes only one operator to cut to given lengths the raw stock for four Bell and Howell Model C printers, that is to say, 240,000 ft in seven hrs, or two box bins of 20 × 6000-ft reels, or three box bins of 20 × 4000-ft reels.

In the case of automatic line, a truck of 20 × 6000-ft reels lasts about one shift of seven hours. The line needs to be fed only per shift. With three continuous line pieces of equipment, it is possible to print, in a day of two shifts, 60 prints of 6 × 2000-ft reel picture, with 12 operators under the authority of two staff members.

5. Effective High-Speed Film Cleaning. *By R. Barnett, W. Clark, C. F. Mossman, and B. Taylor*, Rank Film Laboratories, London, England

New negative emulsions and higher standards of cleanliness were contributing factors which led Rank Film Laboratories to design and produce a new, efficient 35-mm and 16-mm film-cleaning machine.

It is easy to use, fast, sprocketless, gentle to the film but highly effective

in removing firmly adhered particulate matter, which is often a problem on prehardened negative emulsions. Using an antistatic conditioner in the solvent safeguards against static being generated and the attraction of particulate matter during subsequent rewinding operations.

The added protection of the ramped starting and stopping maintains careful control so that speeds in excess of 106 m/350 ft/min can be used if required. The speed and footage are shown as digital displays.

The equipment was designed bearing in mind health regulations and output considerations, so it is operated continuously in the threaded condition. This negates the undesirable exposure of the operator to the solvent fumes.

The method of drying the film ensures an extremely low consumption of solvent which renders solvent vapour recovery unnecessary.

6. Micro Computer Printer Control Unit. *By W. Clark, V. Dey, J. Gear, S. Morrissey, and C. F. Mossman, Rank Film Laboratories, London, England*

Rank Film Laboratories has developed a new type of control unit for film-printing machines.

It provides a new approach to the operation of printing machines with greater efficiency for typical printing operations and a lower incidence of operator errors or machine failure. The unit is based on a 16-bit 64K byte microcomputer.

It is designed and constructed in logical modules and features extensive self-testing capabilities.

This paper describes the design, functions, and layout of the printer control unit.

7. Seventy-Five Years of Motion Picture Standards: The Contributions of Bell & Howell Company. *By John Ehrenberg and Laurence J. Roberts, Bell & Howell Co., Chicago, Ill.*

In this its 75th anniversary year, Bell & Howell Co. recalls its modest beginnings in a 30 by 60 ft loft in Chicago and how the company has grown by adapting to changing conditions over the years.

Donald J. Bell, a movie projectionist, and Albert S. Howell, a young engineer who impressed Bell with his knowledge of movie projectors, met at

a machine shop where Howell repaired and modified movie projectors. Howell's first invention, a framing device for the Kinodrome projector, convinced Bell that he should form a company in which Howell would have a substantial interest. Bell & Howell Co. was founded in 1907.

Bell & Howell's motion-picture system addressed two of the major problems of the fledgling movie industry: flickering images and lack of standardization of equipment. The system Howell developed consisted of refinements to the Kinodrome projector, followed by the film perforator, camera, and continuous printer, all of the 35-mm width. It was the use of the complete Bell & Howell system that solved the flickering problem of the early movies.

Bell & Howell had a policy not to produce or service products of any size other than 35mm. This policy had the effect of forcing customers to accept 35-mm size if they wished to have Bell & Howell products, which were recognized for their excellence and reliability. For many years all Bell & Howell equipment carried a lifetime guarantee.

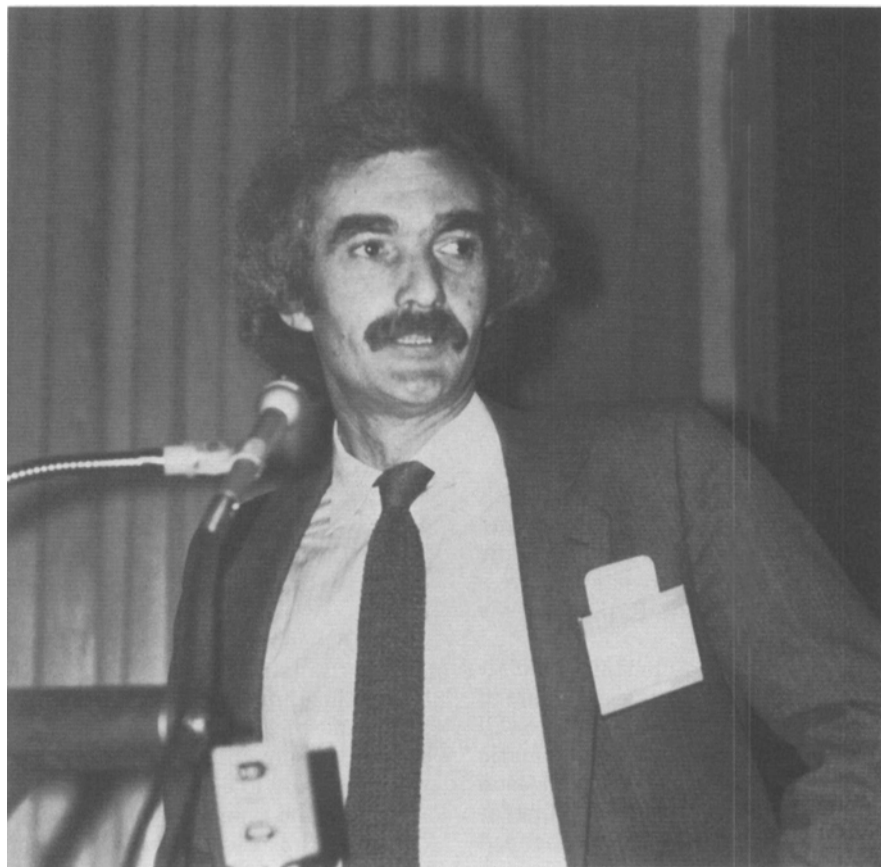
From Bell & Howell's early wooden-box motion-picture cameras soon developed the all-metal standard

2709 cameras. Within the next few years Hollywood was said to have been almost 100 percent equipped with Bell & Howell equipment.

In 1916 Donald Bell was one of the incorporators of the Society of Motion Picture Engineers (now SMPTE). Early Bell & Howell standards for 35-mm film and equipment were the basis for many SMPE standards issued in the formative years of the Society. In 1941 Albert Howell was approved for Honorary Membership in the SMPE, a distinction given to pioneers who contributed inventions of basic importance to the motion picture industry.

Donald Bell sold his interest in the company in 1917, feeling that the market for B&H products was saturated. After Bell left the company and Joseph McNabb took the helm, Bell & Howell began adapting its products to the ever-changing demands of society. In 1923 the company entered the amateur photography market by introducing the spring-driven Filmo model 70 16-mm camera and model 57 projector.

The company's early line of Filmo-sound projectors brought out in 1932 utilized much of the basic engineering of the first 16-mm Filmo projectors of 1923. The Filmosound projector was



Ioan Allen at the session on Motion Picture Sound.

an excellent training tool and was soon in use in churches and schools all over the country.

After the introduction of the 16-mm portable camera, the 35-mm Eyemo portable camera was introduced in 1925. It was the first portable spring-driven professional cine camera and became the camera most used for newsreels. During World War II the Eyemo camera was used by all branches of service.

The Great Depression paved the way for the development of the 8-mm market by encouraging the production of equipment at about half the cost of the 16-mm models. Bell & Howell adapted to the new economic conditions by bringing out its first 8-mm equipment in 1934.

Bell & Howell's very first business is now the business of its present-day Professional Division, which has been a leader in professional motion-picture equipment since its inception. In 1954 Bell & Howell received the first Oscar ever presented to a manufacturer by the Academy of Motion Picture Arts and Sciences for its role in the standardization of movies. Since then the Professional Division has received Academy Awards for its fully automated color film printer in 1962, its motion-picture punch tape in 1975, and for the modular film printer in 1981. John Ehrenberg, co-author and presenter of Bell & Howell's paper, has been with the company since 1956, with the Professional Division since 1966, and President of that Division since 1974. He is also a Fellow of SMPTE.

After the close of World War II, Bell & Howell entered the microfilm field and in 1958 the mail-handling business, laying the foundation for its specialized business equipment line, a large portion of its business today.

Today Bell & Howell is a worldwide company with significant involvement in a variety of information transfer technologies and services.

Small Format Videotape Cassette Recorders

8. Recent Advances in Analog Component Videotape Recorders. *By C. Robert Thompson, RCA Broadcast Video Systems, Camden, N.J.*

Recording technology for broad-

cast-quality video performance can be divided into four separate categories.

Analog composite videotape recorders have been an industry standard since the invention of the method in the mid-fifties.

Digital television recorders became very interesting, from an engineering point of view, in the mid-seventies, when technology was developed to permit recording the composite digital signal with reasonable tape consumption. In fact, the SMPTE expended a considerable amount of effort toward standardizing a digital composite interface for such VTR's several years ago.

During evaluation of alternatives to sampling the digital composite signal, it became clear that certain advantages in post-production activity could be realized if the components of the television signal were available.

Television components are the signals comprising the television picture. Three of the most widely discussed sets are as follows: R:G:B; Y:I:Q; Y:R-Y:B-Y.

The third set was selected for International standardization during 1981. This standard is based on digital components, where the luminance (Y) signal is sampled at 13.5 MHz and each of the color difference signals is sampled at 6.75 MHz. Quantization levels at 8 bits per sample result in a total bit rate of 216 MBPS. Recording technology requires additional progress before a VTR can be brought to market to satisfy that data rate while requiring no more complexity or cost than today's C-format units.

The fourth category of video recording technology, Analog Component, has become popular only during the last year or two, since the introduction of one-piece recording cameras and small tape formats. These formats use the tape very efficiently — a comparison is shown in the paper.

In addition, the future for additional analog component VTR's could be very bright — several scenarios are discussed.

9. Innovations in ENG Recording Equipment. *By Thomas Mehrens, Sony Broadcast Co., San Jose, Calif.*

A review of the design considerations of a 1/2-in. cassette-based Y/R-Y/B-Y component recording system for broadcast applications. The subject of physical characteristics

(size, weight, etc.) is related to electro/mechanical design requirements such as writing speed, drum diameter, loading mechanism, power requirements, tape carrier, etc. Electrical characteristics are presented in terms that relate to the basic recording format, a time compression/division multiplex encoding technique for the color component signals, and the adaptability of equipment presently in use to a component system. The application of CCD Technology to the encoding and decoding of component signals to improve recording density and chrominance component isolation is discussed.

10. The Lineplex System and its ENG/EFP Application in Broadcasting. *By Heinrich L. Zahn, Hubert Foerster, Winfried Horstmann, and Heinz-Dieter Geise, Robert Bosch GmbH, West Germany*

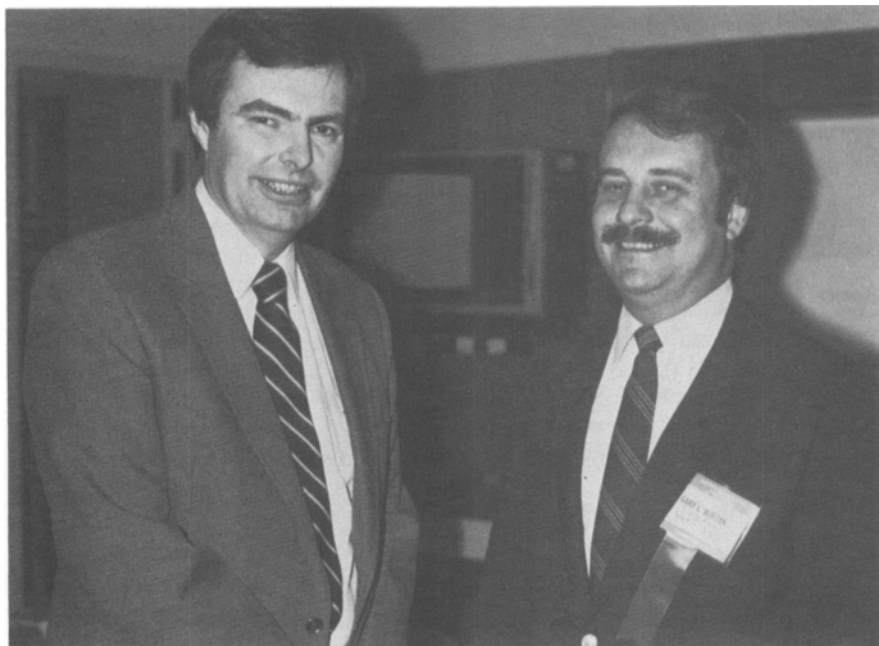
The paper describes the Bosch Lineplex recording principle utilized in the novel KBF 1/4-in. ENG/EFP cassette recording system, which is used in the world's smallest camera-recorder combination.

Lineplex is basically a double-multiplex processing and recording method. The first step is time-division multiplexing of expanded luminance and compressed color difference signals, which results in equal recording densities for all signal components.

The second step is partitioning the time-division multiplexed FM video signals into two identical recording channels. This gives a down-transformation of frequencies by a factor of two and, thus, a doubling of recorded wavelengths without increasing head-to-tape speed. So, good signal-to-noise ratios are achieved with a narrow track width.

These two measures lead to an area recording density, which is much higher than with all other professional systems. This most efficient use of the real estate on the tape allows more than twenty minutes of playing time on a CVC 1/4-in. video cassette with the necessary picture quality for ENG and EFP, which is considerably better than that of existing 3/4-in. recording systems.

The complete system consists of a line of equipment which is also described in the paper. The system offers all the necessary items and features for efficient field and studio operation. At the output of the system, all three sig-



Dr. Richard Green, Television Co-Chairman, and Gary L. Borton.

nal components (luminance and color difference signals in a simultaneous form) as well as the composite NTSC signal are available.

11. Small Format Video Recorders — A Systems Perspective. *By S. Merrill Weiss, Engineering Manager, KPIX Television, San Francisco, Calif.*

Any time a new form of format equipment is introduced, it should be analyzed to see how well it fits into the system environment. Its characteristics then should be optimized for best overall combination of performance within the system, individual performance, and cost. A further consideration is that, if changes in the overall system are known to be imminent, the characteristics of the new equipment should be optimized not only for the existing system but also for future systems. In this way, the new equipment or format will have the greatest longevity, as the systems around it change, and will ease the transition from one system to another.

Small format video recorders are an important new format for which such an analysis must be done. In a previous paper, the author has shown that the ENG and EFP equipment will be the last in an overall system to change in a transition to a digital system. In this paper, he shows that it might be the first to change in a transition to Multiplexed Analog Components (MAC), which many within the industry are

beginning to see as an intermediate step between the current analog composite systems and future digital component systems.

The areas examined include the necessary interface characteristics for each of the various system formats, the general equipment characteristics required of small-format video recorders to interface optimally with each of the current and future system formats, and any additional complexity which might be required to lengthen the life of the new recorder format by making it work better with the future system formats. An effort is made to put the cost versus format life trade-off into perspective.

12. Panel of Authors: Response to questions from the audience on small format cassette videotape recorders

Laboratory Practices II

13. Psychophysical Relationship of Image Quality Characteristics of Motion Picture Color Films. *By W. Liekens, Agfa-Gevaert, Mortsels, Belgium*

The results of a psychometric evaluation of image quality characteristics of a series of motion-picture color films are compared with the data obtained by physical measurements of corre-

sponding image quality parameters.

Implications of psychometric scaling of image quality characteristics by means of a paired comparison method are discussed, and the psychophysical relationship among measured quantities — RMS granularity, FEM, and MTF — and the psychometric scale values are examined by a regression analysis technique.

The relation between scale values for graininess and granularity parameters appears to be linear.

14. Conforming Single Strand Originals to Workprint in the Optical Camera Using the Du Art Computerized Frame Count System. *By Paul A. Kaufman, Fredrik Schlyter, and Irwin W. Young, Du Art Film Laboratories, Inc., New York, N.Y.*

Part I — Procedures for Cutting and Timing of the Original Negative for Later Conforming in the Optical Camera

The following information of the edited workprint is recorded into memory by frame count — effects, length of each scene, and key number of each scene. This is done at a special work station where a synchronizer and CRT are interfaced to a computer. A television camera and monitor assist in reading the printed through key numbers from the original. A paper tape reader and punch and a hard copy printer are also interfaced to the computer. The hard copy printer prints two listings for negative cutting.

List 1 identifies each scene by key number in scene order.

List 2 identifies each scene by key number in key number order, and also lists the unused footage between each negative cut.

Using the information from the two listings, the negative cutter assembles the original negative in single strand for printing.

The newly assembled negative is delivered to the special work station. Using the synchronizer and CRT terminal, the frame count of each negative splice, followed by a negative key number, is recorded into computer memory. This information is added to the edited workprint information already in computer memory. Upon request, the paper tape punch will deliver a cueing tape for timing. The Timer reads this tape into the computer interfaced to the Hazeltine Analyzer. The display on the Hazeltine indicates to the Timer what part of the scene is

to be printed to guide him in timing.

When completed, a new timing and cueing tape is retrieved for the contact printer. The sections of the scenes that are not to be printed will be zero cut so the Timer will have to review for corrections only those sections being used. After the completed print is reviewed by the Timer, he adds timing corrections using our print correction system.

15. Conforming Single Strand Originals to Workprint in the Optical Camera Using the Du Art Computerized Frame Count System. By *Paul A. Kaufman, Fredrik Schlyter, Irwin W. Young* Du Art Film Laboratories, Inc., New York, N.Y.

15. Part II — The Optical Printer Used to Conform the Cut Negative to the Edited Workprint

The following units of our Research Products Optical Printer were interfaced to a Nova 4 computer — the stepping motors that operate the camera and printer head, camera fader, display, keyboard, frame count, paper tape reader, and the Bell & Howell Additive Lamphouse.

The information we recorded from the edited workprint and the cut original negative, with its timing, is read into the computer. The optical printer, by frame count, uses this information to conform automatically the original to the workprint in the camera. Effects that are programmed in the system are fades, dissolves, freeze frame, double exposure, skip frame, stretch, and re-



Loren J. Mages presenting a paper on location power sources.

verse action. The system allows the user to program manual operations at whatever footage he requests. The Optical Dept. has its own work station where a CRT, paper tape reader and punch, and hard copy printer are interfaced to the computer. Here the Optical Dept. can make its own conforming tapes without going through the Negative Dept.

16. Printing Systems Evaluation. By *Denise Q. Humphreys, Richard C. Sehlin, and Paul J. Mutter*, Eastman Kodak Co., Rochester, N.Y.

The Printing Systems Evaluation, or PSE, is a system to equate printer operations in terms of printer lights. This system, which relies on standard industrial practice, incorporates such parameters as lamp type/wattage/

voltage, trims and tapes, filters, shutter angle, aperture, and film-transport speed. PSE is applicable at the laboratory level for use with the additive and subtractive printers, as it provides a means of improving the operational efficiency of such printers. PSE can be beneficial to printer and film manufacturers in the designing of better equipment and new films.

17. Lubrication of 35-mm Release Prints. By *Edward Mino and Rodney S. Perry*, Eastman Kodak Co., Rochester, N.Y.

Current investigations continue to demonstrate the necessity of proper edge-waxing of 35-mm release prints to significantly extend projection life over unlubricated prints. This paper reviews previous work and presents results of a recent trade lubrication survey. A 35-mm edge-waxing applicator suitable for in-line installation on processing machines or off-line batch use is also presented, along with recommendations for solution formulation, solution use rates, applicator operation, and wear-and-tear evaluation procedures.

17A. The Beginning of the End for Paper Tape — A Centralized Data Collection Computer. By *Michael V. Chewey, III*, Systems Unlimited, Woodland Hills, Calif.

A centralized, multi-user microprocessor system is described. This system is expandable and supports multiple remote terminals or other input/output stations. FCC and RGB data is collected and sent to a central hard disc file; the data is collected at an



Jonathan Erland and Roger Dorney of Apogee, Inc. during Motion Picture/Special Effects session.

analyzer, a synchronizer, and a comparator-projector. Other collection stations may be easily added, if desired. Data files are accessible for updating or hard copy printout. Paper tapes may be generated. Transmittal of data directly to a printer is possible, eliminating the need to collect and transport data by any medium such as paper tape, floppy disc, magnetic card, etc. A negative vault terminal is provided to permit inventory controls; the system is expandable to most areas of the lab. The system also provides rapid documentation of machine and employee activity, if desired.

17B. Chemelec — The Novel Electrolytic Recovery System for Metals From Dilute Solutions. By Denise Tomlinson, Rank Precision Industries, Nyack, N.Y.

Chemelec system is a unique silver recovery system designed to give maximum versatility, performance, and economy to motion picture laboratories. The paper describes how the system was developed from another research project and was applied by using the unique Chemelec patented method of agitation with a fluidized bed of inert glass beads.

The results are higher current efficiencies, lower power consumption, purer silver recovery, even at low concentrations, without sulphiding.

Current and Future Technology in Lighting

18. Overview — An Introduction By E. Carlton Winckler, Imero Fiorentino Associates, New York, N.Y.

Synopsis not available at press time.

19. The T.O.L.D. Conference and SMPTE. By Leland (Lee) H. Watson, Purdue University, West Lafayette, Ind.

Most national concept conferences of industry leaders meet, issue a manifesto, and slip rapidly into either oblivion or history. Not so with the TOLD Conference. TOLD, or "Training of Lighting Designers," was held at Purdue University, January 10-11, 1981. SMPTE was a most ac-

tive participant, with Roland Zavada, Engineering Vice-President, officially representing SMPTE, which has since affirmed strong support of the TOLD conclusions. It is the evolution of that conference, selection of official participants, conclusions, and the continuing effect it is having upon lighting education, which is our subject.

The TOLD Conference had absolutely nothing to do with how lighting design is taught. It was convened by this author while President of USITT (U. S. Institute for Theatre Technology). Its principal focus was the "pulling together" of those in many different lighting design specialties, i.e., theater, film, TV, amusement parks, landscape and architectural lighting, concert lighting, consulting, education, etc. To expand and improve the nature of lighting instruction, it seemed most feasible to convene leaders of the lighting industry — estimated to be some 50,000 strong — from the five major professional societies. There were official representatives from USITT, SMPTE, IES and their TIFL, ASLD, IALD and PEPS. All these organizations have since lent their official support to the TOLD Conference report.

The TOLD statement has been widely published in nine industry publications. The designated six major areas of instruction, which should be included in any program of lighting instruction, is the result of selfless work by 22 individuals working for the continual improvement of our total industry through restructuring the American educational approach to those whom we will hire and work with

tomorrow.

A steady stream of letters of inquiry continues to come in. To give the TOLD Statement some "teeth," the IES Board of Directors suggested that major higher educational accrediting agencies should be approached. This has been done. Contacted were NASM, NAST, ABIT, NAAB, NASA. All are members of COPA (Commission on Preparation and Accreditation), the umbrella group of all accrediting organizations. USITT has received assurances that COPA found the TOLD Statement most useful and is utilizing it in the process of evaluating instruction in lighting design — in all areas — in the accreditation process. This is a start!

In September of 1981, Jim Nuckolls, a conference participant, instituted the complete TOLD program leading to an MFA degree at the new Lighting Institute of the Parsons School of Design, New School for Social Research, New York City. There are many others moving in this direction. Prof. William Nelson at Carnegie Mellon is active in architectural lighting as well as theater lighting design and teaches both; so does Prof. William Warfel at Yale. Prof. Michael Gillette at Arizona State has expanded his instruction to include TV lighting as well as theater. Prof. Gil Hemsley at University of Wisconsin-Madison has directed his students into extensive TV and film lighting as well as theater. Penn State's architectural lighting students take theater lighting courses and theater students take architectural courses. This author, at Purdue, teaches large classes in Landscape



William G. Connolly and William C. Nicholls chair the session on Videotape Recording.

Architectural Lighting Design and Interior Lighting, as well as a full theater lighting program. The TOLD Conference gave a "boost" to a trend already under way, strengthening this trend and giving it broader application.

While the TOLD Conference was a one-time gathering, the effects of its deliberations is having an ongoing and constructive effect on the industry and will continue to do so in the foreseeable future.

Any attempt at change is always a long, slow process. SMPTE, through Roland Zavada and Carlton Winckler, with the support of SMPTE's Board of Governors, has done much to further two objectives:

1. Bring together and in communication those concerned with the better use of designed light. This is bringing a needed exchange of ideas and techniques throughout the industry.
2. Help advance the broadening of instruction in lighting.

These are the beginnings of a process that can only result in better-trained members for each of our industries and all of the concerned professional organizations in the years ahead.

We seek your continued support in keeping alive a process well begun — thanks in part to the dedicated efforts of SMPTE. We all thank you.

20. Field Report, Television Lighting. By David M. Clark, Imero Fiorentino Associates, Inc., New York, N.Y.

Wishes and dreams would seem to be out of place in a brief, practical report to an engineering society, but, if we do not wonder about what is over the horizon, we will never go there. The dreams of the lighting designer become the challenge to the designer of new luminaires, and his dreams become the challenge to the designer of an improved source of light. The quartz-iodine source has evolved into flexible and practical luminaires. The HMI and CSI sources are in the midst of the same process.

Each new generation of luminaires eventually reaches the goal of installation somewhere in the world. Power is applied and a new kind of light emerges in all its technical glory. Then the emerging light hits something in the real world like a tree or a face and a metamorphosis takes place: the objective technical achievement becomes



Thomas Stockham speaking at the session on Motion Picture Sound.

a subjective artistic tool. Like a promising college graduate becoming a lowly business freshman, a new luminaire must cultivate a whole new group of friends. Lighting designers must be convinced that it is comfortable and dependable. It must perform.

Performance certainly means output in lumens, consistent color temperature, and a consistent field distribution curve. Performance also means a list of nonphotometric features by which new luminaires become popular field items:

1. How many men does it take to lift it?
2. How many can you fit in a station wagon?
3. Can a hand with an asbestos glove on it operate the release catch to open the door to change the lamp when the luminaire is hot?
4. Do moving parts work smoothly, cold and hot?
5. Do locking adjustments hold their position when accessories are added?
6. How easy is it to attach and adjust accessories?
7. How easy is it to accomplish No. 6 from the top of a ladder?
8. If the luminaire falls off a tailgate, will it still work?
9. Can average tools be used for minor repairs?
10. Does this particular luminaire have an easy-to-remember nickname like "Tota-light" or Micky Mole?

A simple list like the foregoing is dangerous in its simplicity. For in-

stance, we would consider the two or more men required to lift a Brute arc onto a stand as worthwhile because of the unmatched output of such a unit. We are impressed by the progress of HMI luminaires as they approach the lumen output of Brute at considerably less head weight. Lumens are a very handy way to express the quantity of light leaving the luminaire. In the field, however, it is a case of how much of the light arrives as foot-candles where the actors move through smoke and haze with the barn doors half closed and the voltage at about 105V. After a shoot the ground is covered with lumens that never made it to the action. We have learned to order extra lumens to compensate for the casualties.

The search for the clean single source that approximates the sun even though the luminaire is huge is matched on the opposite end of the size scale by the search for tiny sources of light to hide behind ceiling beams and in rear seats of small cars. This does not mean that a lamp enclosed in a small housing that gets so hot that it melts its own plastic knobs is going to be a big seller. Current attention to low voltage lamps developed for aircraft and display use is encouraging. Small size is the goal with output less important. We are not trying to light a whole scene with this small unit, we just want a little something on the clock face. Even smaller HMI and CSI sources than now exist will arrive some day with more light than heat for these tuck-away applications. It is especially true in a small luminaire that eventual popularity depends a lot on how varied are the ways it can be mounted using

standard grip equipment or sheer imagination.

Television lighting and film lighting are rapidly blending into the same thing as far as equipment goes. Those of us who entered television early, especially on the East Coast, were stuck with the requirement of high levels coaxed out of swarms of converted theatrical luminaires mounted overhead out of the way of floor traffic. As television has matured we have welcomed the introduction of film style luminaires and their marvelous grip equipment. The single most remarkable feature common to most film equipment is the solid simplicity of it. It is comfortable and dependable. It performs.

Here, then, are some brief thoughts of a working television lighting designer about new equipment in general. Perhaps this will trickle back up to the folks who are trying to figure out why we haven't become comfortable with their latest effort.

21. The Answers — Current and Future, *From the Suppliers of Light Sources*

Synopsis not available at press time.

22. Update on Today's Lighting and Control Equipment for Motion Pictures and Television. *By Nathan "Sonny" Sonnenfeld, Sonnenfeld & Co., New York, N.Y.*

Synopsis not available at press time.

23. New Looks in Lighting From Lowel. *By Art Kramer, Lowel-Light Mfg., Inc., New York, N.Y.*

At Lowel-Light, research and development in the field of light-weight location lighting systems for motion picture and television applications are an ongoing activity. In 1982, Lowel advanced the state-of-the-art in three areas. First, several existing fixtures evolved into more complete and versatile lighting systems. Next, several systems were revamped and repackaged to better reflect the current need of motion-picture and tele photographers on location. Finally, plans were put into motion to unveil several new products and systems aimed at further easing the burden of location lighting

professionals.

In the field of evolution, the Lowel 'D' focussing spotlight has now become the more flexible Lowel 'DP' light. The Lowel Softlight 1500 has evolved into the more powerful and, similarly, more flexible Lowel Softlight 2. Both of these fixtures bring with them expanded accessory systems and new system packaging.

Extensively revised is the kit packaging of the Tota and Omni systems. New selections and assortments, along with several new kit cases, combine to offer many more choices in lighting kit selection, some of which will be of special interest to the currently emerging cable industry.

We expect to have several new items available in time for a U. S. introduction at the SMPTE Conference and look forward to introducing them to you at that time.

24. Question and Answer Panel — Current and Future Technology in Lighting

25. Live Demonstration of Lighting Techniques. *By David M. Clark, Imero Fiorentino Associates, Inc., New York, N.Y.*

The first demonstration will examine a single source of light on a face from various angles with notation of the dramatic and cosmetic effect.

The second demonstration will continue with one light and variations of picture elements other than the face to achieve a balanced image for the television system.

The final period will include the addition of a soft fill light and back light from various angles with constant reference to the wave form monitor and the television picture. The resulting conclusion will be that simplicity is the secret ingredient of advanced lighting.

Laboratory Practices III

26. A New Laboratory Aim Density (LAD) Control Film. *By John P. Pytlak, Eastman Kodak Co., Rochester, N.Y.*

Motion-picture laboratories contend with several sources of variability in

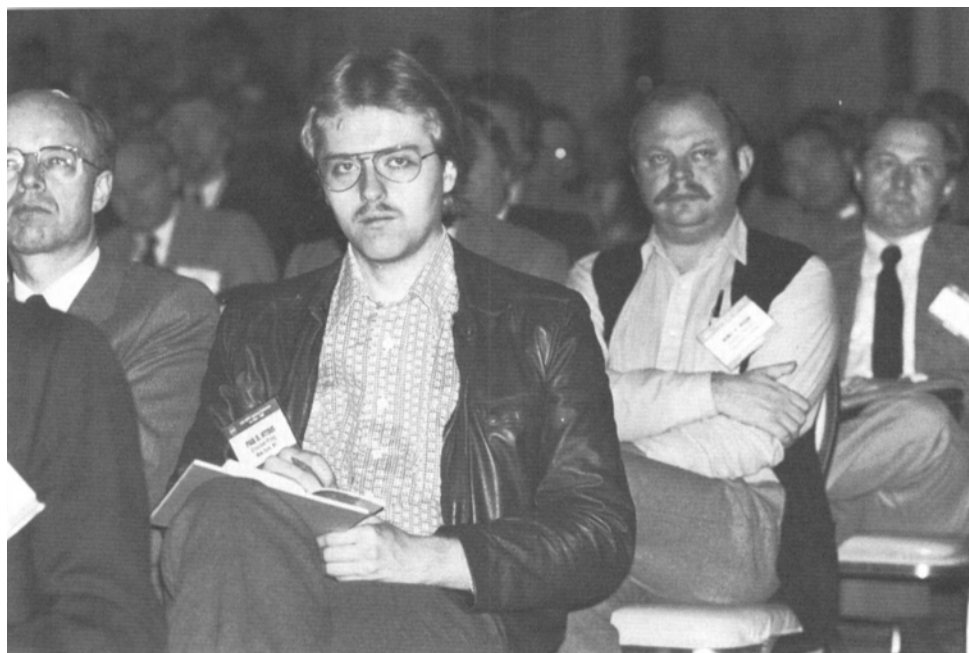
producing consistent, high-quality duplicates and prints. The Laboratory Aim Density (LAD) control method, described in the October, 1976 SMPTE Journal, provided a simple, inexpensive, and easily implemented control method for the production of interpositives, duplicate negatives, and prints from negative originals. One major impediment to the universal acceptance of the LAD control method has been the lack of a subjective "real scene" that printed exactly like the LAD Standard Patch and provided subjective verification of the good duplicating provided by the LAD control method.

This paper describes a new Laboratory Aim Density (LAD) Control Film that combines the objective control features of the LAD Standard Patch with the subjective verification provided by a real scene. This control film features a live model for subjective judgment of color balance, and measurable areas of white, black, and gray (LAD) for objective evaluation of tone reproduction. The LAD gray reference patch was chosen so that when it is printed to a gray of 1.00 visual density on the final print, the flesh balance is acceptable. A six-step gray scale and red, green, and blue color patches are also provided for subjective evaluation of tone reproduction and identification of color separation exposures. A unique feature of the LAD control film is an opaque frameline that generates a "reference white" to aid in objective and repeatable setup of electronic color analyzers.

The paper briefly reviews the Laboratory Aim Density (LAD) control method. The choice and specification of the various scene elements are outlined, and production methods and use within the laboratory are discussed.

27. The Effect of Film Format on Film Speed Indices. *By Daan Zwick, Eastman Kodak Co., Rochester N.Y.*

The exposure index recommended for a film is directly related to the minimum amount of exposure necessary to achieve a certain level of picture quality. Picture quality is also affected by the degree of magnification or enlargement at which the photographic image is viewed. Degree of magnification, of course, is directly related to the recorded image size, or format. If factors that determine image quality are influenced by both image magnification and film exposure



Attendees at one of the sessions.

level, image magnification will have an effect on the choice of an optimum exposure. This tutorial paper describes the interaction that may occur between film formats and exposure indices.

28. Improved High Speed Eastman Color Negative Film. By J. W. Erwin, G. L. Kennel, F. R. Reinking, and S. W. Spakowsky, Eastman Kodak Co., Rochester, N.Y.

At the 123rd SMPTE Conference in Los Angeles last year Eastman Kodak Co. announced a new high speed film, Eastman Color High Speed Negative Film 5293/7293. This paper describes an improved high speed color negative film based on the advanced technology used in 5293/7293 film.

29. A New 16-mm Eastman Color Negative Film. By F. R. Reinking, S. W. Spakowsky, W. A. Szafranski, and G. L. Whittier, Eastman Kodak Co., Rochester, N.Y.

An improved Eastman Color Negative Film, to replace Eastman Color Negative II Film 7247, is described.

30. The New Peterson Full-Immersion Rotary-Buffer Film Cleaner. By Chuck Zichter, Peterson Enterprises, Inc., Glenview, Ill.

A new, full-immersion rotary-buffer film cleaner has been designed specifically to clean and remove any tenaciously adhering traces of dirt, grease pencil, and finger marks from film

negatives and other films used in motion-picture laboratories, video laboratories, film distribution centers, film libraries, etc. The concept of design was to produce a simple piece of equipment that would really clean film.

Cleaning the film is accomplished with the use of lintless dacron buffer rollers. With the film threaded between two sets of buffer rollers, the complete mechanism is lowered into the solvent cleaning tank. The solvent is inhibited trichloroethane I.I.I. When lowered completely, the film travels at a speed selected by the operator of up to 250 ft/min. With the buffer rollers rotating in the opposite direction of travel of the film an "aqua-planing" action takes place, creating a high-velocity movement of the solvent against the film, along with the rotating buffing action of the rollers.

As the film exits from the solvent, immediately after cleaning, it passes through a warm pressure-jet solvent spray-rinse which strips both sides of the film of excess solvent. Then a set of warmed-air knives completely dries the film before it leaves the cleaning tank. The film is transported through the cleaner by a sprocketless film transport system and taken up on a D.C. motor takeup. A dancer arm controls a D.C. servo motor for the film feed, thus assuring uniform film tension at all times.

Simplicity of design is facilitated by the straight-through threading path of the film through the buffer rollers, plus a minimum number of buttons to actuate during the functional operation of cleaning. An added optional feature

for the recovery and reclamation of the solvent is also available.

30A. Bi-Directional Total Immersion Printing System and High Speed Servo Light Value. By Harry Teitelbaum, Hollywood Film Co., Hollywood, CA.

Film-to-Tape Interface

31. Full Immersion Wetgate-System For Telecine. By C. Geyer, Geyer-Werke GmbH, Hamburg, Germany

Nearly two-and-a-half years ago Geyer-Werke developed a 16-mm full-immersion wetgate-system for the Rank Cintel Mark III, that has been in absolute unproblematic use since. Later on this development was also extended to a 35-mm unit, which was put into operation early in 1982. Both wetgate units are in daily operation for many hours at Geyer Video.

This paper essentially deals with technical problems, which raised the development of this wetgate-system, and their subsequent solutions.

Furthermore, the system is explained in technical details, and the question of its operation and maintenance is discussed.

A demonstration tape shows a direct comparison between a dry and a wet film-to-tape transfer regarding cleanliness, scratch visibility, image sharpness, and steadiness.

32. New Tools for Improved Telecine Quality. By Kenneth G. Lisk, Henry A. Barrett, and John P. Pytlak, Eastman Kodak Co., Rochester, N.Y.

Motion-picture film is assuming an ever-increasing role in providing high-quality images for television programming. To assure that this quality is fully translated through the television system, a survey has been conducted by Eastman Kodak Co. to evaluate telecine performance. Emphasis was placed on the new generation of telecines such as the CCD and flying-spot types that cannot easily use a test slide format. Both subjective and objective film materials were used in this test.

In general, most of the telecines tested gave satisfactory quality; however, variability in gray scale and color

were noted. This paper describes a telecine alignment film (T.A.F.) and an Eastman video display analyzer (E.V.D.A.) for color monitor adjustment measurement to aid in reducing this variability.

33. An Experimental Trinoscope for Improved Video-to-Film Recording. By Henry A. Barrett, Robert Collette, Kenneth G. Lisk, Jerry Sager, and Richard J. Sypula, Eastman Kodak Co., Rochester, N.Y.

The trinoscope, or tri-optical recorder, has proved over the years to be a highly successful device for transcribing video images to film. At present, this recording technique is used throughout the world to make high-quality television-to-film recordings primarily onto Eastman color negative II film 7247 (16mm) or 5247 (35mm).

This paper describes the construction of a new trinoscope that takes advantage of advances in electronic technology in the area of signal processing and CRT geometry correction. Also described is cathode ray tube selection.

A unique feature of this new trinoscope is its ability to expose Eastman color internegative II film 7272. This film is extremely slow, having an exposure index of approximately three; however, it has very fine grain and high resolution.

A picture demonstration compares Eastman color negative II film 7247 with Eastman color internegative II film 7272.

34. Film to Tape to Film. By Tom Mann, Image Transform, Inc., North Hollywood, Calif.

This is a discussion of the problems of (and solutions to) shooting on film, editing on tape, and either transferring the tape back to film or conforming the original film negative to the edited videotape.

All methods are discussed. The basic 24-frame film transferred to 30-frame NTSC and then transformed to 24-frame film is the basis of the discussion. The other possibilities of shooting the film at 30 frames, transferring to 30-frame tape and then to 24-frame film, as well as 24 frames all the way, film to tape to film, are presented.

Slides of actual film-to-tape-to-film

frames are shown to portray the difficulties explicitly. In addition, 35-mm motion-pictures demonstrate various methods of film-to-tape-to-film transfers.

This includes a demonstration of a commercial shot on 5293, transferred to HDTV ImageVision™, edited on tape, and transformed back to 35-mm film.

A new method of identifying the proper field relationship of an edited NTSC 30-frame videotape to eliminate the strobing that is possible in film-to-tape-to-film transfers is shown.

35. A Unified, Reliability Directed Approach to Controlling the Film-to-Tape Transfer Process. By Eric L. Steinberg, Teletronics Inc., New York, N.Y.

In setting up a negative film-transfer facility, Teletronics was faced with the need to include a color correction and control system in the design. An informal study was undertaken by this author and others to determine what alternatives were available, and to find which of those would best satisfy our needs according to a set of criteria developed (again, by this author) as follows:

1. Speed/ease of operation — simple operator control sequences with a minimal number of key-strokes, along with careful consideration of location and grouping of controls.
2. Reliability — use of off-the-shelf components, elimination of

analog circuitry and of mechanical elements where possible, use of mass-termination and high reliability connections throughout the system.

3. Maintainability — modular construction, easily replaceable components, thorough documentation.

4. Operational flexibility/resistance to obsolescence — broad range of control capabilities, ease of adding upgrades and enhancements or of reconfiguring parts of the system if necessary.

5. Aesthetic appeal — the operator's interface should be visually striking without containing any strong colors, and should complement and the overall room design in a pleasing way.

After an evaluation of the commercially available devices, as well as our existing Palette color correction systems, it was determined that no system existed which met all requirements as set forth. In addition, as the problem was studied, another feature which had yet to be applied to the film-to-tape process emerged as being highly desirable. This was the idea of bringing all of the studio's functions together into a comprehensive, unified control and display center. It was felt that this would be a major step in improving flexibility, ease, and speed of operation, and would provide a framework into which new functions and controls could be easily integrated.

Based on these considerations, the company decided to design and construct a new system which would, on a frame-accurate, scene-by-scene basis, put color correction, blow-up/reposi-



Television Production Chairmen Robert Muller and Wayne Grennier.

tion, pan-scan, switcher, transport, tape editing, general purpose interface, and utility functions literally under the operator's right hand, and which would embrace all of the originally listed criteria. The system, based on a DEC LSI-11/23 computer, includes additional advanced features such as a digital color-mix entry system which eliminated potentiometers and the analog-to-digital converter, while preserving a pot "feel," a large event capacity with list management capabilities, ability to store and retrieve event lists on diskette, and a comprehensive video display not unlike those used in the more advanced video tape editing systems.

In conclusion, although not all of these ideas are brand new, they have not before been applied all together to a film-to-tape transfer control system, possibly because of the limited commercial availability of such systems. This step is, we feel, a major one in the maturation of the film-to-tape transfer process.

36. Magnetic Control Surface — A New Film Electronic Interface. By *D. L. Carr, H. J. Kroll, W. W. Peck, R. K. Schofer, and R. E. Uhlig*, Eastman Kodak Co., Rochester, N.Y.

Synopsis not available at press time.

Motion Picture Sound

37. A New Generation of Magnetic Film for Motion-Picture Recording. By *Donald A. Anderson*, 3M Co., St. Paul, Minn.

Improvements over the years in magnetic oxide have made possible a new high-output, low-noise magnetic film. This product allows higher recording levels than any other magnetic film currently available. The third-order harmonic distortion content is exceptionally low, and recorded sound quality is comparable to the finest analog music mastering tapes in use today.

A proprietary method of oxide surface treatment produces an additional benefit by greatly reducing asperity noise normally caused by untreated oxide coating surfaces. This magnetic film also has greater sensitivity, espe-

cially at higher frequencies. It enables equipment to use approximately 3dB less high-frequency record equalization to achieve a flat response.

Modulation noise is greatly reduced because of the smooth, mirror-like recording surface. The extended range of sound level is a very respectable 75dB in S/N.

Data is presented showing comparison between present magnetic film and the new product in the areas of distortion, maximum output, and sensitivity.

This film is made with a very durable magnetic coating binder system allowing many record/play passes without signal degradation or oxide shedding. The oxide/binder construction is similar to 3M's music mastering tape Number 226. This durability feature is extremely important in the method of film recording called "pickup recording," in which it is not uncommon to subject sections of the film to hundreds of record/play passes. There is no tendency for high frequency response to increase with additional record/play passes since the coating has been "pre-polished" in the surface treating process. The excellent wearing properties will be a benefit to other heavy use operations, such as production of Foley tracks and dialogue replacement.

The new product uses polyester as a substrate and is coated on standard gauge stock, 5 mil and 3 mil in thickness. It will be available in 35-mm and 16-mm widths. To clearly indicate the difference between this and other films, the polyester base material of this new product is unique in color. The base material was deliberately made to appear different from the oxide not only to indicate it as a premium product, but to reduce the possibility of threading up the roll in a "B" wind condition.

Recording engineers have long expressed a need for sound quality which approaches that possible with today's music mastering tapes. Their concerns should now be allayed, with ability to reproduce the excellent quality of music scores and many of the electronic sound effects found in modern films. The introduction of this product is timely because it will augment the recent improvements in sound quality due to better optical sound tracks and noise reduction.

38. Test Films for Stereo Optical Equipped Theatres. By *Ioan Allen*,

Dolby Laboratories, San Francisco, Calif.

New techniques and test materials have had to be introduced for the installation and maintenance of theaters equipped for the playback of Dolby Stereo optical sound-tracks. This paper discusses the selection of test films employed and their practical usage.

39. The Basic Principles of Digital Audio and Its Fundamental Benefits. By *Dr. Thomas G. Stockham*, Soundstream, Inc., Salt Lake City, Utah

After a complete but brief and simple presentation of the basic principles of digitizing audio, this paper describes the two major benefits, quality and permanence. While interest has thus far concentrated on the quality benefit, the future may reveal the permanence benefit to be the more important and useful.

40. Digital Audio for Motion-Picture Film Production. By *David W. Spencer II*, WED Enterprises, Glendale, Calif.

Walt Disney Productions has recently completed the construction of a video assisted digital audio dubbing system, for motion picture and television post-production. During the development of the system, many unique advantages of the digital audio medium were realized. These advantages, besides the obvious quality improvement, pertain to the fact that all digital audio is time-base related. This time-base relationship allows a similar control technology to exist between digital audio and video production systems. This is particularly apparent when both editing and synchronizing methods are examined.

The first key element, in a system such as this, is a synchronous transfer of material in either the digital audio or video medium, made possible by the introduction of a common, master "house" sync. In videotape editing systems, VTR'S are synchronized by changing the capstan speed until they are in sync with one another, at which time the capstan control is released and "house" sync takes over to ensure that they remain frame locked and synchronous. A digital audio tape system is controlled in the very same manner. Once synchronized and under "house" sync, digital audio transfers can be

made, in the digital domain, without loss of signal quality or increase in noise.

The second key point is that, just as SMPTE time code on videotape is time-base related, so must the time code be, on a digital audio tape. That is to say, a SMPTE frame should have a finite number of samples corresponding to it. Once time code on a digital audio tape is related to its time-base, it may be manipulated in the various ways videotape time code is currently used.

The aforementioned dubbing system utilized these timecode techniques to create a unique post-production system. The system itself is comprised of four multitrack digital audio recorders, nine videotape players, and a distributed control processing network. The digital audio recorders collectively provide over 90 digital sound tracks on line and in sync with the picture at all times. These sound tracks can be offset from the picture or one another in any multiple of 1/100-frame increment.

The nine videotape players provide a projected 360° picture, comprised of nine separate 12-ft screens arranged in circular array. In the center of this array is a unique analog audio mixing and processing section capable of over 64 inputs and over 16 outputs, with the ability to pan any one track anywhere within the 360° screen array.

The distributed control processing network is comprised of a central processor responsible for system initialization, time code offset generation, transport status reporting, and production logging. This central processor communicates to intelligent interfaces which in turn control each one of the digital audio and video transports. The intelligent interface is the element responsible for the actual control and synchronization of all elements within the dubbing system.

In application, film is transferred to videotape. These videotapes, as well as all digital audio tracks, are then slaved to a master SMPTE time code source. Once in sync, all nine VTR'S and 90 digital audio sound tracks are locked to a common "house" sync. All elements thereafter remain in sync until such time as they are commanded to chase to another section of the program for resyncing. Chase times are limited only by the transport speed of the digital audio recorders. Using these techniques, it is possible to "rock and roll" record on this dubbing system.

The system was first put into use in January 1982 for the digital rescoring

of *Fantasia* and subsequently has been used exclusively for seven multiple-screen motion pictures produced for Walt Disney's EPCOT Center opening on October 1, 1982.

41. Cancelled.

42. The Lucasfilm Audio Signal Processing Station. By James A. Moorer, Curtis Abbott, James R. Lawson, and John M. Snell, Lucasfilm Ltd., San Rafael, Calif.

The digital audio project of Lucasfilm has completed the construction and debugging of a large-scale digital audio processor that will be the basis of an audio processing station that is capable of performing all the functions of sound editing, synthesis, and mixing for film sound production. The raw sounds are digitized at their earliest moment and stored on large computer disks. All editing and processing of the sound from that point on is done entirely in the digital domain. At the last instant, conversion to audio is done to make the 6-track master. The advantages of this procedure are as follows.

- 1) No generation loss. Premixes may be made ad infinitum without any loss of quality or any accumulation of noise.
- 2) Complete automation. All manipulations and gestures by the editor or mixer are recorded automatically, so that a premix (for instance) may be remade exactly. Edits and processing may be rehearsed and altered at will.
- 3) Recutting aids. Since all premixes can be edited without losing any gestural information, recutting efforts are reduced to a minimum.
- 4) Exotic processing possible. The entire spectrum of digital signal processing is available for exotic applications, such as speech synthesis or partial signal restoration from degraded recordings.

The system consists of three major parts: the controlling computer, with graphical interfaces, the audio signal processor (ASP), and the console. The ASP and the console were designed and built in-house. The total bandwidth of the minimal system is sufficient to duplicate the functions of an 8-channel mixer, with considerable audio processing horsepower left over

for special effects. The system can be easily expanded up to a maximum of 64 channels, but can be extended to any number of channels with some further difficulty.

43. The Compact Disc Digital Audio System. By Bert Gall, NVP Eindhoven, The Netherlands, and Wayne Scott, Consumer Electronics Group, Knoxville, Tenn.

A total system of optical digital sound reproduction has been developed. The system uses a 120-mm (4.12 in.) disc as the medium to store more than one hour of high-quality digital audio in two channels. Dynamic range and channel separation are both better than 90 db. Wow and flutter are virtually nonexistent. The output is flat from 20 Hz to 20 KHz with distortion below 0.05 percent. Scratches and other defects are made inaudible by a digital error correction. The readout of the information is accomplished by means of a non-contact optical pick-up using a solid-state laser. The reflective track is covered with a transparent plastic seal which affords permanent protection. Surface blemishes and finger prints on the surface of the disc are kept out of focus.

In addition to the audio information, a special code has been incorporated into the standard. This data can be used for tracking, search, and find facilities. Supplementary information such as program title and composer can be included.

44. Digital Fluorescent Soundtracking — A System Development Progress Report and Open Discussion of Format and Data Sampling Rate Standards. By Peter Custer and Dr. George Bird, Digital Fluorescentsound, Princeton, N.J. and Glendale, Calif.

Digital fluorescent soundtracking is a high-data density digital sound record multiplexed with the picture. Six discrete channels of uncompromised, 100% redundant soundtracking. Requiring a data rate of 10.5 million bits/sec. They are electrostatically printed, using a high-resolution liquid toner, over the entire 25-mm space between the sprocket holes on 35-mm release prints as a colorless and transparent, brightly fluorescent data image. The soundtrack is invisible on the screen, but when excited by long-wave ultraviolet in a readout stage that

retrofits into the magnetic track penthouse position on the projector, the surface of the film emits bright blue visible light. This data image is "counted" by a line-scanning 2048-pixel photodiode array, error-corrected and converted back into an analog signal, reproducing the source with great accuracy and without distortion or noise.

Recording the sound on the film as numbers that are used to reconstruct the analog wave form — not as a direct analog of the wave structure — separates the sound record and gives it immunity from the noise inevitably imposed on an analog film soundtrack by the recording medium, optical silver or magnetic oxide. Film is damaged by both wear and abuse. The error correction possible in a digital sound record, because it uses computer technology, excludes noise caused by splices, dirt, and scratches. The fact that the data is buffered — stored for an instant — and precisely clocked out of memory electronically eliminates distortion of the signal caused by mechanical wow and flutter. These and other inherent digital sound properties make digital soundtracking uniquely advantageous to motion-picture film.

U.S. Patent 4,308,327 was granted on December 29, 1981 for the invention of the toner and its index of refraction-matching overcoat that both protects and makes the data image disappear. It also covered the process of creating the fluorescent data image, and a second patent on the film itself was allowed in August of 1982. The system development is funded and under way in California and Princeton with a first theater demonstration to be made in less than two years.

When this work was first made known to the film industry through SMPTE, it was not obvious that a digital sound record had true utility on motion picture film or that digital sound recording would dominate the recording industry as it does today. For instance, most classical music is now mastered digitally — that question is considered to be behind us. The movie audience will, within the next two years, become entirely aware of the astonishing accuracy of reproduced digital sound recreating with precision the "live" experience because of the introduction of the compact digital audio disc. Some of the advanced theaters in planning stages now — anticipated in the immediate five-year future are ultimately practical only if

they use a true digital sound-on-film soundtrack.

It is at this point in time, while system design specifications and the recording format are being set, that we ask for comment, constructive criticism, technical advice, and cooperation from within the film industry. We want to avoid mistakes that can be anticipated and corrected before the system design is out of this first experimental and prototype demonstration phase and is ready for use as a standard motion-picture theater digital sound record.

Motion Picture Production

45. Feathercam C.M. 35 — A New Lightweight Portable and Versatile 35-mm Movie Camera. *By John Carroll, Feathercam Inc., Van Nuys, Calif.*

This new 35-mm camera is loaded with features not found on most of the cameras which are currently in service. The new film transport mechanism is a new but simple concept. It provides two claw pull-down and two pin registration. The result is dependable performance and absolute image stability at all operating speeds. The whole mechanism can be removed from its base for servicing.

The film gate is much larger (6 in. long) than that normally found in other cameras. This provides for gentle but even pressure on a larger area of film and alleviates the possibility of film damage or emulsion deposits. No lacing is needed, as this is automatically achieved when the magazine is fitted.

The 180° shutter is a dynamically balanced rotating reflex mirror, set at an angle of 45° to the light entering the lens. The shutter is also designed to stop in the viewfinder open position, so no adjustments are required.

The snap-on 500 ft co-axial magazine can be changed on the camera in less than two seconds. The magazine is simple to load, since it incorporates a unique loop-forming threading system which ensures correct loading every time. When loaded, there is no loop of loose film to catch or snag, and no lacing or threading is required on the camera. Just snap on the loaded magazine and shoot. A mechanical footage counter is incorporated in the maga-

zine. At the request of many cameramen, an inching knob has been added to the camera. Most of the electronics have been taken out of the camera and put into a small base tray that sits underneath the camera and supports the magazine. This tray also holds all the switches and plugs that operate the camera.

A bright reflex viewfinder provides the operator with a brilliant image. It can be set for right or left eye viewing in seconds and is never obscured by the shutter. An extension eyepiece has been added that extends the viewfinder to the rear of the magazine for tripod work and helicopter mount use, plus many other applications.

A new motor provides variable speed performance frames/sec. Over the range of 4 to 48 frames/sec, whatever setting is used, the motor is electronically controlled to maintain speed regardless of film loading or temperature extremes. In addition, two switch-selected quartz crystal locked speeds of 24 frames/sec and 25 frames/sec are provided. An instant "soft start" facility assures gentle film-handling no matter what frame rate is selected.

The camera features two bright, three-digit L.E.D. read-outs mounted on the top of the camera and easily visible to the operator or his assistant. One read-out indicates film speed in frames/sec, and the other footage shop. The latter incorporates a built-in memory to show how much film has been used even when the camera is unplugged. The footage read-out can be switched to meters when required. A battery condition indicator light is mounted on this same display.

A video tap has been designed that is simplicity itself, to add to the Feathercam by removing a plate on the right-hand side of the camera. The whole video tap assembly can slide into position and be secured in less than a minute and is very easily operated.

A hand support system has been designed that features a koa wood handle, for operating in all temperatures on a sliding rod that is adjustable to different cameramen's needs.

A feature that greatly benefits the cameraman or rental facility is the easily changed lens mount which accepts both spherical and anamorphic lenses. By the simple removal of four screws, the lens mount can be changed, making the Feathercam very versatile and compatible with virtually every lens on the market. Other lens mounts will be made upon request.

46. The J-6: Linear Variable Differential Transformer Technology Applied to the Design of a New Zoom Control. By Robert Auguste, and Edwin S. Clare, Cinema Products Corp., Los Angeles, Calif.

Zoom lenses are manufactured with the greatest emphasis placed on optical tracking characteristics. The resulting performance in the field is a sum of many variables, including the internal design. By comparison, less emphasis is placed by the manufacturers on the human engineering, for instance, the needs of the operator or requirements for moving the external lens barrel. Seemingly effortless zoom shots are often the result of a combination of a well functioning zoom lens, a good operator, and either motorized zoom controls or mechanical fluid drive units. This paper examines the design goals and the performance specifications of the J-6 Zoom Control from Cinema Products.

The J-6 is different from previous designs in that it utilizes Linear Variable Differential Transformer (LVDT) technology for stability and reliability. It is the evolutionary outgrowth of systems J-1, first introduced by the company in 1969, through J-4 and J-5, both of which are currently manufactured. Initially, the design goal of the J-6 program was to integrate an entirely new hand control into a J-4 type system. These systems usually consist of a control, motor, and cable. The new J-6 systems will include J-6 Control, either a J-4 or J-5 motor, and appropriate cabling. A J-6 system will use the same lens bracketry required by current J-4 and J-5 motors.

In the film format, this hardware works with popular zoom lenses from manufacturers such as Angenieux, Canon, Rank, and Zeiss. In the video format, lenses are often supplied with integral motorized systems, or sometimes with flexible cable drive systems. Departures from tradition are occurring with the design of Electronic Cinematography cameras. The EC-35 camera, from Ikegami, will accept lenses from manufacturers such as Canon, that are not equipped with an integral motorized or a flexible cable drive, but suggest the use of a J-6 type system.

An internal battery pack powers the J-6, or the entire unit can operate from an external source with voltages ranging from 12 to 30 V DC. An LVDT device is used as a speed control

transducer. The LVDT device has no moving parts to wear out and is very stable. This is the first known application of LVDT technology to motorized hand control design. Zoom speeds ranging from 2 sec to 3 min are achieved using a single revolution rate control potentiometer. Speed stability is monitored through a closed-loop DC feedback system. Because the circuit design includes test circuitry, the J-6 can be serviced in the field with only a v/ohm meter.

The operating features found on a J-6 control are as follows: power on/off/external switch, forward/reverse switch, speed rate dial, joystick control, low-battery warning (LED), motor operate (LED), speed times twenty button, camera run button, charger input connector, and motor cable connector.

47. Cancelled.

48. Mobile Electric Power Sources for Location Lighting. By Loren J. Mages, Forces, Inc., Hillside, Ill.

Many desirable locations for motion picture and television production are not served by electric utility company lines. Or, if the site is served, the power lines may prove to be inadequate. Voltages may not be as required, the power lines may not be accessible, voltage may be unstable, or line capacity may be limited. Portable and/or mobile electric power supplies can be utilized. This paper reviews alternate power sources and explores advantages and limitations of various optional electrical power supplies available.

Storage batteries do not create audible noise and may be the power source of choice when a limited electrical supply is required. Output from battery packs is direct current (DC). Several types of batteries are available. Lead-acid (LA) batteries are low in initial cost and are readily available. An undesirable characteristic of lead-acid batteries is the fact that terminal voltage drops as a function of load and time. Variations in battery voltage cause lamp color temperature changes. Nickel-cadmium (NiC) batteries maintain an almost constant voltage output. However, initial cost is six to ten times higher than LA types of equal ampere-hour storage capacity. Special battery chargers are required for use with NiC batteries.

Alternating current (AC) can be

produced from battery power or other DC power sources by employing DC to AC conversion devices. Inverters, converters, motor generators, and dynamotors are used for this purpose. Older-style inverters use vibrating reeds as interrupters. Modern inverters are solid-state. There are several problems of concern when DC-AC power conversion is employed. AC-produced waveform may be other than sinusoidal. Also, output of the power converter is frequently directly related to input voltage. As input voltage drops, the AC output voltage will also fall. At the same time, the frequency will drop. These unfavorable characteristics make conventional DC-AC conversion devices unsuitable as electric power sources for production lighting systems. Several manufacturers now offer specially engineered units designed to be used with HMI lights. Mechanical governors, often used with rotary power conversion machines, do not regulate speed (directly related to frequency) well enough to permit motor-generators to be used as HMI power sources.

Engine-driven electric generators are usually employed where larger blocks of power (over 2500 W) are required. Generator output voltage can be either DC or AC to meet the requirements of the particular lighting system(s) being used. Generating systems can be driven by engines using gas, gasoline, or diesel oil for fuel. Advantages and disadvantages of the various fuels are discussed. For almost all motion-picture and video applications, steady voltages are essential. And, when AC is used, frequency must be precise and stable. Methods used to accomplish stability of voltage and frequency are covered in detail.

Noise, both audible and of radio type, present problems on location. Radio noise (electromagnetic interference — EMI) can adversely affect audio, radio, and video systems. Audible noise interferes with sound pickup. There are potential fire and explosion hazards when engine-driven generators are "blimped." Means of reducing audible and radio noise, as well as safe "blimping" are discussed.

After reviewing this paper, readers should have a basic and practical understanding of reliable power sources to operate any style of lighting system requiring either DC or AC power supplies. They should be able to determine the kilowatt (KW) capacity of the generator(s) required and to spe-

cify the technical parameters needed for the particular lighting systems to be employed on location. Readers will be able to identify abnormalities and direct corrective measures necessary to insure performance equal to that available by using the best of commercial utility-company power sources.

49. Researching and Restoring Pioneer Talking Pictures — Commemorating the Seventieth Anniversary of the Theatrical Release of Kinetophone.
By Art Shifrin, Thomson-CSF, Stamford, Conn.

This presentation will try to clarify some of the obscure beginnings of sound motion-pictures. Within the past year, startling new information has been uncovered about Edison's work in this medium. This has been due to the splendid cooperation of the staffs of the Edison National Historic Site and of the Gramophone Department of the Swedish Radio Company. Two technical perspectives are pursued. One describes Kinetophone. The other explains the use of modern audio, film, and video technologies to generate picture and sound whose qualities are much better than are ordinarily presumed possible for productions as old as these.

Combinations of motion pictures and phonographs date back to virtually the beginnings of both. Edison's assistant, W. K. Laurie Dickson, described in 1933 a demonstration which he made to Edison on October 6, 1889. It was a crude servo between an electrically driven phonograph and "Kinetoscope" (projector). Other inventors shortly thereafter attempted to develop and exploit talking pictures. They even included precocious optical and magnetic methods. Ruhmer, Lauste, Reis, and Poulsen started their work prior to 1913!

Before 1930 there were three relatively successful film-phonograph synchronous systems. The last precipitated the demise of silent films. Begun by the West Street Labs of Western Electric, "Vitaphone" was a sound-on-disc system. It was first licensed to the Vitaphone Corporation which trademarked it. Vitaphone's theatrical debut was on August 6, 1926. It used electrically recorded, laterally cut 33 $\frac{1}{3}$ -rpm discs. The frames were full aperture and did not accommodate optical soundtracks. Synchronization among the cameras



Abdelnour Tadros and Max Berry chair the session on Television Post-Production.

and recorders was electro-mechanical. Playback was via a projector whose motor was geared to its turntable. Synchronous films were shot at the still standard 24 fps (90 ft/min of 35-mm film). Silent films were scored for playback at that speed, regardless of the rate at which they had been cranked.

A predecessor of Vitaphone was developed by Orlando Kellum. It consisted of laterally cut, acoustically recorded discs which ran at about 78 rpm. Because the recording horns were insensitive, the performers had to remain close by, so only tight shots were possible. Reproduction was also acoustic, so there were severe limitations on volume and clarity. Perhaps the most ambitious use of this process was during the spring of 1921 in D. W. Griffith's feature, *Dream Street*. This film contained synchronous sections which included a prologue spoken by the director.

The synchronous version of Kinetophone premiered at Keith's Colonial Theatre in New York City in February, 1913. Evidently, other film-phonograph systems (including an earlier Kinetophone) had used records made to accommodate previously shot films, or films shot to correspond to previously cut records. Clearly evolved from Dickson's 1889 experiment, the system used very large, acoustically recorded, vertically modulated cylinders. These were celluloid "prints" molded from electroplated wax masters dubbed through a mechanically amplified pantograph.

The artifacts uncovered in West Orange and Stockholm include wax and celluloid cylinders, metal moulds, documents, stills, equipment, and

films. Fortunately, we have cylinders for six of the seven surviving reels of film. Analysis of them is helping to reveal previously unavailable information. Both Edison's penchant for secrecy and a devastating fire at his plant in December, 1914 had conspired to conceal and destroy information about Kinetophone.

In January, 1908 Daniel Higham of Bridgeport, Ct. proposed by letter that he be retained by Edison to "perfect" talking pictures. He was armed with a patent for a mechanical loudspeaking amplifier which was necessary for theatrical exhibition. The cameras were driven by DC motors which governed the spring-driven recorders. Even sync slates were recorded at the head of each cylinder, which also included visual cue points. Playback was via a 220 V, DC-driven phonograph which was located behind or below the screen. It servoed the hand-cranked projector via a belt which ran back to the projection booth. The projectionist was part of the servo system, being ultimately responsible for correcting sync problems by advancing or retarding the cranking rate.

The process of recreating these films involves special playback methods and reprocessing. These include creating a completely new electronic cylinder playback system which circumvents the assortment of problems inherent in the original reproducers.

The picture components present equally challenging problems, primarily because they were shot at 16 fps (60 35-mm ft/min). The videotapes must therefore be derived via variable speed telecines. The picture is then reproduced at the correct speed without the stroboscopic effects of

"stretch" printing.

Some of the revelations contained in these productions include on-location recording, surprisingly accurate sync, and subjects consuming up to five reels! The repertoire includes vaudeville, operatic, dramatic, and documentary materials. Films for two of the most historically interesting cylinders have unfortunately not yet been found. They are lectures by Andrew Carnegie and by Thomas Watson, Bell's collaborator on the invention of the telephone.

This presentation, in addition to the videotapes, includes slides and audio tracks. The slides show the Kinetophone Studio and equipment, various kinds of cylinders, and some stills from Kinetophone films. The audio materials will demonstrate various kinds of recordings from that era to establish a perspective on their limitations and capabilities.

This research is supported in part by Ampex Corporation. Film restoration specialist Karl Malkames reprints the picture components. The videotape production is done at the Sound Shop and Reeves Teletape.

50. Film and Video: A Producer's Viewpoint. By Paul D. Mareth, Jura-mar Communications, Philadelphia, Penn.

This is a discussion of film and video production for educational and commercial uses. Special emphasis is placed on the growing interdependence of these two formerly disparate media, and the ways in which high-quality production values can be obtained on limited budgets.

50A. SMPTE Time and Edit Code and its Application to Motion Picture Production. By Michael Strong, World Wide Pictures, Burbank, Calif.

The application of the computer industry's achievements has led to improvements in many other industrial tasks. The television industry was one of the first to adopt available technology by generating a time and edit code which enables technicians to synchronise video tapes and to perform the many editorial tasks of assembling and displaying programs.

In a paper published in the August, 1976 *Journal*, the author describes a system for recording information for

multi-camera filming using a dedicated micro-computer. For this type of filming and many other synchronising needs, the motion-picture industry has started to apply the same technology which is found in supermarket check-out stands and banking, in conjunction with time code technology. The paper reveals the difficulties of this task and surveys present film production techniques. As chairman of an SMPTE working group studying the practical application of a 24-frame, 80-bit SMPTE time and edit code to motion-picture production, the author describes some technical barriers that have been crossed, to develop new ways of handling film.

Through a consortium organized by the Motion Picture Association of America, further steps have been made to involve many of the different crafts in the new tooling being developed. Both magnetic and optical technologies are discussed as well as the use of both in the new tooling. A survey of the changes and additions needed in applying the new technology are listed. The paper concludes with an appeal to each discipline of the motion picture industry to apply these techniques for greatly improved efficiency.

50B. Time Code on Film — A Systems Approach. By Ivan Kruglak, Coherent Communications, Inc., Sylmar, Calif.

This paper presents the following:

1. A comparison of optical and magnetic technology for writing SMPTE 80-bit time code on film.
2. The advantages of using time code from production of a film through the post-production and release stages.
3. Comparisons between traditional film editing and film editing with time code. Pros and cons of transferring film to video tape for editing purposes, along with some problems in negative-cutting and conforming the video tape to the original film.
4. A review of the types of new equipment required, such as modifications to existing cameras, tape recorders, and laboratory processing machinery.

Future Television Studio Design

51. Implementation of the Digital Component Video Standard — A

625-Line View. By J. L. E. Baldwin, Independent Broadcasting Authority, United Kingdom

There are many factors that differ from one studio complex to another, so there will be no generally optimal single method of implementing digital studios. Important factors are the age of different items of equipment, the replacement philosophy, the type of operation, the size of the total operation, the geographical distribution of equipment within a plant, possibly the geographical positioning of plants, and, of course, the financial and other resources available.

We do not know when the different items of component equipment will be offered for sale. Users tend to the view that there is no point in producing a digital component environment until a large range of appropriate equipment is available. This view is understandable but it is equally understandable that manufacturers are hesitant about introducing new digital component products for an environment which does not yet exist. It seems to be a typical chicken-and-egg situation with the implied question — which comes first? This question, as worded, cannot be answered directly; the important solutions will be those which make the question irrelevant.

Luckily, the situation is not so disastrous as it appears at first sight. Some equipment can only be realised satisfactorily in digital component form; at present this incorporates composite signal decoders and recoders so that they may operate in an analog composite environment. These include special effect and still picture storage equipment. Some of these use sampling based on 13.5 MHz, and there is a desire by users that certain items of equipment should be able to communicate directly using an agreed digital interface, yet to be defined. Once there is agreement it seems probable that there will be rudimentary component systems introduced. This will cause a demand for further associated equipment and progressive enlargement of the component digital system.

A possible alternative escape strategy from the analogue composite stranglehold is to adopt analog components. These may be time-multiplexed together and require a bandwidth increased in the ratio of about 2:3. It seems that nearly all analog equipment could be retained with little modification except for special effects.

It would then appear to be relatively easy to introduce digital component equipment in a piecemeal manner in this analog component environment. There would then follow a change of sections of the system from analog components to digital components until eventually the component digital studio became complete.

52. Some Concepts for the Digital Studio. *By Kenneth P. Davies, Canadian Broadcasting Corp., Montreal, Quebec, Canada*

The availability of the all-digital TV studio is eagerly awaited by many in both the technical and production sectors of the television industry. This is due to its inherently lower distortion of the picture and the potential for increasingly sophisticated picture processing.

This paper examines the impact of the digital approach on the key elements of the studio and develops some possible system designs and interconnection schemes appropriate for this major advancement in television technology.

53. Intra-Studio Distribution and Processing of Future Video and Audio Signals. *By Birney D. Dayton, Grass Valley Group, Grass Valley, Calif.*

Currently, there is considerable worldwide research taking place on improved-quality television. High definition is a major thrust, but better signal-to-noise and improved colorimetry are receiving attention also.

Most significant is the trend toward footprintless component rather than frequency-interleaved composite systems. The relative merits of digital, time-compressed component, and three-channel component systems as related to the studio environment are discussed in this paper.

The current trends in television audio are toward more signals and better quality, particularly in dynamic range. These trends are highlighted by the movement toward a stereo standard and the increased availability of digital audio recording equipment.

Future delivery systems, such as optical disc, DBS, and wideband channel cable, will be able to support much higher-quality video and audio signals than current systems are able to deliver.

Improved source-quality, coupled with delivery systems capable of better quality than current composite studio standards, will soon put pressure on the production environment to distribute and process a new genre of video and audio signals.

Distribution of digital video signals will be more easily accomplished in serial form than in parallel, due to a greatly reduced interconnect requirement. However, component digital system requirements for even current picture scan rates require serial data rates of 200–250 M baud. E.M.I. generation and reflections due to connector mismatch will be the major cabling obstacles to serial systems. Fiber optics may one day offer an economical solution to these problems, but current technology indicates a poor cost:benefit ratio. Digital distribution switching, on the other hand, promises

advantages in that current bipolar LSI circuits are capable of 300 ps gate delay, and future processes have been described that will allow loaded gate delays of 10 ps. Thus, the indication is that digital routing switchers, at least for systems not exceeding 300 M baud/channel, will be more compact than current analog switchers and probably will be limited in size reduction only by power and connector density.

Time-compressed analog signals will be the most compatible with present distribution systems, but for very high-definition systems, time-compressed signals will be increasingly sensitive to time-domain distortion.

Three-channel analog will be the only practical system for some time to come for several-thousand line systems, such as have been suggested for electronic cinematography.

Audio distribution, on the other hand, lends itself to a digital format for the distribution switcher environment. Some of the advantages of digital audio routing switchers will be compactness and random-channel mix for multi-channel systems. For systems where several conversions from analog to digital and back are desirable, relatively high digital sampling rates will be desirable in the interest of keeping anti-aliasing filter costs and group delays to a minimum.

For the video production switcher function, component coding, whether digital, time-compressed, or three channel, offers many picture-quality advantages over composite coding. Color matting improves dramatically in the absence of interleaved subcarrier, as does the visual quality of wipes and titles. Spatial image processing is practically possible only by component digital means, and the demand for spatial processing is on the increase. In fact, due to the trend toward spatial processing, the production switcher has the most impetus for a digital format of any element in the studio chain. Analog switchers, however, will be simpler and less costly for some time yet. This suggests that future analog video systems must be compatible with a component coded digital format without leaving a footprint. Three-channel component coding and time-compressed coding both fill this requirement.

The audio production console will have reason to stay analog for some time, in that audio, by its very nature, lends itself to frequency-domain processing in contrast to video, which is



Bill W. Peck presents a paper on Film-to-Tape Interface.

waveform sensitive. Digital audio consoles will probably take root only at the high end for some time, due to cost pressure from ever-improving analog systems.

In conclusion, as new standards development takes place, it will be of paramount importance in both audio and video systems, that footprintless format transitions from analog to digital and back be considered a basic requirement.

54. High Definition Television in the Future Television Studio. *By A. A. Goldberg, CBS Technology Center, Stamford, Conn.*

The concept of component television signals in digital form is driving the design of a new generation of studios. It anticipates a future when composite color encoding will be done just prior to broadcasting. These ideas have given rise to a family of digital component codes culminating in CCIR recommendations AA/11 and BA/CMTT.

Many broadcasters believe that major programs could be produced in a high definition television system employing greater bandwidth and more scan lines, yet be readily transcodable to signals recommended in CCIR AA/11.

The new spirit of cooperation among broadcasters made evident by the recent agreement in CCIR also raises the possibility that video programs could be produced with the same technical standards throughout the world. The family of digital codes can be extended when agreements are reached on the scanning format, resolution, aspect ratio, and convertibility to broadcast standards. Modern digital circuit technology will make it feasible to handle HDTV in the studio complex.

55. Television Studios of the Future. *By Eric Rosenthal and Robert Plath, ABC, New York, N.Y.*

As the number of commercial, cable, and public access outlets grows, the broadcasting pie is getting bigger, but it's being cut into smaller pieces. While the demand for products will grow, it will be for products aimed at market fragments, based on geographical, demographic, ethnic, and other special interests. Since the audience for each product will be smaller, production budgets will be corre-

spondingly smaller, and there will be more emphasis on producing programming as inexpensively as possible.

To meet these needs, the television studio of the future must accomplish three goals: it must be capable of a higher level of productivity so that the cost of the facility to each user is minimized, it must be flexible enough to be usable by a variety of types of programs, and it must contain equipment that reduces manpower costs.

In the area of rigging, movable lighting pipes can speed reset operations by clearing standing scenery so that striking can proceed unhindered, and by reducing the need for time-consuming ladder work by stagehands.

The ultimate in quick-change scenery is the old theatrical technique of flying scenery in and out, and I think we may see more studios being built to accommodate flying scenery either with manual, counterweighted, or motorized pipes. In the same vein, projected backdrops in lieu of scenery will be attractive from a cost standpoint.

The computerized lighting systems that are already widely used in the industry are designed to accommodate a quick-change application by means of their electronic cue storage.

The development of so-called high-density dimmers by a number of manufacturers and their associated lower price will end the use of patch panels in most studio applications. Aside from reducing the amount of time required for lighting calls and resets, manpower needs are also diminished. We have recently seen the development of digital dimmers. Eliminating the need for periodic trimming inherent in analog dimmers helps to reduce overhead costs.

Reliable, remote-controlled lighting fixtures could add to efficiency, especially if information concerning their placement and focus could be stored, in addition to their intensity setting, in the lighting system computer.

56. The New Production Suite: TV Master Control. *By James O. Monneyhun, Vital Industries, Inc., Hollywood, Calif.*

Data-processing techniques and post-production editing equipment are being introduced to TV-station master-control rooms, and the still current concept of master-control automation

that first appeared in the late 1960's is becoming outmoded.

The limited acceptance by the industry of master-control (MC) automation equipment was caused by burdensome data-entry requirements and the achievement of only marginal operational improvement. Although interfaces to business systems solved the data entry problem, the use of video cart machines made MC automation equipment even more marginal.

Ironically, the passage of time has found the video cart machines to be more often disparaged than appreciated, and the economics of commercial television has brought about the need for a new level of computerization that deals with the cart machine dilemma: too many stations do not want to operate with them, but can't operate without them.

A number of stations are using their cart machines to make "composite commercial reels" or "commercial dub reels" for use in prime time, in a manner reminiscent of the era in which daily splicing of film commercials was common. In this decade, the value of one lost commercial to a sold-out TV station is many times greater than it was a few years ago, when most stations could make good their missed spots.

The advantage of the composite reel is that it runs on a simpler and more reliable tape transport, and once it starts, it is very likely to continue to produce acceptable output throughout the duration of a four-announcement break.

The making of composite reels from individual reels is essentially an impossible task for some larger stations; only cart machines provide sufficient efficiency in loading and unloading the tapes. Even then, a significant amount of added work is necessary to accomplish the process of production and airing.

Thus, there is the need for a system that will automate both the composite-reel generation process and the air-time process, requiring only that an operator load and unload carts at the command of the system.

Not surprisingly, the way to automate these processes is to employ the same methods and equipment that have been used for years in TV post-production systems, including SMPTE time code generators, writers and readers, and tape servo controllers.

A system known as SAM, or Station Automation Manager, does precisely

that, using the station program schedule as the edit decision list for the basis of production operations. It will also automate production and air-time rolling of protection or backup reels.

But one should not stop at merely dubbing from cart to reel. There is still the need for "audio overs," slide tags, character generator inserts, and a few other effects. Inclusion of a production switcher, controlled by the computer, would provide for fully-assembled composite reels.

Next, we might consider total elimination of the cart machine. The composite reel is now two generations down from the original reels, which were dubbed to carts. If the cart machine were to be eliminated, one tape generation would be gained.

By adding some traditional data-processing techniques to the system, as well as some more post-production techniques, it becomes possible to eliminate the cart machines from the process, using instead a configuration of hardware and software that we can refer to as a Random Access Tape Library System.

This tape library system would store an inventory of 2000 commercials and public service and promotional announcements on perhaps ten reels of tape. A typical network affiliate could automate the composite commercial reel process to the extent that the ten library tapes would be loaded, one at a time, once each day; the rest of the operation could be automatic, except for the updating of the library reels, which would be a separate process. The minimum number of tape drives required is three: one for updating and playback, one for recording, and one for airing. Four tape drives, one providing a second recording unit, would enable the typical affiliate to generate two composite reels with only one pass through the set of library tapes.

Starting with composite reels that have been pre-recorded with time code, the system would do insert edits on the basis of having already examined the entire schedule which is to be recorded on that reel. An important point is that minimum stress is applied to the library reels, while the composite reels, which will only be used once, are made subject to almost all of the high-speed shuttling done by the system.

And thus, with this use of data processing and reel-to-reel tape units, the avoidance of complicated mechanical equipment, and the use of post-production editing equipment, TV stations can have a low-cost, high-reliability

alternative to video cart machines.

57. Panel discussion and response to questions from the audience on future television studio design.

Motion Picture Special Effects

58. Reverse Blue Screen Traveling Matte Process. By Jonathan Erland, Apogee, Inc., Van Nuys, Calif.

This paper outlines a new approach to the production of motion-picture traveling matte photography. A solution is demonstrated that overcomes the problems encountered when photographing models, when these incorporate surface finishes such as specular metallic or glossy paint, or when they include thin sections such as struts or antennae.

The recent wave of motion picture special-effects films, and the growing sophistication of the audience that the genre enjoys, have put an enormous strain on current traveling matte techniques; there recently have been some nineteen patents issued in connection with this one facet of cinematography. Most of these approaches, such as blue screen and sodium vapor, have been directed at the need to capture both the matte and the live-action foreground scene simultaneously. In the realm of model photography, the introduction of sophisticated motion controls permitted the shooting of registered sequential passes in what is known as the front-lit/back-lit system.

All systems, however, that depend upon an illuminated screen beyond the subject to produce a matte, are prone to the problem of reflected light, known as "blue spill." Additionally, very thin sections of the model tend to be "wrapped" by the light and drop out of the matte.

To counter these problems, Jonathan Erland and Roger Dorney turned the blue screen process "inside out." Instead of photographing an opaque subject against an illuminated screen, they developed a technique of photographing an illuminating source against an opaque background. This process differs from the familiar "front/back lit" process in that the subject itself becomes a source of radiation rather than merely a reflector of radiation.

This is accomplished as follows. A subject model is prepared in the usual way for photography. It is then coated

with a transparent medium containing a phosphor which is invisible in the absence of ultra violet radiation. The subject is irradiated with ultra violet radiation. The ultra violet light striking the subject is converted by the phosphor incorporated in the surface coating from 360 nm to about 430 nm and thus re-emitted as visible blue light.

The subject then functions as an illuminating source rather than as a reflector of light falling upon it. It is this source which is photographed. An ultra violet blocking filter, such as a Wratten 2E, is used at the lens to exclude from the camera the rather substantial amounts of ultra violet light which would otherwise effectively fog a color-film emulsion. The image is further refined by the use of a color-separating dichroic filter at the camera lens. The image is thus formed almost exclusively by the phosphor from the model itself. In this way, variations on the model brought about by paint color, texture changes, etc., are minimized, as the object is to produce a monochromatic image with as uniform a density as possible.

The resultant matte image has some substantial advantages over mattes produced by other means. There are fewer steps and fewer pieces of film required in the optical composition sequence of the process. Highly reflective or blue surfaces, as well as fine elements such as mesh, thin wires, struts, and wings of very narrow section can be incorporated. Even under some extreme conditions, such as a subject receding into the distance and becoming quite small, the image retains its integrity and refuses to disintegrate (as happens when the same shot is attempted via conventional blue screen). Still another advantage is the ability to better record the "streak" of moving subjects.

The procedure in the optical department is straightforward, fast, and economical. The original negative matte image is printed to a high-contrast stock via a blue filter. The reverse is then printed from this matte, completing the set. The first matte, or "burn-in," is bi-packed with a positive of the original negative, printed, and followed by a bi-pack of the background scene with the "hold-out" matte. Alternatively, a red phosphored backing may be provided beyond the model, and by the use of appropriate filtration, an image is produced that yields both the "hold-out" and "burn-in" mattes of the same genera-



Lab Practices II Chairmen Paul Kaufman and David C. Hubbell.

tion to each other. Further, a green phosphor image can also be recorded, and from the three different mattes, permutations, or "matte-difference-mattes," can be produced.

The process (a patent has been applied for) will be further refined and made available to the industry under license from Apogee, Inc.

59. The Film Stocks used for Optical Special Effects — A Range of Horses in Unusual Courses. By Roy Field, Pinewood Studios, England, and Tony Iles, Kodak Ltd., Hemel Hempstead, England.

This paper considers the wide range of film stocks used for optical special-effects work.

Each of the different types of film used has a particular application, which sometimes goes beyond the manufacturer's original intentions.

The color rendition and the definition in today's motion-picture films are extremely good, so it is essential that the optical work be invisible on the screen.

Optical trick work is called for with various types of film subjects. The "fantasy" movie is an obvious application. It is just as frequently used, however, to create scenes that would be too difficult and too expensive to film in the normal way. It is also very effectively applied to enhance sequences that have been filmed using conventional cinematography.

Examples of the use of travelling mattes and painted mattes are discussed, and also problems of matching

contemporary work with that from archival sources.

At least a dozen different types of film emulsion are in common use for optical work. Without this wide range it would not be possible to achieve the results that we enjoy today.

The properties of the different films used are described, together with the reasons for their selection and application.

The paper is illustrated with excerpts from *The Dark Crystal*, *Gandhi*, and *Outland*.

60. Computer-Generated Imagery for Theatrical Film Production. By Phillip S. Mittelman, Mathematical Applications Group, Inc., Elmsford, N.Y.

The hardware and software available for the production of computer-generated imagery have improved so rapidly in the past three years that it is now practical to generate theatrical-quality images by computer. That is, scenes can be shown in movie theaters on wide screens, and the fact that these scenes were totally generated by a computer process will not be obvious to most members of the audience. Further, the cost and time required to produce these scenes is generally less than would be required to produce them by any other method. Often the scenes could not be practically produced by any other method.

The first film to exploit the new technology was *Tron*, recently released by Walt Disney. The premise of this film is that the action seen on the screen of a video game is a represen-

tation of real action taking place in an alternate computer world. Tank battle video games are a representation in the computer world of battles between real tanks. Many of the special effects in *Tron* involving fantastic battles, chases, and other action scenes were totally done by computer simulation with pictures of live actors cut in at appropriate points to enhance the feeling of realism. *Tron* contains about 15 minutes of totally computer-generated imagery (CGI).

The creation of theatrical CGI involves the close collaboration of scene designers, animation choreographers, computer animation artists, computer programmers, and film technicians, all working under the guidance of the film's director and its creative director.

Different production companies work in different modes. This talk illustrates the approach to production taken at MAGI.

The scene designer creates a full-color, large-scale painting or rendering of the scene environment and of the objects which appear in the scene. The painting shows the lighting effect desired.

At this point, the creative director and animation choreographer work out a storyboard showing sketches of the key frames in the scene. Along with these sketches, they produce a commentary on the motion desired.

MAGI-SynthaVision directors (SDs) take over at this stage. They take the design of the environment and of the objects in the scene and model these using Boolean combinations of solid primitives. The models are input to a Perkin-Elmer 3240 computer. Light and camera locations are also specified and the SynthaVision program is directed to compute several views of the object and environment. These are viewed on a high-resolution Chromatics 7900 display in full color. When the SD is satisfied with the design, it is photographed at high resolution — 2400 lines — on a Celco CFR 4000 film recorder and/or the image on the Chromatics 7900 is transmitted by phone to another 7900 at Disney.

Once the object and environment designs are complete and approved, work starts on the scene choreography. SynthaVision has a Director's Language which permits the SD to specify the motion of objects, cameras, and lights in a simple English-type language. Working from the storyboards and scene narrative, the SD creates

input to the Director's Language that should result in the desired motion. This data is input to the program and a low resolution (about 190-line) motion test is calculated. The computer produces a series of black and white pictures showing each frame of the picture in a line drawing mode (without hidden lines) including the outlines of all shadows. This sequence can be photographed by the Celco and shown as a movie. More often, however, it is transmitted to the Chromatics 7900 and stored on eight 1000 × 1000 pixel memory planes as 2, 4, 16, 64, or 256 frames. Using a Chromatics animation program, the motion can then be viewed in real time or slower.

Appropriate modifications are made to the motion, and the data is then transmitted by phone to Chromatics at Disney. When approved by the scene choreographer, the scene is then computed at high resolution and photographed on color negative film at 71 lines/mm. All images are generated in a Vistavision format 1.485 in. × .667 in., similar in size to 35-mm slides. After development, the film is sent to Disney for final approval and incorporation into the final version of the film. In this final step, a sound track is added and live action is cut into the film at appropriate points.

61. Human Components of Three-Dimensional Reconstruction. *By Judson Rosebush, Digital Effects Inc., New York, N.Y.*

Although a body of literature exists on reconstructing three-dimensional objects and environments from photographs utilizing mathematical techniques, in practice the activity involves a considerable amount of human perception, juggling, and black magic. Thus, the focus of this paper is on the imprecise aspect of the activity — the part of it that doesn't quite follow rules, that makes up what just isn't there, and that makes what is there "better." Examples are drawn from the author's experience in a commercial computer-animation facility and covers situations that involve coordination with transitions to live action as well as static reconstructions.

62. Design, Diversification, and Integration of People, Equipment, and Technology Within a Special Effects Company. *By Robert M. Greenberg, R/Greenberg Associates, Inc., New York, N.Y.*

Specialized film production is a collaborative effort rather than a personal, individual art form such as painting. In film, artists and designers interact with production technicians to maintain creative control in each step from storyboard to completion. In an integrated production company, such as R/Greenberg Associates, members of both professional and technical staff — and thus the firm itself — perform diverse roles and functions, providing the broadest possible range of creative and technical capabilities.

The difficulty of starting such an integrated production company varies within the film and video industries. However, there is no more complicated a facility to develop than in the area of special visual effects. This is due primarily to the intricacy of combining the diverse technical and design skills necessary to create highest state-of-the-art imagery. In addition, equipment costs are astronomical, and there is always the risk of failure to produce.

Creative solutions begin with the designer. The successfully integrated company is structured to insure that key creative decisions come from the film designer rather than the technician. Eventually, an atmosphere of joint creativity evolves, in which technicians have become design-oriented and designers technically oriented — and all can speak the same film language.

Diversification can occur in the areas of both production capabilities and in the nature of projects. In film production, there is a need for a full range of technical options to insure that the work is at the optimum creative level and can also be completed on time and within the budget. The minute you go outside for opticals, as an example, you feel yourself at the mercy of a technician with whom the kind of design-directed communication you need is impossible. The same is true with animation, live action, motion control, darkroom production, editing, and computer-generated imagery; each must be an in-house capability.

Also, to fully capitalize on the industry's diversity, one has to be able to work in many areas of production. Logotypes, industrials, commercials, feature promotion, feature openings, and feature special effects all contribute to the company's visual vocabulary and keep the business running when one particular section of the industry is slow.

Finally, it is most difficult — and

most important — to integrate the creative team with technicians and production crews, and with equipment and computers. Introducing a traditional graphic animation designer to a computer-assisted animation stand is not an easy task. Introducing a person who is used to working with computer-aided animation production to a computer-generated image screen is even more complicated.

Of extreme importance is that the operating programs and equipment be designed for the designer, so that it is user-friendly and that the two areas of traditional animation are able to be mixed with computer animation or opticals, video, motion control, etc. The end result is the ability to achieve an endless range of visual images.

When this creative technical interaction works, a most difficult and risky business can also become a most exciting visual art form.

63. Digital Special Effects. *By Lance Williams, New York Institute of Technology, Old Westbury, N.Y.*

Digital computer technology has begun to make substantial inroads in commercial and special-effects animation. The spectacular results made possible by digital computers may have a new and different look which distinguishes them from the more familiar optical, mechanical, and hand-drawn methods. As yet, however, the new technology is little known; the digital animation technique appropriate to a given project may be difficult to select from the various commercial computer-animation shops, whose approaches vary greatly.

It is instructive to characterize what kind of animation a digital computer can produce by the kinds of information it is programmed to manipulate. The kinds of information can be usefully organized by their basic geometry. Animation can be performed with points, lines, areas, surfaces, and volumes. In this hierarchy, the complexity and expense of animation increase with the dimensionality of the data. The expressive power of animation is still very much the responsibility of the artist, but an overview of the various digital techniques can be very helpful in composing a particular sequence or effect. For many applications, conventional methods may prove quicker and more economical. To realize the unique power of the digital approach it is necessary to choose the application carefully.

Television Audio

65. A New Generation of Voltage Controlled Gain Elements and Their Impact on Audio/Video. *By Paul C. Buff*, Valley People, Inc., Nashville, Tenn.

The future holds a tight marriage between audio to video. Instead of television and stereo, living rooms will be dominated by the "AV," or audio/video center. In addition to being fed signals from conventional television transmissions and phonograph records, input will come from VCRs, videodisc, satellite, DAD (digital audio disc), and many other sources. We are at the threshold of an explosion of audio/video techniques.

The sound which accompanies the picture will no longer come out of a 4-in. speaker. Rather, it will exit from the same high-quality speakers used for reproduction of the finest audio sources.

Increased AV production to feed these many sources will require new state-of-the-art facilities technically equal to or better than the finest present-day audio-only studios.

These facilities should be cost effective, no more expensive than what we already see not only in the initial equipment cost, but also in costs associated with operational complexity, or programming time.

The scenario for the future is more sound/less cost, more manipulation/less operational complexity, and more control/fewer controls.

These objectives are currently being satisfied via the replacement of redundant mechanical control with either voltage-controlled or digitally-controlled elements. This paper examines that important link between audio signals and the non-mechanical means of controlling them.

Some of the limitations of digital parameter controls are discussed, and methods are outlined wherein analog form signals are controlled by voltage-controlled elements, with the required control voltages generated either by man or machine, by either analog or digital methods.

An in-depth study of the advantages of hybrid controls, primarily as they apply to currently available hardware, is also conducted.

In demonstrating the relationship between redundancy reduction and signal quality, it is shown how one inexpensive voltage-controlled element can be used to simultaneously perform the following control functions, thus definably reducing the signal flow path: channel gain, master gain, grouping sub-master gain, mute and solo, limiting, compression and expansion, panning, noise reduction encode/decode, related gain control functions, and automation.

Additionally, emphasis on the advantages of logarithmic domain control voltages is discussed in detail.

In conducting the study, a complete analysis of system performance is made, covering the noise and distortion levels obtainable, as well as the importance of the less publicized parameters such as slew rate, control rejection, modulation noise, and control range/linearity.

While implementation in future systems is the keynote of this paper, the technologies and hardware defined are available on the commercial market, at low cost.

66. Digital Audio Signal Interfacing — A Progress Report From the AES. *By Alastair M. Heaslett*, Ampex Corp., Cupertino, Calif.

Since the formation of Working Groups under the auspices of the AES in November, 1981, a number of Working Group meetings have already been held. This paper is intended to review these activities and comment on the progress achieved thus far.

The issues involved require the reconciliation of a wide range of operational needs. On the one hand, broadcasters wish to continue using copper inter-connects already in place, and in some cases to improve on utilization by passing stereo signals down one wire pair. In addition, there is the desire to run up to 500 meters with no repeaters. On the other hand, the recording studio user wants the degree of flexibility afforded by one channel per wire pair. Such a user typically needs to run only moderate distances of 20-30 meters, but would also like multiple-channel per connector architecture to facilitate the usage of equipment that may have as many as 32 or 48 channels.

The AES Working Group on digital I/O interfacing has, as its initial goal, the specification of a format and line protocol for usage of a single-shielded twisted pair of interconnects. The connector used must also be recom-

mended. Future tasks may include a multi-pair connection recommendation as well as the potential usage of fiber-optic systems.

The AES must work closely with other representative bodies, such as SMPTE and the EBU to take account, wherever necessary, of the needs of other segments of the audio community.

The Working Group membership therefore includes official representation from both the EBU and SMPTE, as well as an eclectic variety of other interests in the audio field. At the time of writing, certain elements of the format have received a reasonable consensus. Some of these are:

1. The format should permit 20 audio data bits per sample to be transmitted, with a user option for four additional bits.
2. There should be at least one bit-sample available to form a user bits frame of channel and other status information.
3. The channel code used should be self-clocking and polarity independent.
4. The basic line protocol should utilize shielded twisted-pair cable at impedance and voltage levels similar to RS-422.

The paper discusses the thinking behind these and other issues. In addition, the areas still to be resolved will be examined in light of the most current discussions within the Working Group.

The two proposals being considered are discussed. The first, jointly supported by Sony, Studer, and the EBU, would permit one, two, three, or four channels of audio data to be multiplexed on one wire pair. The second, from Mitsubishi, would have only one channel per wire pair, and calls for a different channel modulation code than the first.

67. A Triphonic Sound System for Television Broadcasting. *By Emil Torick*, CBS Technology Center, Stamford, Conn.

Synopsis not available at press time.

68. Modulation Analysis — A Statistical Approach to Audio Measurements. *By Eric Small*, Modulation Sciences, Inc., Brooklyn, N.Y.

Historically, measurements of audio system performance have been measurements of linearity. Sine wave fre-

quency response, total harmonic distortion, various types of intermodulation distortion, and signal-to-noise ratio all characterize linearity as the major performance parameter of an audio transmission or storage system.

Nonlinear audio systems are proliferating. Noise reduction for recording, analog and digital companding for satellite circuits, and compression and limiting for broadcasting are examples. Such systems cannot be characterized by measurements of linearity. For example, one well-respected FM broadcast signal processor produces 23 percent SMPTE intermodulation distortion, yet subjectively it is regarded as a low-distortion device. Because the transfer function of nonlinear systems is program dependent, they can only be characterized by program or program-like signals. Program material, especially music, is statistically complex. It is random and non-stationary and its amplitude is logarithmically distributed. Such statistical characteristics are sensitive to the effects of nonlinear processing, and even a small amount of processing can produce dramatic changes in the statistics of the signal.

Modulation Analysis (MA) is a set of techniques for characterizing an audio program signal using statistical methods. By sampling the signal thousands of times each second and keeping track of the amplitude and frequency content with the aid of a digital computer, measures of the program material for loudness, amount of processing, dynamic range, and stereo separation can be calculated. By observing the same program material through two different paths, e.g., in-studio (reference) and off-the-air, the frequency response of the channel being studied can be estimated.

An important application of Modulation Analysis is in the development of state-of-the-art audio processors. It provides near instantaneous feedback to the designer on such parameters as loudness, peak-to-rms ratio, dynamic range, and average effective frequency response.

When MA is factored into a comprehensive evaluation framework, different processor designs can be compared more accurately and with greater objectivity than has been possible before.

Another application is real-time monitoring of satellite program channels. By comparing the up and down



Peter Custer speaking on Motion Picture Sound at the Ziegfeld Theatre.

link signals using MA, the vital audio parameters of the link can be displayed while the circuits are carrying normal programming.

69. A Program Level Meter with Simultaneous Display of the Peak Amplitude and Average Persistence of the Complex Audio Waveform. By Richard W. Burden, Richard W. Burden Associates, Canoga Park, Calif., and Michael Dorrough, Dorrough Electronics, Woodland Hills, Calif.

The VU Meter (ANSI Standard C-16.5R, 1961) was standardized in the 1930's. It was developed out of the necessity to define program levels, under dynamic conditions, for the broadcast-telco interface.

The VU Meter is basically a voltmeter with specific meter ballistics, calibrated in power. This device provides ballistic movement relative to the average acoustical power of normal unprocessed program material and is useful in setting program levels. However, certain compensations, such as riding dialogue 3 to 5 dB below music levels, are commonplace.

The development of transistor technology placed greater emphasis on the nature of the peak amplitudes and demonstrated a need for an alternative indicator.

The PPM, popular in Europe, has a meter ballistic which has a risetime thirty times faster than the UV Meter.

This meter ballistic allows for indications of peak amplitudes normally ignored by the VU Meter, hence its usefulness in providing information with respect to system headroom. There is merit in both the VU and PPM approaches to the measurement of the complex wave. However, each indicates only part of the information required, and thus demonstrates some anomalies, which result in erroneous indications of the individual interpretations of the complex audio signal.

Equal energy, properly weighted for program material, will be discerned as equal in loudness. Since energy can be displayed as a function of amplitude and time, the use of an oscilloscope will confirm that large amplitudes of short tone bursts will be equal in loudness, as perceived by the ear, to longer bursts of lower amplitude. Basically then, there is a need for an indicating device which will display both the recurrent or persistent value of the waveform, as well as its peak value.

The complex audio signal on an oscilloscope will display the peak excursions of the program material. The use of an oscilloscope with a variable or long persistence CRT will show additional information relative to recurrent amplitudes, which is displayed by the persistence of the screen as a band of energy at the center of the screen. It is these two pieces of information which provide the composition of an acoustically related visual indication of the

complex audio signal. It is on this principle that this Program Level Meter was developed.

This Program Level Meter consists of forty LEDs mounted in a single arched scale, so that it can be easily related to existing metering forms. Circuitry permits amplitudes of short duration to follow a path which will illuminate a single LED indicating peak level, while amplitudes of longer duration follow a different path, which illuminates a series of LEDs in bargraph form. The display has two reference points, one for peak and one for persistence. Persistent amplitudes are displayed by a bargraph, with the peaks displayed by a series of single LEDs which ride above the varying bargraph.

Loudness perceived by the ear from source to source is thus determined by the amplitude of whichever circuit, peak or persistence, is first to illuminate its respective reference of red LEDs.

Therefore, this metering concept becomes useful in those applications where there is an integration of sources, which have differing amplitudes, responses, and compression characteristics, by enabling the operator to ride program levels for equal loudness content.

70. Designing A Mobile Audio Facility. *By Steven R. Colby, WGBH Educational Foundation, Boston, Mass.*

This paper is a discussion of how we approached the philosophical and design considerations of constructing an audio control facility for remote production.

Because of WGBH's pioneering role in stereo simulcasts and remote broadcasting, we saw the need for a dependable location audio facility. In addition, the industry trend toward the live location work that has such a special public appeal indicated to us that rental of such a facility could generate income for our foundation.

Our primary design considerations included choice of enclosure, versatility in function, internal system flexibility, speed and ease of set-up and strike, as well as trouble-free interface with AC power and sound reinforcement systems. Further, experience had shown us that operator and client comfort were strong considerations.

The choice of an enclosure for the mobile involved a detailed examination of the three suitable types of motor vehicle: straight truck, tractor-trailor

combination, and motorcoach. Our main points of comparison included convertible space, engine type, suspension systems, and general dependability. After much investigation into the options and a thorough study of existing mobile units, we settled on the motorcoach. Our study revealed that a motorcoach clearly provided the best suspension system, most usable space, highest appeal, and serviceability for the initial investment of all of the vehicle types examined.

The versatility in function of the facility was an important issue both in terms of being able to effectively deal with the many kinds of productions that WGBH involves itself in and in being able to offer a broad variety of audio services to prospective clients. A poll of the many types of program producers was conducted concerning their production needs of the past and their projections of future technical requests. We discovered a need to design a vehicle capable of satisfying the demands of television, radio, simulcast, cable, film, and recording industry projects.

Much effort and expense were invested in creating a system with high internal flexibility. Accomplished mainly through the use of extensive patching and switching networks, the three major benefits of such flexibility are ease in reconfiguring signal flow to client preference; quick and dependable equipment addition, bypass, or replacement; and the creation of multiple test points for diagnostic and alignment purposes.

Since set-up and strike phases of a typical large-scale location project are frequently costly in terms of time, patience, and money, any mobile unit features or procedures that reduce the time involved before and after the actual program become marketable points to both technical and financial people. To accomplish the desired results, we concentrated on methods of storage for equipment and cabling, accessibility of storage space, use of custom cabling systems, and multipin interfaces, external accessibility of internal systems, effective communications systems, and auxiliary power systems to provide AC power prior to land line hook-up.

Another major area of concentration revolved around dependable and speedy methods of interfacing the audio mobile with the location land power source. Typical problems such as varying available line voltages and noise from in-house lighting dimmers,

kitchen equipment, etc., were solved with the installation of a large capacity, multi-tap primary isolation transformer with electrostatic shielding. A comprehensive metering system provides information on voltage and amperage of the incoming line and of each leg of the on-board distribution system.

Interfacing with sound reinforcement systems or other radio or television production control points is a common demand of a location production. Since the responsibility for splitting the large numbers of microphones used on musical events, awards programs, and many other productions usually falls to the remote company, much time was spent developing a splitting system that was quick, effective, and easy to use. Housed in sturdy road cases that protect the units in transit from the mobile to the stage, our splitting system provides two isolated and one direct feed from each of 40 microphone inputs. Multiple stage input boxes can be placed around the performance area and looped together with multipair cable to help keep single microphone cable runs as short (and neat) as possible.

Since the mobile facility's completion in early May of 1982, it has enjoyed a highly successful track record, completing both internal projects (Evening at Pops-1982 Series; recordings and mixdowns) and servicing out-of-house clients in the radio, cable, and domestic and foreign broadcast television markets.

71. Cancelled.

Projection Practices

72. Imax® and Omnimax® Theater Design. *By William C. Shaw and J. Creighton Douglas, Imax Systems Corporation, Oakville, Ontario, Canada*

Imax® and Omnimax® motion-picture systems were developed to create motion-picture images of superior quality and audience impact. These high-fidelity images, accompanied by high-fidelity multi-channel sound, involve the viewers with the motion picture and with each other in a way that puts everyone in the picture. This strong sense of reality is achieved by reducing or eliminating the various "clues" which normally remind the



Roy Field presenting a paper on Motion Picture Special Effects.

audience that they are watching a motion picture.

Significant features of the Imax® and Omnimax® theater and system design include screen-to-audience relationships which provide every viewer with a very wide field of view. The rear seats in the theater are very close to the screen by normal standards. The bottom of the screen is placed so that the audience can look down as well as up and to the sides. The film format is very large (ten times the 35-mm format area) to produce a grain-free, sharply defined image for all viewers. The projector is especially designed to handle the large format with excellent image stability. Picture contrast and brightness are maintained at a high standard through special attention to screen and illumination system design.

The Imax® system presents motion pictures on a screen which is rectangular in shape and slightly curved. The image occupies a 60° to 120° lateral field and a 40° to 80° vertical field for the viewers.

The Omnimax® system presents motion pictures on a dome screen (typically using about 80% of a hemisphere). In this type of theater, the image occupies a lateral field of view averaging 180° and a vertical field of view averaging 125°.

For the Imax® format, the minimum eye-to-screen distance is .35 times screen width and maximum distance to the last row equals the screen width. Center seat eye horizon is in the range of .28 to .33 percent of

screen height, corresponding to the usual horizon height in Imax® picture material. Seating is curved so that outermost straight-ahead eye positions are aimed at the 0.25 width and 0.75 width points respectively.

The Omnimax® system uses a fish-eye lens with an included beam angle slightly in excess of 180° and an Omnimax® theater is characterized by a tilted dome, typically in the range of 25° to 30°; steeply raked unidirectional seating; star projector and other projection equipment positioned to avoid sight-line interference, producing a strong sense of "space." The Omnimax® motion-picture capability is used to provide enhanced program possibilities, including underwater, terrestrial, and space travel.

The relatively high seating areas for both Imax® and Omnimax® theaters mean that projection ray clearances over the heads of the seated audience, particularly in the front rows, are very tight. We habitually work with minimal clearances over railings, etc., at the front of the theater.

A significant problem in dome theaters is cross-reflection and consequent loss of contrast. To minimize this, it is necessary to use screen gains considerably less than unity. The improvement can be easily demonstrated down to a gain as low as 0.25, and screen gains in the range of 0.3 to 0.4 represent a good compromise. Both motion-picture and star projection benefit from the improved contrast, but projectors must provide sufficient light output to operate with such low-gain

screens.

Omnimax® was developed specifically to provide a film projection system for planetarium-type domes. After the system was demonstrated, we were surprised that some clients (e.g., Caesars Palace, Las Vegas) chose Omnimax® for installation where there was no need for and no thought of ever having a planetarium "star show." They simply liked the big picture. People seem to divide into two groups: those who prefer the sensation of being surrounded by the Omnimax® picture and those who prefer the resolution and steadiness of the "large enough" Imax® picture.

The high-fidelity sound which accompanies Imax® and Omnimax® presentations uses a conservative approach: a dedicated double system 6-track reproducer, wide magnetic tracks on 35-mm full-coat stock, large amplifiers (typically 100 to 400 W per channel, with at least 10 dB of headroom above 95 dBA), and large high-quality speaker systems. There is usually a sub-bass system operating in the 20 Hz to 80 Hz range.

Since a relatively "dead" environment enhances intelligibility, as well as the ability to identify the location of the sound source, the reverberation time for Imax® and Omnimax® theaters is specified in the range of 0.5 to 0.7 seconds, which is quite short by usual standards.

One interesting recent development is the "disappearing screen." At the American Museum of Natural History here in New York City, a screen 67 ft wide by 41 ft high can be caused to "disappear" along with the loudspeakers behind it, all in a matter of a few minutes. This was achieved using a foldable vinyl screen fabric, a support boom which we designed, and a tensioning system on which Imax® has patents pending. The screen is stored with its boom in a 2 ft X 4 ft trough a little longer than the width of the screen and built into the front of the stage. This relatively large screen can be raised and stretched flat in a little more than 3 minutes.

Imax® and Omnimax® represent a new direction in motion-picture technology, and seem to fill a real need in the fields of entertainment and education.

73. Performance of the 1200-W Brite Beam Arc Lamp. By Philip B. Newell, GTE Products Corp. Salem, Mass.

The BB1200/PAR 64 lamp, the newest in a series of arc light sources for studio, theater, and TV (STTV) lighting consists of a mechanically modified 1200-W Brite Arc lamp mounted in a standard PAR 64 pressed-glass parabolic reflector which is coated with a hard, non-conducting interference filter. The unit is hermetically sealed with a clear convex lens and equipped with a Mogul bipost base.

In operation, the lamp emits light with a color temperature greater than 5000 K and a color rendering index in excess of 90. The lamp is suitable for use as a daylight fill, or as a daylight substitute in applications such as TV or motion pictures where color and color rendition are critical. The lamp produces light with an efficiency approaching 50 lm/W in the beam, a factor of greater than three times that of the incandescent PAR 64.

When incandescent PAR 64's are filtered to daylight colors, the light loss ranges from 50 to 70 percent. Thus, for common daylight photography, the efficiency gain of Brite Beam over incandescent PAR 64's is about seven times. The high efficiency not only reduces power costs but reduces labor costs for transportation and installation particularly in on-site use.

The rated lifetime of the lamp is 1000 hours, a value exceeding that of the arc itself. The increased life is due to the fact that the seals of the arc tube are protected by the inert atmosphere within the PAR structure. It should be noted that the useful life of VNS operation is limited by natural aging of the arc tube. As the inside surface of the arc tube devitrifies, the apparent source size increases and the beam becomes larger.

The lamp can be used with a set of four auxilliary lenses which also function as protective faceplates in outdoor fixtures. In addition, the lenses modify the beam from a very narrow spot (VNS), through the range of narrow spot (NS), to medium flood (MF), to wide flood (WF), according to the application. With the clear lens (VNS) the lamp projects a $7^\circ \times 9^\circ$ beam with a center-beam intensity approaching two million candela. Thus, the VNS is well adapted to applications requiring a particularly long throw such as portable lighting for news gathering, arenas, etc.

The MF lens is expected to be the most widely used. It projects a $22^\circ \times 15^\circ$ beam intensity in excess of 500,000 candela. In this configuration,



Denise Tomlinson presents a paper for the Lab Practices II session.

the lamp produces more intensity everywhere in the beam than does a 1200-W Brite Arc or HMI in the traditional Fresnel lantern projector operating at full spot. This substantial improvement in beam efficiency comes about as a result of the precise curvature of the reflector optics as well as the superior reflectance of the dichroic mirror.

An absolutely necessary feature of arc lamps for STTV use is the ability to hot restrike at will. This is made possible in the Brite Beam lamp by the non-conducting dichroic interference mirror, which will not short out the re-ignition pulse.

74. Diagnosis of 35-mm Film Projection Defects with Test Film #35-IQ (RP-40). By Glenn M. Berggren, Optical Radiation Corp., Azusa, Calif.

Prior to 1971, test films available from the SMPTE were made to cover a host of purposes, such as image dimensions, jump and weave tests, and leveling. But a high-definition test film, which made a diagnostic test and direct measurement of image transfer quality at various locations on the film, had not been designed and made.

In 1971, the all-new 35-IQ test film (described in RP-40) was first offered for sale in place of the older APAL (all-purpose alignment) test film. The new test film offers an additional set of advantages in the image quality area, plus other test features, so that test

results lead directly to usual adjustments and also indicate defective equipment. In addition, it provides results in simple numerical form. This permits installation technicians and equipment dealers to recognize the differences in types of equipment for future recommendations. It also permits manufacturers to utilize a test film as a final test instrument in research and development programs, should image quality be a part of the development.

As a new yardstick, the 35-IQ (RP-40) test film has opened a new era in the ability to improve the screen-image quality of projection equipment. This technical paper indicates the reasons for the design of the test film pattern, the basic uses for image dimensions, jump and weave testing, and leveling. Projector gate adjustment, color aberration testing, and correct adjustment for anamorphic (optical) attachments is also discussed. The test film is designed to permit measurement of errors in lens/film curvature fit, and to create the Lens Focus Curve for an installation. Even film curve can be tested and charted.

Some research and development situations are offered, plus graphs of total projection system performance. Even film curve can be tested and charted. Suggestions are made for revisions in the 35-IQ (RP-40) test film to improve testing applications.

75. Screen Image Illumination of

35-mm Film Projection. By *Joseph Kelly*, United Artists Theatres, Meadowbrook, N.Y., and *Glenn Berggren*, Optical Radiation, Azusa, Calif.

The United States has dominated the technical field in film for decades, with progress in both film production and projection standards. In film projection, one of the prime standards is screen light. Although much of the world is standardized near 11 fL (as was the US in 1950), the US standard is 16 fL with appropriate center and side tolerances.

How did these standards develop?

What are the limitations of film projection that tend to position the screen light at 16? How can they be changed? What are the ISO standards as compared to those of North America and other continents?

What tests were conducted to develop the PH22:124-1970 to a state beyond that of earlier light standards?

How can the U.S. next move toward a better light standard?

What equipment changes have aided improved screen light since 1960?

What is the state-of-the-art in stabilizing screen light for different formats and different types of equipment over the run of a particular picture, or during the operation of a theater for months or as much as a year?

What are the allowances for changes in light-producing items, electrical variations, etc., so that the standard can be met for normal operations? Do special films such as 3-D features change the light performance of the theater up or down?

This paper provides examples of theater test data with the usual variations. Good theater planning is compared to poor practice, and suggestions are made to avoid serious screen light problems. Maintenance plans are also discussed.

76. Screen Image Contrast — State-of-the-Art — Data and Proposed Test Standard. By *Robert Pinkston*, United Artists Theatres, Dallas, Tex., and *Glenn Berggren*, Optical Radiation, Azusa, Calif.

This paper discusses the problem of screen image contrast in motion-picture theaters. General trends of theater design and operation have tended to

reduce, not improve, screen image contrast. Does the public know — and is it readily noticeable — when the contrast is much higher in one theater than another?

Actual theater tests are included; comparisons of different equipment are made purely on the data of contrast. Suggestions of upper limits of contrast are made, plus estimates of typical versus unusual theater contrast factors. The control factors are cited, and recommendations are made for general application. A recommendation for an industry Contrast Standard is also made.

77. Tape Splicing of Theatrical Release Prints. By *Paul H. Preo*, Eastman Kodak Co., Rochester, N.Y.

With the advent of large-capacity film reels and platter systems, the use of tape splicing has emerged as the preferred splicing method because tape splices, unlike cement splices, can be disassembled and remade without the loss of film. Furthermore, tape splices permit the splicing of dissimilar film-base materials and films containing post-process coatings.

This paper describes the various tape-splicing methods and equipment needed to make proper tape splices. The paper also discusses the techniques used to make tape splices on existing cement splicing equipment as well as with equipment specifically designed for tape splicing.

78. Projection Performance of Theatrical Motion-Picture Films Using Xenon Short-Arc Lamps. By *Paul H. Preo*, Eastman Kodak Co., Rochester, N.Y.

There has been a rapidly increasing conversion from carbon-arc lamps to xenon short-arc lamps in theatrical applications. This study reports an evaluation of the projection performance of 35-mm color prints using the xenon arc.

The physical performance and screen-image quality of theatrical motion picture film is highly dependent on the level of incident radiant energy at the projector aperture. With the growing tendency for large-capacity film projection systems, the carbon arc is being replaced by the continuously burning xenon-arc lamp. The small size of the illuminance source permits the use of highly effi-

cient mirrors that can produce a highly concentrated, radiant-flux density at the projector aperture. As a result, misadjustment of the xenon-arc lamp may adversely affect screen image quality and cause physical damage to prints.

Current studies have shown that when manufacturers' recommendations are not followed in an attempt to increase screen luminance, radiant-flux densities can exceed the safe upper limit by a factor of two. Under these conditions, color films will exhibit flutter and in-and-out focus in the screen image. Prolonged projection under these high flux densities can lead to permanent color-print damage in the form of scorching or emulsion layer separation. Black-and-white films will blister at even lower flux-density levels.

Data generated during the study illustrate the effect of arc lamp adjustment on the radiant-flux densities and the subsequent projection problems and film damage that can result.

79. The Whys and Wherefores of Film Damage (A Photographically Documented Report of the SMPTE Working Group on Motion-Picture Entertainment Film Damage). By *John P. Pytlak*, Eastman Kodak Co., Rochester, N.Y.

In May 1979, a "Study of Motion Picture Entertainment Film Damage" was begun by a working group of the SMPTE Theatrical Projection Technology and Applications Committee. Distributors, film laboratories, exchanges, and theaters were visited in the United States and Canada. Incidents of film damage, and probable causes of film damage, were documented with interviews and hundreds of photographs. The study identifies many sources of 35-mm print film damage and recommends constructive changes to alleviate film damage.

This information was first presented to the Intersociety Technical Committee for the Enhancement of Theatrical Presentation, and at the National Association of Theatre Owners (NATO) Convention.

79A. Guidelines for the Design of Effective Cinema Theaters. By *William Szabo*, Will Szabo Associates, New Rochelle, N.Y.



Paolo Zaccarian and Donald Musson during the session on International Television Technology.

Modern cinema audiences are demanding that theaters in which motion pictures are presented provide optimum conditions for their involvement with the film producer's art. Effective presentation of motion pictures requires that the architectural environment be as carefully designed as the projection and sound systems are. After reviewing the popular film formats in use today, the paper discusses the architectural elements which influence the presentation of motion pictures, suggesting suitable design methods and offering criteria to be met. Included in the discussion are: (1) the interrelationship between film format, screen size, audience seating and projector location; (2) seating slope and row configuration in relation to visibility and comfort of the audience; (3) acoustical criteria for modern cinema theaters; (4) architectural considerations relating to audience circulation and comfort; and (5) criteria and standards for contemporary film projection and sound reproduction.

A companion paper discusses current cinema theater practice and the commercial restraints placed on optimum cinema theater design.

Television Production

80. The Camraprompter in TV and Film Productions. *By Roy Zeper, Roy Zeper Productions, Clearwater, Fla.*

This paper explains the various components of the new TV and film

Camraprompter and what they do. There will also be a presentation of slides to show:

1. How to make a simple "instant insert" device to use with the unit for quick news flashes for the smaller TV stations; this is also ideal for TV reporters on exterior locations talking to the camera lens, and for short talking-to-the-camera commercials;
2. How to make a guide for composing long scripts in straight horizontal lines with uniform-sized lettering;
3. How to mark up a base plate for instant recognition of the proper holes for various cameras; the base plate has a series of holes for mounting the camera at the proper distance to the Camraprompter, also a series of threaded holes for mounting the camera on the tripod.
4. How to make a right-angle accessory plate so that the Camraprompter may be mounted onto a separate tripod or stand, permitting its positioning in front of any film or TV camera, whether on location or in the studio. It can also be used as an off-camera prompter;
5. How to employ an inexpensive 12-V DC unit (such as Radio Shack's regulated 12-V converter) where 115-V source is available;
6. How to apply a cue-mark for centering the script for the operator and for the speaker;
7. How to attach the script quickly to the take-up roller.

Slides illustrate all of the above, as well as the Camraprompter in use under a variety of situations in various productions.

81. The Use of Sealed Lead-Acid Battery Systems in ENG/EFP Applications. *By Dean D. Schneider, Portable Energy Products, Inc., Denver, Colo.*

Over the past five years, sealed lead-acid battery systems have been used in broadcast as well as industrial/documentary applications as power supplies for video cameras and recorders, motion-picture cameras, and portable lights. Large numbers of these battery systems have also been purchased by the U.S. government for use in high-speed applications.

The outstanding features of no "memory" development, worry-free charging, and excellent cold weather operation have made these battery packs and battery belts popular with many TV stations and producers throughout the continental U. S., Alaska, and Canada. The use of these cost-effective, high-performance, sealed lead-acid battery systems in ENG/EFP applications is steadily gaining even wider acceptance.

The building-block of a sealed lead-acid battery is a dry lead-acid cell, featuring a truly sealed design which incorporates the recombination of gases within a "starved" electrolyte system. No acid or vapor is vented from the cell, which is constructed with thin, spirally wound, pure lead plates for low impedance, low corrosion, and long battery life. The cell may even be punctured, and it will not leak fluid. And there is no loss of electrolyte during normal overcharging. The self-rescaling safety valve will vent under abusive overcharge conditions at an internal pressure of about 50 psi.

There are many advantages inherent in the use of sealed lead-acid cells in the construction of portable battery packs and belts for ENG/EFP applications. Low internal impedance allows very high discharge currents. Sealed lead-acid cells have absolutely no "memory" effect. They have excellent mechanical and vibrational strength. They can be charged or discharged in any position; and their exceptionally low self-discharge rate permits on-the-shelf storage for years. In addition to their superior charge-retaining capability, lead-acid cells generate 2 V/cell. Fewer cells are therefore needed to supply any desired voltage, with greater reliability. Cells can be connected in series or paralleled for additional capacity. Cells are currently available in 2.5, 5, 10, and 25 Ah

ratings (12-Ah cells will become available by the end of 1982).

Long-lived sealed lead-acid batteries can have up to 2000 charge/discharge cycles, depending upon the depth of discharge. They can easily be charged with either constant current or solar chargers. Sealed lead-acid batteries function in a temperature range of -65°C to $+65^{\circ}\text{C}$.

High-performance two-step chargers offer desirable characteristics for battery life and recharge performance. Hysteresis-loop chargers are, in fact, two-step constant chargers that automatically sense and supply battery requirements. The chargers automatically start up at a high rate and display automatic turn-on if the battery voltage is low. Charge rate is automatically reduced when the battery is approximately 95 percent charged. An illuminated red LED indicates high-rate charging. As the battery approaches its fully charged state, the LED lights intermittently to indicate that the charge is now cycling between high and low charge rates. This feature permits leaving the charger on indefinitely without risk of overcharging or damaging the battery cells.

Two-step chargers have been tested and approved by Gates Energy Products and General Electric as ideal charging systems for sealed lead-acid batteries.

82. The Expanding Use of Electronic Graphics in Television News. *By Sheldon Hoffman*, National Broadcasting Co., Inc., New York, N.Y.

Since about 1968, television news producers have been greatly expanding their use of electronic graphics to support and enhance the production of their news broadcasts. 1968 is used as a benchmark because that was the year that the electronic character generator started to come into use as a way of producing "lower third" identifications on programs where the need for quantity and rapid accessibility outweighed the desire for the highest quality graphic look. The units in use at that time were mostly of the dot matrix type which produced readable but aesthetically inferior characters, that is, inferior to characters produced by other methods on slides, art cards, etc.

A couple of years later the Chyron and Vidifont character generators

appeared. These units produced alphanumeric characters equal or superior to characters produced using standard graphics techniques. Electronic character generators rapidly became the standard method for producing lower-third "supers" and other alphanumeric video inserts on local and network news programs.

While the alphanumeric part of television graphic displays was going all-electronic, the other visual material was still being produced on and projected from 35-mm slides, large format transparencies (4×5 or 5×7), 3M color key materials, or as art cards shot on camera in the studio. All of these methods relied on time-consuming photo-optical processes to create the composite effects necessary to produce visually interesting displays. Some ideas for visual could not be executed before broadcast deadlines and simpler designs had to suffice.

The development of electronic still store systems by Arvin-Echo, Ampex, and ADDA, combined with the digital video effects systems produced by Quantel, NHK, and Vital provided news graphics producers with a method of quickly generating, storing, recalling, and dynamically displaying visuals using all of the electronic equipment available in a television facility. In addition to regular graphic art work, the "freeze frame" taken from any video feed (film or tape) became an instant new source of visuals which could be used "as is" or combined with other visual material into a new composite.

This new facility gave the graphic designer access to visual material and electronic effects by which new composites could be quickly assembled and, if necessary, reassembled.

Prior to the use of electronically composited and stored visuals, some news producers rarely considered the use of graphics because of the short deadlines under which they normally operate. The old, time-consuming photo methods of producing graphics acted as a psychological deterrent to many because the inclusion of graphics would add further to their deadline pressure. Unless there was sufficient lead time, or a critical need for graphics material, not too much effort was directed toward their inclusion. The relative ease with which electronically generated visuals can now be created has spurred news producers who, in the past, had seldom used graphics, to use more visuals within their "spots."

At NBC News, conversion to an all-electronic graphics compositing, storing, recall, and display system has resulted in an increased demand for graphics to a point where it was necessary to double the number of graphic artists serving the news division.

More new devices are now coming into use which will allow the graphic artist to draw electronically, eliminating the necessity of using pencil, paper, crayon, paint, markers, air brush, and all of the other commonly used artist's tools.

Past experience indicates that the demands for electronic graphics for news will increase faster than our ability to produce them with the present art staffs.

83. Film and Videotape Editing: The Process of Conformation. *By Joseph E. Rooney*, The Alba Co., Oakland, Calif.

Since the evolution of the videotape editing process began in 1956 with the introduction of videotape recording, videomakers have tried to pattern their processes after filmmaking, where editing had become an art. Filmmakers, on one hand, have looked obliquely towards the world of videotape and have seen transistors, resistors, and invisible images. A marriage would never be made.

The world of film had unique and time-honored practices involved in "making a picture." The crafts had been developed due to the need for specialization. The director was involved in a multitude of responsibilities and respected the responsibilities of others: the writer, the producer and, of course, the editor. The director was responsible for putting the image on film with all of the feeling and sensibilities which the participants could muster, through the performance of the actors, the subtleties of the photography and the elegance or starkness of the set. The editor was responsible for the initial breath of continuity among the variety of scenes and takes that resulted. Collaboration occurred, but more often than not the editor was given the film parts and told to make a whole. The editor, alone, would take a copy of the negative and make the workprint. Quality-poor, the workprint nevertheless revealed the true nature of the film as it neared completion.

Compared to the film process, the world of videotape seemed to come from another dimension, and in essence it did — the dimension of electronics and the speed of light.

The cameras needed light, a lot of it. And the director needed a lot of cameras. And the cameras needed adjustments and an army of technicians to keep them functioning. And editing just didn't exist — at least not until 1956. And when it finally did exist it was all one could do to take a piece of magnetic filings and invisible images and simply remove sections of it and splice it together hoping the resulting video image wouldn't fall apart. The editor was a technician. Art was in a museum.

The world has changed drastically since then. Videotape is overcoming film and the filmmakers know it. The marketplace demands videotape and the editor must speak timecode. It is not, however, as bad as it seems. We have computers now to take the place of the technical army, and we have computers to take care of making the edits, and we are beginning to get directors who want texture and feel in the image and who use one camera to get it. The process is becoming creative.

The sophistication of the equipment, meaning simplicity, and the tremendous existing talent pool, meaning filmmakers, are becoming involved in the maturing process of the electronic image. The editor can now return to making the first assembly of the image without regard to 100 IRE. The editor can now afford to buy the tools of his or her trade, and the office or home is where the rough-cut is made.

The technicians are still needed when it comes to the process of making the release tape. The director works with the editor and with the lab (meaning the post-production facility where the "negative" is conformed — auto assembly) to assure the quality is there. The process is beginning to look more and more like the creative process of film. In coming years technology will make random-access videotape editing a reality. The conformation process will be complete.

84. An Evolutionary Approach to Maximum Profits in Television Production. By David P. Bird, Video West, Salt Lake City, Utah

All areas of our economy are feeling



Alexandar Todorovic of Yugoslavia presents a paper on International Television Technology.

the effects of tight money and high interest rates. Naturally, our dependence upon rapidly-evolving high-technology equipment puts the television production industry in at least as precarious a position as other sectors. Maintaining a competitive edge in our business invariably includes state-of-the-art production equipment, with the incumbent state-of-the-art costs. Establishing and holding a position, while managing to maintain a profitable bottom line, is a tightrope that production management everywhere must constantly walk. With the active cooperation and participation of engineering, this dual equipment-profitability quotient can be effectively addressed and maintained to the benefit of the organization as a whole.

The engineering philosophy outlined in this paper is comprised of three elements, each of which is essential to the success and profitability of the organization's activities. The first is to design for maximum equipment utilization. The second one involves a programmed approach to equipment maintenance for maximum reliability, and the third is a program to train personnel in all aspects of the operation of the company to ensure the best possible client service.

In the first case, it is necessary for a company to utilize its full inventory of equipment, by designing systems in such a way that they are non-dedicat-

ed. The use of centralized equipment and control systems permits rapid assignment of facilities to serve many different and varied functions. In addition, strict attention is paid to personnel considerations, in order to create operational layouts that enhance, rather than conflict with, a pattern that promotes efficiency of movement. This might include allowing one operator to perform several functions simultaneously, rather than tie up three or four individuals to perform the same operations. Finally, (and this will be evident in the third case) companies should train personnel to be skilled in a variety of different technical operations, in order ensure maximum utility of employee time and costs.

The second philosophy is simply organizing a strict regimen of equipment maintenance, in order to head off equipment malfunction and accompanying downtime which is costly both in terms of profit and client satisfaction. This equipment maintenance program runs the gamut from simple head cleaning of videotape machines, to scheduled, daily, routine, and preventive maintenance procedures. Experience has taught us that the time consumed for these tasks is significantly offset by the increased revenues generated from no down time.

The last element in our philosophy addresses itself to our human assets.

The state of Utah is a right-to-work state, which provides us with a certain degree of flexibility in the use of our people, which would be difficult under different circumstances. This allows us to train our employees in a variety of functions, ranging from tape operation and maintenance, to CMX editing, as required. Needless to say, virtuosity proves invaluable in keeping the operation running in the event of illness, or when primary personnel are called away to other assignments. In short, every member of the organization is trained — with the assistance of the engineering department — to be able to provide a number of crossover functions.

We are proud to say that the engineering staff plays an essential role, not just in keeping the "equipment humming," but as a functioning contributor to the success of a growing, thriving business venture.

85. New Diode Gun Saticon®-III; H9386B. *By S. Kato, Y. Nonaka, Hitachi, Ltd., Mobara, Chiba, Japan, M. Maruyama, Hitachi, Ltd., Kokubunji, Tokyo, Japan, and C. Ogusu, NHK Technical Research Lab., Setagaya, Tokyo, Japan.*

In recent years, there have been stronger demands to further enhance the image quality of television cameras, particularly the ENG and EFP cameras. As a result, there has been a need to improve the performance of the tubes used in these cameras.

Saticon, developed in 1973, utilizes the advantages of an amorphous, heterojunction photoconductive layer to achieve high-fidelity color reproducibility, high sensitivity, excellent resolution, low lag, and high reliability. Owing to its outstanding performance, the Saticon has enjoyed immense popularity. Since its first appearance, the electron gun and the photoconductive layer have been constantly improved and their performance upgraded in order to meet the requirements of the television industry.

This report describes the new two-thirds-in. diode gun Saticon-III (H9386B), which utilizes a novel type of diode electron gun that is a significant improvement over all other diode electron guns released to date. A new photoconductive layer used in Saticon-III has also been developed which inherits the superior performance of the previous Saticon products. They reduce the lag and further improve the

highlight characteristics.

If one attempts to reduce the lag without affecting the resolution, there is a limit to the improvement that can be made in a conventional triode electron gun. One solution to this problem that has attracted attention recently is a diode electron gun in which the first electrode works as a positive electric potential vis-a-vis the cathode. Several different types of guns have been proposed. They do not, however, elicit the full advantages of the diode.

When an oxide-coated cathode is used, it is necessary to focus the electron beam. We apply a weak lens effect to the cathode in the second electrode region so as to keep low-beam current density in it. We have developed a completely new type of electron gun by inserting the other electrode between the first and second electrodes. This unique approach achieves the following results and has been confirmed as being effective in reducing the lag of the camera tube.

1. The current-density in the electron gun is held at a lower level than in the case of conventional diode tubes.
2. The current-density peak is placed at a high potential portion by using the configuration of the diverging lens.
3. The lower current-density at the cathode assures a longer life and high reliability.

The newly developed photoconductive layer of Saticon-III reduces the lag effect, produces better highlight characteristics, and reduces the image burn. This improved performance has been achieved by reducing the electrostatic capacity of the photoconductive layer and by developing a new evaporation method for depositing minute amounts of multiple impurities, among other improvements made.

The development of the new diode gun and photoconductive layer has made it possible to commercialize H9386B tubes which are vastly superior to conventional camera tubes. The following are the basic specifications for H9386B tubes.

Amplitude response (5 MHz): 60%
Decay lag (after 50 msec.): 0.8%

86. Electronic Graphics in Television — The Next Step. *By John A. Briggs, Fernsch, Inc., Salt Lake City, Utah*

A new, powerful graphics system has been developed by Fernsch, Inc., Division of Robert Bosch, GmbH to allow the creation of three-dimensional, real-time, animated displays especially for use in television production. Not only does the system allow pictures to be created, but it functions as an advanced character generator as well.

The high performance, microprogrammed bit-slice processors of the system provide 2D and 3D transformations with hidden surface elimination, shading, and viewing window clipping. The system will also operate in non-real-time to create images of unlimited complexity.

Background

Over the last decade and a half, television's use of electronic graphics has evolved from crude 5 × 7 dot matrix displays to sophisticated character generators and painting systems. As each system was mastered by the users, another more powerful system with faster clock times was introduced in an ever-expanding horsepower race.

This paper describes the next step in this evolution, but it is in a new direction.

Rationale

In taking the next step, it was determined that the system should transcend existing systems to strike out on a new path. Basically, the goal was to remove as many limitations as possible from the system. After many discussions with users, the following set of guidelines was adopted:

1. The system was not to be merely another painting system, but rather a graphics system capable of handling characters in a natural way;
2. Three-dimensional displays with lighting model were desired;
3. real-time animation, meaning that displays could be manipulated in real-time, was also desired; no "jaggies" would be allowed, through the use of anti-aliasing techniques;
4. The system should allow unlimited motion control over objects on the screen;
5. Base fonts were to be manipulated dynamically to grow or shrink to any size, avoiding the need for multiple font sizes;
6. Unlimited character overlap was desired;
7. A very large range of colors should be available;

8. No restrictions were to be placed on the number of characters per row or the number of rows per page;
9. See-through objects would allow a broad range of effects;
10. The system was to have the ability to operate at different scanning rates.

The System

The graphics system is capable of creating and displaying an arbitrary scene during every television frame. This real-time display rate is achieved by combining a high-speed hardware processing channel with a real-time scan converter and dual frame buffers.

Objects in the system are stored as vectors of data representing solid-area polygons together with lists of instructions which control the display of each polygon — how each is to be scaled, rotated, and positioned on the screen. Since these instructions can be dynamically altered, there are virtually no limitations on how things are displayed.

Each polygon is represented by an ordered list of points which are the vertices of the polygon. Each of these vertices is actually the top of a vector coming from the coordinate system origin. In order to rotate a polygon, the vectors whose tips are the vertices of the polygon are multiplied by a rotation matrix to get a set of rotated vectors.

Rotation is merely one of several transformations that can be represented by a matrix. Others, for example, are translation and scaling. Several of these matrices may be multiplied together to form a single 4×4 matrix combining all of the operations which can then be applied to the vectors to be modified.

The System CPU

The CPU is a special design based on the Motorola 68000 microprocessor. The CPU has the task of controlling the entire system — serving input devices, sending messages to the workstations, running the disc system, outputting to the graphics processor, etc.

The Graphics Processor

The graphics processor is a series of special purpose arithmetic processors. Each has four microprogrammed bit-slice microprocessors which handle such transformations or translation and rotation.

The Scan-line Converter

Until reaching the scan-line converter, the data has been in the form of vectors representing the polygons displayed on the screen. The scan-line converter sorts the edges and converts the vectors into a scan-line representation which is then stored in a novel frame buffer which permits real-time operation.

The Frame Buffer

The frame buffer memory is "smart" in the sense that it has circuitry to perform anti-aliasing on the data as it is being loaded in real-time.

The Video Section

In the video section the digital outputs from the frame buffer are converted from digital to analog and passed through an encoder to become video. Because the video I/O handling is virtually independent of the digital processing, it is a simple matter to change display rates from 525/60 Hz to 625/50 Hz.

Work Stations

Each work station is equipped with its own floppy discs, CRT, keyboard, joystick, and digitizing tablet. It may be used independently of the main system for data entry and editing.

Conclusion

The graphics system is a significant step in the ongoing evolution of television graphics equipment. It is unique in that it combines complete character generation with real-time animated graphics. It will find many applications in production work.

86A. Museum of Broadcasting: The Collection and Preservation of Broadcast Technology. By Robert M. Batscha, The Museum of Broadcasting, New York, N.Y.

The Museum of Broadcasting has established an ever-growing collection of broadcast programming and related materials. The Museum plans to complement its programming collection of broadcasting and home receiving equipment, and thus further improve and enhance its service and importance to broadcasting professionals, students and scholars, and the general public.

The purpose of the Broadcast Technology Collection is to acquire, preserve, and make accessible to the public a select but significant collec-

tion of broadcasting and home receiving equipment, which will preserve and demonstrate the chronology of progress in broadcast technology. The collection will be coordinated to complement the Museum's collection of radio and television programming.

The Broadcast Technology Collection is made up of equipment (e.g., cameras, transmitters, microphones, antennas, receivers, recording and editing equipment), landmark engineering designs, technical specifications, correspondence relating to new developments, ideas, and controversies, and historic advertisements for items in the Broadcast Technology Collection. In order to preserve the history of broadcast technology and to ensure that today's equipment and papers are preserved for the future, the Museum acquires both historical and current equipment and papers.

Television Post-Production

87. A Cost-Effective Video Compressor. By Kieran K. Fok, Echo Science Corp., Mountain View, Calif., William F. Herzog, Apert-Herzog Corp., San Jose, Calif., and Paul R. Insko, Echo Science Corp. Mountain View, Calif.

Echo Science Corp. of Mountain View, Calif., is introducing a versatile but low-cost video compressor called "Squeezer" for the budget-minded user. The Squeezer consists of a rack-mountable main frame and a remote controller which may be operated up to 100 ft away. The controller contains all necessary switches and joysticks to manipulate the compressed image which can be either live or frozen.

Image processing is performed digitally using dynamic RAMs. There are four compressed image sizes the user can select. Using a joystick, he positions the image any place in the picture raster. Two more joysticks are used to adjust cropping position and cropping size. The image may be cropped to infinity by the size joystick. The effects these three joysticks control can be varied in speed by a rate adjust knob.

The user may add a border around the cropped image by pressing the border on/off button. The border width is variable in increments of 0.1



Projection Practices Topic Chairman Joe Kelly.

μ s up to a maximum width of 1.6 μ s. Border hue and saturation are also variable.

The user may store the compressed image settings he desires in one of four memory locations. He can pre-select image size, its position in the picture raster, the cropped size and position, and the border hue and width. He then recalls these settings any time by pressing the corresponding pre-select button. This is a back-up battery system for the memory cells, so information stored in them will not be destroyed even after a long period of power down.

The video signal to be compressed is converted into components of Y, B-Y and R-Y. The sampling frequencies are 5, 2.5, and 2.0 MHz respectively. To minimize the unpleasant interlace flicker caused by vertical compression, three field stores are used in the read/write process to obtain the best squeezed image. This approach also helps in preserving the life-like smooth motions in the compressed picture.

The choice of the most cost-effective number of bits used in the system deserves careful consideration. It is essential for time base correctors and synchronizers to have at least 8-bits resolution for high signal-to-noise ratio, due to the potential for multi-generation use where quantization noise will accumulate. A Squeezer, on the other hand, will not be involved in a multi-generation process. There is no

need to compress an already compressed image. Once an image is compressed and used in a tape production, the Squeezer will no longer take part in the multi-generation process.

An experimental Squeezer capable of operating at various bit rates has been constructed for close evaluation. Different schemes of interpolation techniques have been analyzed and compared. After careful studies and experiments, the Echo Science design group has finally come up with a very efficient approach that allows them to use considerably fewer parts without sacrificing picture quality. Together with effective packaging techniques and no-frill special-effects features, the Squeezer can be acquired at a much lower cost than other digital special-effects devices.

88. A Digital Manipulation Unit for Keys and Video Wipes. By James W. Norman III, Digital Services Corp., Gainesville, Fla.

The design criteria for this device was to be able to perform the digital effects exemplified by the digital video special-effects units available, but to apply these effects to keys and wipes to maintain a reasonable cost. The effects were to include spin, flip, rotate, compression, expansion, and combinations of these effects. The expansion

capability could not be limited to four times or even eight times the original image. This device had to have the capability of infinite expansion to permit digital wipes, that is, a single pixel element which could be expanded to fill the screen. The device was to operate at four times subcarrier. It also would include a serial communications channel for interfacing with other equipment. The effects were to be software driven so that updates could be offered as additional effects were developed, thus keeping the device state-of-the-art.

A Motorola 6809 microprocessor was chosen for the controller. Producing the desired effects required implementing the trigonometric computations in hardware and pipelining part of the arithmetic processing unit to keep up with video speeds. Because the computations are calculated in real-time with the resolution previously defined, the visual result is extremely smooth, jitter-free transitions.

This device is incorporated into a video system through the video path or through the key input to a switcher. The unit itself has A video, B Video, Key Video, and Genlock inputs. The two outputs are the manipulated Key output and the composite Video Out. In this manner, the unit can operate stand-alone. A built-in matte generator can replace B video.

While in the development stage, it was brought to our attention that the device would be even more powerful if a disc drive could be added to store images. This would permit the special effects for a news, sports, or program opening and close to be stored in the unit itself for recall as required. An optional floppy disc drive was added for this purpose.

The resulting final product has over 200 preprogrammed effects. There are 40 effects that can be user-generated. The image can be doubled and then combined to form a single image.

The product met our design goals and we already have on the drawing board the product enhancements that we expect to offer next year.

89. Television Post-Production: Editing Suite Design. By Dean M. Winkler, Teletronics, New York, N.Y.

Two problems traditionally ignored in the design of videotape post-production editing suites are room

acoustics and overall system integration with the editing computer. This paper offers a possible solution to each of these problems. An acoustic room design incorporating symmetrical non-parallel surfaces, tuned Helmholtz resonating cavities, and active real-time analysis is examined. Also presented is a system integration scheme, which uses serial communications based on the SMPTE Digital Control Interface Protocol. This design enables the video switcher, audio switcher, digital effects devices, and character generator to communicate with a single port of the editing computer via a microprocessor-based communications interface. Additionally, a simple method of interfacing an audio mixing console with a computer-controlled crosspoint switcher is described. Other considerations, such as room lighting, console design, and human engineering of the work environment are also discussed.

90. Post-Production: Today and Tomorrow? *By Herb Ohlandt*, National Video Center, Glen Rose, N.J.

This paper details the equipment complement of today's post-production suite and its present economic realities. From this point of reference, we can look at where the industry is heading. The advent of high definition television and the gradual introduction of digital video into present 525 and 625 machinery will have profound impact on the post-production suite of tomorrow. A plea is made for constant consideration of end-user costs as the technologies are developed.

91. VTR Modifications for Computer-Assisted Editing Systems. *By Doug Thornton and Gene Simon*, CMX/Orrox Corp., Santa Clara, Calif.

Many VTR's, particularly $\frac{3}{4}$ -in. "U-Matic" format machines, are not designed with application to high-speed time code editing in mind. This presents a major challenge to the designer of computer-assisted editing systems, whose goal is to provide the user with consistent maximum performance, regardless of type of VTR selected.

Editing systems must adhere to the stringent standards of performance demanded by the video post-production industry. Included in these standards are:

1. Ability to search and cue to any

time code value on a tape, even if discontinuities in time code exist.

2. Ability to edit consistently on the precise frame and field selected regardless of the model of VTR being used.

3. Complete interchangeability of VTR's used for editing a tape. (i.e., the results of an edit must be identical from machine to machine, even though the tape was not recorded on the machine in use.)

In order to accomplish these goals, it is necessary to evaluate each model of VTR carefully before it is interfaced to the system. Measurements are made, and exceptions are noted. In particular, the ability to use audio channels at very high and low speeds, accuracy of control, edit timing sequence logic, as well as the dynamics of video versus control track and tach pulse signals are examined. In some cases it is possible to tailor the microcomputer program in the "intelligent interface" to accommodate machine characteristics. However, it is frequently necessary to modify the design of the VTR in order for its performance to meet the requisite standards.

The addition of circuitry and playback heads to facilitate the high-speed reading of time code is one major area of modification. This becomes necessary when the characteristic rolloff of the VTR's audio channels prevents reproduction of the SMPTE code, and when the use of partially threaded tape paths prevents use of the machine's reproduce head in high-speed search modes. Switching circuitry must also be added to select the normal audio channel at play speed.

The other major area of modification is the addition of circuitry to allow the correct relationship of control track to video information. Various models of $\frac{3}{4}$ -in VTR's adhere to different conventions in this area, and in order for tapes recorded on one model to be accurately synchronized, and frame and field accurate edits produced, on another model of machine, compensating circuitry must be introduced. This typically consists of a circuit added to the control logic of the VTR, which is driven by the editing system to correct the reference information within the machine and provide complete compatibility.

Finally, the effect of these modifications must not be such as to interfere with the normal use of the VTR in a "stand alone" configuration, or with other equipment. Provisions must be

made to deactivate them in such cases. This is accomplished through the use of logic added to the specialized circuitry to disable it when the machine has been disconnected from the editing system.

92. Post Production Facilities of Unitel. *By Ted Dunn*, Unitel Video Services Inc., New York, N.Y.

The last six to seven years have seen dramatic changes in videotape post-production facilities. From a single, three-machine, 2-in. (quadraplex) manual editing room, the facility has expanded to include three additional computer-assisted editing suites, each consisting of four C-Format, 1-in.-videotape machines. For the last two years, plans have been formulated to replace the original 2-in. Editic room. With a few additions, however, this room remains an efficient and productive operating area, capable of producing a unique product.

In this paper, I describe how and why the facilities have grown as they did, how our concept of what an editing room should be has evolved, and what we feel should be added to new facilities that are still in the planning stages.

All of the post-production facilities at Unitel have been designed with two major considerations in mind. From a financial consideration, maximum utilization of equipment must be obtained. From an operational consideration, maximum flexibility of the equipment within the system must be easily obtainable. In spite of these requirements, it is mandatory that the editing facilities be operationally logical and straightforward.

The great attraction of the videotape medium is its speed. When a client completes the edit session, he or she can walk out with the finished product. During the session, changes can be made very rapidly and evaluated instantly. This can be both a blessing and a curse to the industry. In trying to implement new techniques and equipment into new systems, great care must be taken not to compromise quality for expediency.

Unitel pioneered the development of the first real-time animation system. The Unimatic Stand is a servo-driven titling stand in which the X and Y motion of the artwork moves synchronously with the zoom lens of the color camera. The Unimatic Stand was developed specifically for making



Max Rotthaler of West Germany presented a paper on International Television Technology.

test commercials from story boards (animatics and photomatics). It is also used to add depth and motion to slide presentations, and to generate unique optical effects.

The telecine bridges the gap between film and videotape. For high-quality transfers of 35- or 16-mm prints, or 35-mm slides, Unitel has designed and developed a computer-controlled scene-by-scene color correction facility.

93. A New Editing System Characterized by its Synergistic Approach to Video Post-Production. *By Karen Mills, EECO, Inc., Santa Ana, Calif.*

This paper describes an original microprocessor-based single-source editing system that provides transparent-to-user SMPTE longitudinal time-code editing functions.

The component parts of the post-production process have been integrated into the system.

Utilizing custom I.C.'s, a time-code generator, readers, NTSC sync, and color black, generators provide source and record VCR prestripping, automatic dubbing, and programmable fade-to-black capability.

Videotape Recording

94. Automatic Editing Control Data Collecting System. *By Shigetoshi Kawaguchi, Nobuhisa Nagata, and Hideo Ikegami, NHK, Japan Broadcasting Corp., Tokyo, Japan*

It is most important to reduce the time for collecting the editing control data in post production. Recently, NHK has developed an efficient and inexpensive editing control-data collecting system in addition to the totally computerized existing editing system. It collects the data from off-line edited $\frac{3}{4}$ -in. video cassette automatically within one-half the usual time, filing the data on floppy disc simultaneously. The filing data on floppy disc controls the on line VTR editing system.

Generally, the editing process in producing a program, with its many cuts and videotaped segments, takes a very long time. In order to save the on-line editing time of expensive conventional VTR machines, an off-line editing system, using inexpensive $\frac{3}{4}$ -in. video cassette recorders, has been adopted. In off-line editing, the operator completes the desired editing by repeating the video cassette editing after many attempts.

Until now, the on-line editing operator has collected the editing control data by playing back the edited cassette, cut by cut, then inputting the data manually into the floppy disc. This data-collecting procedure is very laborious and time-consuming and sometimes the operator makes mistakes. The automatic editing control data collecting system has been implemented in an effort to resolve the problem.

In off-line editing, the vertical interval time code is continuously recorded on each original $\frac{3}{4}$ -in. video cassette segment. These original video cassette segments are edited into one master video cassette, and the VITC of the master video cassette is not continuous at each editing point as a result. Therefore, the editing control data can be collected by detecting the discontinuous points of the VITC of the edited master video cassette. The principle of data collecting is not so complicated; it is, however, very difficult to collect the data without reading errors from the repeatedly edited VITC of the master video cassette.

To collect accurate editing control data, the following measures are adopted:

1. When the time between preceding and following discontinuous points of the VITC is less than a specified extremely short length, the system does not judge the two points as editing points. These two points sometimes occur in repeated off-line editing.
2. When the Drop Frame Mode is used as time code and specified frame numbers are omitted, the system does not judge these discontinuous points of the VITC as "editing points," but just prints them out as "Drop Frame."
3. To secure the synchronizing pulse separation, the video signal level is suppressed to less than 70 IRE when the original videotaped segments are duplicated to $\frac{3}{4}$ -in. video cassette for off-line editing.
4. To maintain frequency characteristics, the Y-C separated output signal is edited in off-line editing.
5. To compensate for repeatedly edited and distorted VITC, the high-frequency compensating circuit is attached to the VITC reader.
6. To collect the editing control data accurately by playing back the edited master video cassette at double speed, the noise protection circuit is attached to the servome-

chanism of the $\frac{3}{4}$ -in. video cassette recorder.

The system is capable of reducing the manpower and time needed for editing operations, as well as preventing operational mistakes.

95. A Study on Variable Speed Reproduction of Digital VTR. By Yasuhiro Hirano, Seiichi Mita, Akihiko Kohgami, and Yoshizumi Eto, Hitachi Ltd. Kokubunji, Tokyo, Japan; and Kazuyuki Takeshita, and Nobuo Fujimura, Hitachi Denshi Ltd., Koganei, Tokyo, Japan

The basic characteristics of a digital VTR, such as picture quality, tape consumption, and circuit scale, have been confirmed by several experimental machines. Some additional functions are still expected for a digital VTR to be used practically. One of them is variable speed, with still, slow, and shuttle reproduction capability. In the case of variable speed reproduction, the playback heads scan across the plural signal tracks and the relative speed between the heads and the tape changes from the normal speed. From these standpoints, the optimum parameters of data format and tape format have been investigated, and a new scheme for a timing recovery circuit has been developed.

The data format has been designed considering how to divide a data stream into multi-recording channels; how to distinguish a recording channel, a data block, and a field sequence; and how to exchange an error correction and concealment mode between normal and variable speed reproduction.

The ratio of the signal track width and the guard band width has been studied to optimize the signal to noise ratio and the noise band width.

The capture range of the PLL has been improved to follow the change of clock frequency. The phase difference between the data and the clock is kept constant by an automatic phase adjusting circuit.

These optimum parameters will be discussed theoretically and some experimental results will be introduced.

96. Wideband FM Recording for a High-Definition Videotape Recorder. By Hironobu Katayama, Kouji Kamijou, and Hiromichi Shibaya, Technical Research Laboratories,

NHK, Japan Broadcasting Corp., Tokyo, Japan

The design policy, the construction, and performances of the experimental VTR for the high-definition TV signal (HD-VTR) have been already reported.¹ To record magnetically the wideband signal of the HD-TV, many methods, such as a multi-channel narrow band recording system, or a small number of channel wideband recording systems, are considered. In this paper, the latter wideband recording is discussed.

It made use of FM techniques to record the wideband video signal. The available minimum recorded wavelength is about $0.8 \mu\text{m}$ with (Co) $\gamma\text{-Fe}_2\text{O}_3$ coated tape. To increase the upper limit frequency of the recording signal, the relative speed between tape and head have to be increased. The frequency responses of the tape-head system, with various relative speeds, were measured. These curves show that the bandwidth of magnetic recording can be enlarged to 60–70 MHz by increasing the relative speed. With this condition, the higher carrier frequency and wide deviation could be settled for the FM recording which resulted in obtaining a wide bandwidth and a large SN ratio of the demodulated signal.

In this case, the characteristics of playback equalization (PB-EQ) were very important. In order to design the playback equalizer unit for the HD-VTR, the magnetic recording characteristics of the wideband FM signal were measured. The video input signal up to 20 MHz was FM modulated with the carrier frequency of 30 to 40 MHz and recorded on the magnetic tape. The playback signal was amplified and equalized to compensate the various losses and effects of the tape-head system. The equalized FM signal was then demodulated to reproduce the video output. Attention is now paid to the contents of the losses and effects of the tape-head system to be equalized.

The sideband components of the FM modulated signal, played back from the tape, did not move along the frequency response of the maximum playback signal level with sine wave signals² (Fig. 2). The amplitude of the lower sidebands, however, became larger than the original values (in recording current), and those of the upper sidebands became smaller than the original values. These novel characteristics are called the "expansion

effect" of the lower sidebands and the "suppression effect" of the upper sidebands of the video tape recording. These two effects became pronounced with the higher carrier frequency, the higher modulation (video) frequency, and the larger value of recording current.

Using the staggered CR (one pole one zero point type) equalizer unit resulted in reproducing the video signals almost flat, up to 20 MHz with the large SN ratio (42 dB, non-weighted).

References

- (1) H. Shibaya et al: Development of a VTR for High-Definition Television, "Tomorrow's Television," pp. 237–247, *SMPTE J.*, April 1982.
- (2) H. Abe et al: Magnetic Recording of a High-Definition Television Signal, *SMPTE J.*, Vol. 90, No. 3, pp. 192–195, March 1981.

97. SMPTE Time-Code Recording on $\frac{1}{4}$ -in. Tape: Technical Aspects and Utilization. By Andre M. Bourget, Studer International AG, Zurich, Switzerland

Until now, no standardization has been established concerning the problems of SMPTE time-code recording on $\frac{1}{4}$ -in. tape along with two audio tracks. In early 1981, discussions took place between Willi Studer Co. and Nagra-Kudelski in Switzerland to reach an agreement guaranteeing compatibility between time-coded tapes and machines. Later on AEG-Telefunken in Germany joined the group.

This paper describes exactly the technical specifications that have been worked out by the Studer/Kudelski/Telefunken group. It is shown how time-coding can be efficiently used, with practical examples.

There are five basic parameters to ensure compatibility of time-coded tapes:

1. Track positioning on the tape;
2. Track width, together with audio erase, record, and replay track dimensions;
3. Modulation type;
4. Magnetic flux; and
5. Real distance offset between the audio signal and the coded time recorded on the data track.

These five parameters have been studied, and the optimum solution to each is presented with pros and cons.

The result is a system which retains the quality of today's two-track recording on 1/4-in. tape but with additional time-code information on a center data track. Compatibility between conventional (without time code) recordings and time-coded recordings is assured by keeping cross-talk at a very low level.

There are many possible utilizations of time-coded 1/4-in. tapes. However, the main advantage of this system is that it provides real-time synchronization between several units.

Typical examples of utilization are:

1. Video-audio full interlock for editing;
2. Film-audio full interlock for editing; same process as normal Rock 'n' Roll with sprocket machines (here film coding and code conversion systems EBU/IRT/SMPTE are discussed);
3. TV-simulcasting;
4. Radio automation;
5. Audio logging;
6. Audio-Audio interlock for full electronic editing and special-effects generation;
7. Mixing console automation; and
8. Audio-visual systems control.

Finally, today's existing hard- and software used in 1/4-in. tape-recording equipment with time-code is listed.

98. Digital Video Recording Based on the Proposed Format from Sony. *By H. Yoshida and T. Eguchi, Sony Corp., Atsugi-shi, Kanagawa-ken, Japan*

A Digital VTR which can record and play back 4:2:2 component digital video data was demonstrated at the SMPTE Digital Demonstration in February, 1981, in San Francisco. The performance of this DVTR contributed significantly to the consideration of a world-wide component digital video standard. It was felt, however, that another form of DVTR would have to be developed in order to meet the various users' requirements, as well as to be accepted as a standard DVTR Format. In compliance with the activities of the SMPTE Study Group of Digital Television Tape Recording (D.T.T.R) and the E.B.U Specialist Group Magnum, a new type of DVTR has been developed at Sony which is designed with a different philosophy



A. H. Jones of England during the session on International Television Technology.

from the previous ones. This paper first describes the basic principles of this new format and, secondly, makes comparisons in various respects with other possible approaches.

This new DVTR system has been demonstrated privately, taking advantage of the SMPTE DTTR/Magnum joint meeting held in the UK in April, 1982. Therefore, the paper also gives reports on this demonstration with opinions and views expressed by SMPTE DTTR/Magnum members during the demonstration.

99. The Effect of Word Distribution and Channel Codes on the Error Management of Digital Television Recorders. *By J. L. E. Baldwin, Independent Broadcasting Authority, United Kingdom*

In SMPTE and the European Broadcasting Union, groups are working toward a single format for digital television tape recording. One approach is to consider, in isolation, each of the many different parameters of such recorders that will need to be agreed upon before a worldwide format can be defined. This is obviously true where the parameters are not closely interrelated; unfortunately, many are closely linked.

One of the more important considerations is tape consumption, in that this affects the size of the mechanism which in turn affects the cost. Decrease of tape consumption requires the packing density to be increased. This may be achieved, for example, by decreasing the wavelength to be recorded or decreasing the track width. Either change will worsen the signal-to-noise ratio and increase the frequency of incidence of drop-outs which, in turn, may require a fundamental change of tape coating or an increase in the redundancy used for error control. In either case, the channel code may need changing, which could result in an increase of data needing to be recorded.

Sometimes it is possible by logical processes to evolve an optimum set of parameters. Some indication of whether an optimum is a local or a global optimum can be obtained by starting from different surmises and seeing if these different initial paths converge. Frequently, one has to depend on an innate feeling that the solution is right and appropriate; this feeling is partly emotional, partly philosophical, and perhaps also partly intuitive.

Sometimes it may be more constructive to forget the confusing intricacies of the problem and the niceties

of the arguments and to look philosophically at the problem from the outside and from different points of view. Initially, this approach is adopted in the paper, which starts by considering what is discernable to the viewer. This suggests the relative benefits of different methods of distributing words on the tape and between one head and another. In turn, these better word-distribution methods restrict the validity of certain types of channel code.

The reduction in the number of different methods for distributing words on the tape, together with some reduction of the number of channel codes, provide a significant reduction in the number of possible combinations of parameters which need to be considered in reaching agreement on a single format for digital television tape recording.

100. Long-Term Storage of Videotape. *By Jim Wheeler, Ampex Corp., Redwood City, Calif.*

Increased use of videotape and the growing concern over color loss in film have caused uneasiness about the longevity of videotape recordings. In 1979, Ampex undertook a study for the U. S. Air Force, aimed at determining the best way to store instrumentation tape. Much of the information in this paper is derived from that study.

The videotape recorder was developed by Ampex and introduced in 1955. Some of the videotapes recorded in the 1950's have been kept, and can be played back today. Many factors necessary for proper long-term tape storage are widely practiced, such as operating in a clean, air-conditioned environment, and maintaining the VTR's properly. What is not so well known, is that videotape should be kept in a cool, dry environment even before it is recorded, and that it should be wound end-to-end to an environment similar to the one in which it is to be stored. A family of constant-moisture curves is given in the paper to illustrate the environmental limits of both the tape and the VTR.

This paper describes tape faults, proper wind tension, and how often to rewind the tape. It also lists about 24 measures that should be taken to increase the life of videotape and contains a section on what to do if the tape has been exposed to heat or water.

International Television Technology

101. Digital Video Effects: New Tool or New Trap? *By E. Lionetti, RAI Radiotelevisione Italiana, Rome, Italy*

The availability in the market place of equipment for generating video digital special effects has caused great interest in the program-making community. In the hands of the program director, this kind of equipment is considered to be a powerful new tool. Improvements in the quality and quantity of such digital effects are continuously and earnestly requested.

What is the real potential of this new tool to improve television programs and to optimize the use of television resources? Is this a passing fad that will eventually come down to size, as has happened to other kinds of special effects, or is it a valuable new working tool?

RAI has produced a series of experimental programs in order to try to find an answer to these questions; the programs are largely based on the use of electronic effects for a variety of visual purposes including the simulation of conventional scenery. Some excerpts of these programs are shown and described.

The experiment has produced interesting technical and artistic results, but it has brought to light a dangerous increase in the studio time required for production. This makes it desirable and indeed mandatory to move several of the picture processing operations that are now by necessity performed in the studio to post-production. The artistic and technical limitations of the equipment presently available are described and discussed in the paper, as well as some possible lines of technical development that should be encouraged in order to make it possible to move most picture processing to post-production.

102. E.B.U. Activity in the Standardization of Films for Television and Television Film-Scanners. *By Max Rothaler, Institut für Rundfunktechnik, Munich, Germany*

The European Broadcasting Union (E.B.U.) is an association of broadcasting organizations with currently 40 Active Members, mainly from countries in the European broadcast-

ing area. A primary objective of the Technical Committee of the Union is international collaboration in the technical field of broadcasting. This activity comprises all aspects of research and development where international agreement or mutual information is required.

One of the main subjects of study is related to production-equipment technology, with five working groups responsible for the different technical fields. Since 1966, all aspects of utilization of film in television have been assigned to Subgroup G3 of Working Party G. As indicated in its terms of reference, it has to study the steps that may be taken to promote optimum technical standards for television programs exchanged in the form of films between broadcasting organizations. For this reason Subgroup G3 has to foster the standardization of the characteristics of films used in the exchange of programs and to recommend preferred practices for the technical operation, alignment, and measurement of television film-scanners. In pursuance of this, G3 has to develop and formulate any proposals that could be made by the E.B.U. to the appropriate international standardizing bodies (CCIR, ISO) for new standards or changes to existing standards.

At the time of the introduction of color television in Europe it was revealed rather quickly that the characteristics of color film materials intended specifically for use in television must differ in several aspects from films for cinema presentation. So, in 1968 Subgroup G3 of the E.B.U. established a set of essential requirements that should be fulfilled by these characteristics. In 1979 these specifications were revised, taking into account the progress achieved in the meantime. Besides a more general chapter on the use of film in television organizations, the E.B.U. technical document specifies both the physical and technical characteristics of film stock.

The most important physical parameters — with some of them still under study — are dimensions of both raw stock and processed film, friction behavior, and resistance of film-surface to abrasion and scratches. The main part of the document deals with the photographic performance of film stock for image structure, luminance characteristic, usable exposure range, neutral color balance, and color reproduction. It is of particular impor-

tance that the test conditions for the determination of the sensitometric characteristics were specified in detail, as well as the measurement procedures of definition and granularity. As a result, exchanges of data between broadcasters and raw film manufacturers have been facilitated. An E.B.U. film-test chart was standardized to enable intercomparisons of the various photographic parameters between different types and gauges of film materials. There is presently some activity to extend the density range on film, due to advances which have been made in film stock and with telecine equipment, but it was felt that no final decision should be made at this early stage of work. A third edition of the technical document is now in preparation and details on the envisaged changes to existing specifications will be described.

Television film-scanners show great diversity in their mechanical design, their picture-scanning methods, and the electronic signal-processing used. The E.B.U. has considered it desirable to indicate a certain number of fundamental requirements regarding the performance characteristics of these machines. If these requirements — set out in a technical document — are fulfilled, the broadcasting organizations which undertake the exchange of television programs on film can be assured that the reproduction of these programs in other countries will meet well-defined standards of quality.

Besides a description of fundamental characteristics and optional facilities, the main chapter in the document deals with methods of measurement. Appropriate methods and test patterns are recommended for the determination of the luminance transfer characteristic, definition, flare, SNR, colorimetric fidelity performance, and picture steadiness. With new types of telecines (using CCD sensors) appearing on the market, these measurement procedures have to be checked with regard to further suitability.

One of the points under discussion now within G3 is the automation of alignment and color-correction procedures of telecine machines by use either of a standard test-pattern in the space between successive frames, or of a transparent magnetic coating across the back surface of the scanned film.

103. 70-mm Film Laser Telecine for High-Definition Television. *By Take-*

SMPTE Journal, January 1983



Glenn Berggren presented a paper on Projection Practices.

his Ishida, Ken-ichi Hayashi, Teiichi Taneda, Toshio Motoki, and Yukio Sugiura, NHK Technical Research Laboratories, Setagaya, Tokyo, Japan

NHK (Japan Broadcasting Corp.) has been carrying out research and development of a high-definition television system — HDTV — since 1970. This year, in January and February, demonstrations of the HDTV system were held in Los Angeles, New York, and Washington, D.C., using prototype equipment including cameras, VTR, CRT monitors, and TV projectors.

Motion-picture film provides one of the important and attractive program sources for high-definition television. NHK has developed an entirely new telecine for HDTV using a laser flying spot scanner. This equipment was designed to use 70mm motion-picture film in order to obtain higher picture quality because the sharpness of the HDTV system is superior to that of 35mm motion-picture film. The Laser Telecine has many advantages in terms of performance and function. The principle of the Laser Telecine is similar to that of the CRT Flying Spot

Telecine.

In the laser-telecine, three laser beams, for red, green, and blue channels, are combined into a single beam, from which a raster is formed, after being deflected horizontally and vertically. This raster is focused on the film plane through a rotating polygonal mirror which rotates synchronously with the continuously running film. The laser beam passing through the film is decomposed to R, G, and B components, each of which is converted to electrical signals by using photo-multipliers.

The raster change from one frame to the next in a continuously running film is performed in a lap-dissolve fashion by the splitting beam, with the edge line between any two sides of the rotating polygonal mirror for frame synchronization.

The principal features of the laser telecine are: (1) picture quality excellent in resolution, signal-to-noise ratio, and color reproduction is obtainable because film reading is performed by a laser beam of small spot size, high intensity, and narrow-width spectrum. (2) by adopting a lap-dissolve reading method, the television-scanning standard and the film-running speed can be

freely selected. Moreover, the picture movement reproduced on the monitor screen is smooth.

Principal components of Laser Telecine equipment:

1. Three lasers

For R channel: He-Ne laser (wave length 632.8nm, power 15mW)

For G channel: Ar-Ion laser (wave length 514.5nm, power 5mW)

For B channel: He-Cd laser (wave length 441.6nm, power 12mW)

2. Three light deflectors

For horizontal deflection: a 25-sided, 40-mm dia, 81,000-rpm — rotating polygonal mirror with an aerostatic bearing system.

For vertical deflection: a galvanometer with a position detector for a feedback loop.

For synchronization between a raster and film motion: a 48-sided, 60-mm dia, 30-rpm rotating polygonal mirror.

3. A continuous 70mm film transport mechanism

4. Dichroic mirrors and photomultipliers

5. Video processor — gain, black level, shading adjustment and gamma, aperture correction.

The resulting characteristics are (1) aperture response of the scanning laser beam is about 35% with 1000-TV lines; (2) signal-to-noise ratio is more than 40 dB for a video frequency bandwidth of 30 MHz; (3) vertical picture instability is hardly recognizable on the monitor screen.

The laser telecine provides lustrous pictures with high resolution, that are noise-free with high color saturation. The laser telecine is an entirely new system which has introduced laser technology into a film-to-video transfer system. Furthermore, this technique can also be applied to a 35-mm motion-picture film telecine and film recorder which transfers HDTV video signals to 35-mm motion-picture film. This is very useful in making electro-cinematography a reality in the near future.

104. The Implementation of the Agreed Digital Video Coding Standard.
By A. H. Jones, BBC, Kingswood Warren, England

Many items of studio equipment are now available in digital form, and the agreement on a worldwide video coding standard will no doubt accelerate this trend. This standard amounts to a mathematical description of the signal

to be handled, and contains most of what is necessary to ensure a maximum degree of compatibility worldwide in the design of equipment. Further standardization is required, however, to facilitate the adoption of digital techniques throughout the signal chain, and much effort is being expended in international discussion to establish agreed interface standards, a DVTR (Digital Videotape Recorder) format, and a standard for international exchange over digital links.

All of the digital equipment now in use employs digital techniques either because the processes they carry out cannot be performed in any other way, or because they do the job much better than they would if they used analog techniques. Examples are timing correction, synchronization, standards conversion and transcoding, noise reduction, picture storage, caption and symbol generators, graphics equipment, and special-effects devices.

The direct digital generation and processing of images is a relatively new and very thriving art in which the skills of the graphics designer and the software designer are brought together to assist pre- and post-production processing. The electronic workshops now being assembled will include storage devices of a capacity sufficient for the processing of short program sequences, and this will open the way to animated graphics and the production of sophisticated title sequences, program trails, and other new forms of program insert.

We can already see the growth of a predominantly digital area, even though many of the interconnections are currently being made analog. We look forward to the emergence very soon of agreed digital interfaces. Within studio areas these will, for the time being, adopt a parallel form (bits of different significance being carried on different wires), since that is how the signals are normally handled within the equipment itself.

It is generally agreed that the equipment that will have the greatest influence on the timescale of digital implementation is the DVTR. Consultations between broadcasters and manufacturers are proceeding under the auspices of the SMPTE and the EBU, and the degree of consensus achieved so far gives good hope of an agreed format giving the maximum worldwide compatibility provided by the studio code. This will signal the development of all-digital editing suites, providing comprehensive post-

production and multigeneration copying facilities without noticeable deterioration of quality.

The emergence of the DVTR will also influence the design of the studios themselves. With the advantages of separate component coding realised in post-production, there will be a growing desire to avoid composite coding earlier in the chain.

We may expect that by the end of this decade several studio areas will be substantially digitalized. We therefore need to evolve a strategy for converting the studio complex as a whole from analog to digital operation, and for establishing digital interconnections between one area and another.

The parallel interface currently under discussion will not be an attractive proposition for interconnections between the studio areas of a major production center, because considerable lengths of cable and complex matrix switching arrangements are required. It is therefore likely that a serial interface will also be proposed in due course.

How the serial data stream might best be carried is an interesting matter for discussion. Co-axial cable of the type currently used for video signals is certainly able to convey the 250 Mb/sec or so data stream, but losses are heavy at high frequencies and care is needed in the equalization and avoidance of crosstalk with connections greater than 200m. Optical fibers do not suffer from appreciable loss, and the cost of the necessary transducers may well fall to an acceptable level as they are increasingly applied across the wider communications field. The problem with such systems in this application is that methods of switching and regenerating the optical signal are as yet at a very early stage of development. Current signal routing systems are centered on complex switching matrices, and optical techniques would therefore be more attractive if the switching could be distributed around the periphery of the network, where the signals are still in electrical form, rather than concentrated in the middle. It is not yet certain, however, whether a distributed rather than a centralized routing system would best serve the needs of a modern production center.

Another matter that will need to be decided is the manner in which the signal sources should be clocked, and the signals brought where necessary into synchronism with one another. At present, this is largely achieved by



Session Chairman Stephen Chamberlain and Session Co-Chairman Lawrence Sapadin are assisted by Audiovisual Chairman Richard King during the session on Motion Picture/Special Effects.

locking all sources to a master generator and carefully equalizing the cable runs between the generator and the points at which the signals are mixed. In these days of digital synchronizers it is possible to run all sources asynchronously. But the digital center will probably best be engineered by distributing master clocks, plus some phasing information, to the sources and then equipping mixers with short-range synchronizers for final adjustment. Full-range synchronizers could be used on outside sources at the point at which they enter the studio center.

It will probably be convenient to distribute a master 48-kHz audio clock, and to lock this to the video clock. The video signal already tends to suffer much more delay in its passage through the signal chain than does the audio signal, and means will need to be provided for restoring the balance. The inclusion of a time label within the interface standards will facilitate this process.

The author is grateful to several of his colleagues in the BBC for helpful discussions, and to the BBC's Director of Engineering for permission to publish this paper.

105. The Magnum Specialist Group and the EBU Approach to the DVTR. *By Aleksandar Todorović, Televizija Beograd, Belgrade, Yugoslavia*

Investigations on the future digital videotape recorder started within the European Broadcasting Union (EBU)

a few years ago with the issuing of a questionnaire to assess user requirements. Once the answers were compiled, it became evident that the DVTR was a subject of particular importance and a separate Specialist group, Magnum (abbreviation of the French MAGnéoscope NUMérique — digital video tape recorder) was founded. Its task was to "study measures to be taken to achieve a single standard for the international exchange of television programs by means of digital recording techniques."

In order to comply with its terms of reference the Magnum group had to:

1. provide precise definition of the user's operational and quality requirements;
2. establish close and permanent cooperation with all the parties involved in the process of developing and standardizing the new DVTR;
3. design optimum procedures which will permit successful progress towards a definition of a single digital recording format.

In the EBU it has been accepted as a rule that all documents drafted by any Working Party, or Specialist Group, have to be processed and approved by the appropriate Steering Committee, the Bureau, and the Technical Committees (where all the members of the Union are represented), so that once the document is published it reflects the position of the whole Union.

It is possible, therefore, to affirm that all the members of the EBU are firmly persuaded that the future digi-

tal videotape recorder should comply to one single standardized recording format. Such a recorder, in order to be widely accepted by the users, should respond to the quality and operational requirements as they are stated in the document D-36 1982, and that all those requirements can only be fulfilled by recording component signals, which should be in accordance with the CCIR Recommendation 601 (13.5: 6.75: 6.75).

In order to assure worldwide cooperation, the Magnum group has established cross membership with the SMPTE Digital Television Tape Recording Study Group, and one joint EBU/SMPTE meeting was held earlier this year. At the same time, all manufacturers were invited to participate in the work of Magnum. Since the industry responded very readily to the offer to combine efforts in order to achieve a worldwide standard, all meetings of the Specialist Group were joint meetings with the representatives of the industry.

Every videotape-recording format is defined by a multitude of different parameters, and it was necessary to select from that multitude those which ought to be subject to agreement and eventual standardization. While considering these parameters, we must be aware of the fact that all technical and financial elements indicate the necessity of having the largest possible commonality between 525 and 625 digital videotape recorders. Such commonality can be achieved if we can assure in both standards:

1. the same data rate to be recorded;
2. the same linear packing density;
3. the same recorded error strategy;
4. the same track length;
5. the same number of recording video heads; and
6. the same number of video channels.

Starting from those and other assumptions, the MAGNUM group has discussed with the manufacturers possible approaches to different relevant parameters, and it can be said that some crude boundaries, delineating the possible area into which the optimum values will probably be found, are now emerging.

The joint efforts of the manufacturers, SMPTE, and the EBU have led us to a point where we can hope to achieve a single recording format for a digital videotape recorder designed

to handle the component coded digital studio standard. All our efforts should henceforth be directed toward the accomplishment of this difficult task, of the utmost importance for the whole broadcasting community.

106. Aspects of Cable-Vision in the Netherlands. *By Simon J. Noteboom, Netherlands Broadcasting Corp., Hilversum, The Netherlands*

The European scene for development of CATV systems will be affected by present deregulation and the free-enterprise approach of the United States. In the Benelux countries — Belgium, The Netherlands and Luxembourg — cable systems have already exceeded a penetration degree far in excess of 50 percent.

In the upgraded systems, available in the majority of larger cities, technical capacity (channels) is in excess of available programming. Updating regulations could open a market for cable-programming. Cables are likely to be used in connection with direct broadcasting satellites (DBS) by direct reception of programs outside the covered area, even more than at present with terrestrial off-air reception across the borderline.

In this respect, DBS and cable have to cooperate. The EBU will standardize a multiplex, multi-language sound-channel to accommodate six to eight different languages and text-transmissions together with the vision signal. A further aim is to upgrade the vision-channel for DBS within the WARC 77 BS-Geneva agreement to develop one uniform TV standard for direct broadcasting cable purposes. In this way, new markets for cheap receivers will be opened in the European Broadcasting environment and, of course, this will stimulate program production extensively.

107. Cancelled.

New Technology for Television I

108. Videodisc Technology and Applications Trends. *By C. Robert Paulson, AVP Communication, Westborough, Mass.*

After the 1970's — a decade filled with promises about forthcoming nonmagnetic videodisc systems in many proprietary formats — the dawn

of the 1980's finally saw successive introductions of compatible laser optical reflective (LOR) Systems by North American Philips/Magnavox, MCA-Discovision/Discovision Associates, Sony, and U. S. Pioneer. RCA and several licensees followed with an introduction of the capacitive electronic disc (CED) system.

Promotional efforts, ranging from pinpoint spot-market campaigns to saturation mass-media PR and advertising campaigns using print and TV, purported to convince the U. S. consumer market that the new era of entertainment and cultural programming distribution on videodiscs had really arrived. Sales results on players and discs, however, have not lived up to developer predictions in the ensuing two years. JVC has continued to defer the U. S. debut of its video high density (VHD) system. It must be concluded from these events, therefore, that a profitable consumer videodisc market does not now exist. Only retrospective wisdom in the spring of 1983 will reveal if there was a Santa Claus to these consumer market developers in late 1982.

On the other hand, a seemingly healthy and ready-to-grow market is developing for the LOR random-access, frame-synchronous videodisc system. Particularly strong are player systems whose operation can be controlled by computer programs resident in micro-to-maxi computers electrically interfaced to the player. The first section of the paper reports the results of a market research study which was devised to define these systems and their present and developing applications in business, industry, education, broadcasting, and videotape and film production.

Many analysts of the consumer market's peregrinations have concluded that the potential will never develop until a recordable videodisc and hardware have been introduced. In contrast, however, developers of such recordable systems have only considered them to have application as computer peripherals for higher density digital data mass storage.

In the second half of the paper the chasm separating the projected costs and capabilities of currently announced digital read-after-write systems and the desired costs and capabilities of television disc recording systems is examined. Projections of potential applications and needed performance specifications are drawn from the market-study data. Opinions

of industry experts about the feasibility and timetables for developing the desired systems are summarized.

109. Videodisc Standards: A Software View of the Technology. *By Wolfgang Bock, Beta Film, Munich, West Germany*

Software for audiovisual systems may be partitioned into two classes: linear and nonlinear, the former being intended for collective viewing on broadcast media and thus excluding any individual user control over the flow and delivery of the program, the latter explicitly aiming at such control and therefore being, at least in a great variety of cases, unsuitable for direct consumption via broadcast media.

Many technologies compete as delivery systems for both of these classes. First is the videodisc in its read-only, DRAW, and erasable forms, each of the latter embodying many subcategories both in technology and implementation thereof. The read-only versions, the optical and contact, are currently out and battling for control of the consumer and industrial markets.

Secondly, there are a number of other technologies, past, present, and future, which are similarly capable of replaying linear and nonlinear software and can be adapted to the needs of the consumer or the lower end of the industrial market. These include linear-motion videotape replayed on random-access players, at least one practically defunct but very interesting system based on conventional film, some of the larger slide projection systems, large capacity computers now being built for the storage of television software, and, at the end of a very long road, all solid-state storage.

An interesting special category is formed by small computers which, although they cannot handle the same amount of stored information as the above systems, bring graphics capabilities to the table which gives useful approximations, in some cases, to what a videodisc system could do.

Based on this review, it is claimed that, at least in the area of nonlinear software replay, where the pressure of the market may not be sufficiently strong, competing technologies capable of replaying linear and nonlinear software will continue to exist side by side, and new ones will emerge, in the foreseeable future.

The corresponding replay systems will therefore be nonstandardized in at

least four areas: the media, the playback machines, the computers controlling them, and the software driving both of the latter. Hopes for harmonization are low in the former two areas, and zero in the two others.

Therefore, a case for an intermediate standard is made, such a standard being as technology-independent as possible, taking the form of a language in which videocdisc programs can be formulated and published, and implemented on a variety of delivery systems.

A framework for such a language is derived by first abstracting the various technological contenders to a single common denominator: that of a delivery system for parallel streams of video and audio information. From the resulting analogy with parallel computer processing, the elements of the language are developed and a list of desirable language features derived. It is then argued that, for example, the language Concurrent Pascal embodies many of the required primitives, and that it has certain other advantages over its contenders.

This language is first restricted to a manageable form, then augmented by certain primitives allowing hardware information to be expressed. Access time, number of video frames accessible on-line, and availability of still-frame sound are some examples.

Examples are given to show that this standard, even in its restricted form, is sufficiently rich to accommodate a wide variety of practical applications.

for videocdisc programs, starting with the structurally simplest variant, linear film with synchronous mono sound, and ending with multiple-image, multiple-soundtrack systems under computer control.

Finally, some language primitives which may be useful for nonlinear software programming, but which are not yet implemented in current videocdisc systems, are discussed.

110. Development of a Three-MOS Color Camera. *By Nobuo Murata, Dr. Chikafusa Hirano, and Masaharu Ooka, Hitachi Denshi Ltd., Woodbury, N.Y., and Shusaku Nagahara, Control Research Laboratory, Hitachi, Ltd.*

A solid-state camera has lately been put into practical use since fixed-pattern noise and blooming, inherent to the solid-state camera, have been improved by the development of new imaging devices and noise-suppressing circuits.

Featuring lag-free, sticking-free and long-life characteristics, compact and lightweight industrial B/W cameras, three-chips color cameras, and home-use single-chip color cameras are used in various fields.

Under these circumstances, we succeeded in developing a solid-state ENG camera with three MOS imaging devices.

The major characteristics of the camera are as follows:

1. A high horizontal resolution of 450 lines is obtained by the development of imaging devices on which picture elements are located close to each other.
2. A highly efficient optical system matched to the spectral sensitivity of the imaging device and low-noise circuit provide the sensitivity of f3.5 at 2000 lx and signal-to-noise ratio of better than 49 dB.
3. Imaging devices are arranged on the three surfaces of the prism with an accuracy within 0.05% of picture height. Thus, the registration adjustment is eliminated.
4. Vertical smear is reduced to a minimum with a suppressing circuit.
5. IC's are extensively employed and the power consumption is reduced to 8 W. The camera weighs only 3.2 kg.

111. An Ultra-Lightweight Color TV Camera Design. *By Frederick J. Haines, Harris Corporation, Quincy, Ill.*

A new three-tube portable color camera has been designed which weighs under seven pounds (3.2 kg). To achieve this remarkably low weight, many innovative design techniques were employed. These are described, along with the electrical design which includes extensive use of LSI chips for unusual stability and reliability. The camera design concentrates on operator comfort and convenience. A key in the new camera is the use of the new 1/2-in. (13-mm) pickup tubes.

112. The Video Sequence Processor: A New Approach to Television Equipment Development. *By John R Nickolls, Picture Element Limited, Palo Alto, Calif.*

The complexity of television equipment is growing rapidly, and the time required to design and develop it is increasing rapidly as well. This problem is magnified for image-dependent (adaptive) signal-processing equipment used in bandwidth reduction, composite signal decoding, digital special effects, animation, noise reduction, digital VTR error concealment, and so on. Furthermore, a hardware prototype is normally required just to test a signal processing technique, because the performance of



Paolo Zaccarian chairing session on International Television Technology.



R. Dennis Fraser hears a question during the session on New Technology for Television.

television equipment must be subjectively evaluated on moving video sequences.

In other engineering fields, computer simulation is the tool of choice for developing complex equipment, because it substantially reduces development time, risk, and cost. Until now, simulation has not been viable for television engineering because computers have not been able to input or output moving video sequences.

The Video Sequence Processor (VSP) offers an effective solution to this problem; it is a complete digital picture computer with a unique capability to acquire, store, process, and display real-time moving video sequences. It can be configured to accommodate analog and digital monochrome, composite, component, and RGB video, with broadcast TV, high-definition TV, or computer graphics formats. The VSP can store from 1 to 8 min of live video in digital form. Each component can be digitized with 8 to 11 bits at sampling rates up to 18 MHz, or with 8 bits at sampling rates up to 60 MHz.

Once a video sequence is stored, the VSP computer (or a host computer) can process any picture element, as well as create new sequences. A library of video processing software modules provides many of the functions needed for simulating television equipment. During subjective evaluation, sequence playback can be real-time, slow motion, or stop motion.

113. Teletext Standards — A Prog-

ress Report. By *Bernard J. Lechner*, RCA Laboratories, Princeton, N.J.

In January of 1979, the Broadcast Television Systems Committee of the Electronic Industries Association (EIA) created a Teletext Subcommittee with the objective of recommending a U. S. Standard for broadcast teletext to the FCC. In 1980 and 1981, petitions for rulemaking were filed with the FCC by CBS and the United Kingdom Teletext Industry Group. On October 22, 1981 the FCC issued a Notice of Proposed Rulemaking. This paper reviews the activities of the EIA Teletext Subcommittee and related events leading toward a teletext standard.

114. Videotex in America. By *Joe Roizen*, Telegen, Palo Alto, Calif.

The past few years have seen a growing number of experimental teletext and viewdata systems in operation in America. So far virtually all of these have been based on technology developed in the United Kingdom, France, and Canada, and modified to U. S. technical requirements.

In addition to the basic features of these systems, many new potentials have been added to accommodate the more demanding applications that have been identified in this country. On the teletext side, such refinements as flexible captioning, downloaded alphabets (DRCS), and PDI graphics are being tested to see whether the benefits warrant the additional circuit

complexity. On the viewdata side, field trials of interactive systems are being conducted to determine customer response to data base-access, in home electronic shopping, and closed user group proprietary information transfer.

The hardware and software to accommodate these services has evolved in the last two years, especially with regard to the physical size and cost of the decoders. This paper provides a general overview of the current experiments being conducted, and looks at the actual equipment in use in various parts of the country.

In particular, the teletext services now provided by KNXT, KNBR, KCET in Los Angeles, KPIX in San Francisco, and WFLD in Chicago are described and illustrated with typical examples of on-air pages.

New Technology for Television II

115. Satellite Communications — Current and Future Applications. By *Vincent Godleski*, Scientific Atlanta Inc., Fair Lawn, N.J.

Rapidly changing new technology and additional satellites are expanding the opportunity and applications for the efficient dissemination of video, audio, data, and voice traffic. This paper covers the current state-of-the-art, forthcoming technological changes, and the long range impact of projected new technology. The topics will include:

1. Satellite communications — background and update.
2. Satellite capacity — current and projected:
 - C-Band operations
 - Ku-Band operations
 - Other bands
3. Equipment developments:
 - Video
 - Digital
 - Multiple access sub-systems
4. System planning
5. Long range outlook

116. The Advent of Direct Broadcasting Satellites. By *R. Dennis Fraser*, Alcoa-NEC Communications Corporation, Elk Grove Village, Ill.

The next stage in the ongoing revolution in broadcasting is being set by the advent of direct broadcast satellite

service — a system whereby the consumer may receive signals directly from a satellite rather than by some other means of relay such as CATV, broadcast stations, or the Multipoint Distribution Service.

DBS is intended to operate directly to the individual residence or apartment building throughout the entire nation. It is estimated that there are currently 5 million homes in America that cannot receive any television service because of geographic location. A total of 29 million homes receive three or fewer channels, due either to location or to an inability of the regional market to support multiple channels. DBS will be a welcome asset to these under-served television homes. It could also be an augmentation of service even to those areas with numerous channels available.

It is anticipated that DBS will operate on completely different frequencies than today's television satellites, and more importantly, that it will have greatly increased power in transmission, permitting the use of much smaller antennae for home reception. Rather than the 5 W-per-channel power level currently delivered by satellites serving CATV, the high-power DBS satellite will offer as much as 200 W-per-channel; and the antenna required to receive the signal will consequently shrink to a size of 0.6 or 0.75 meters (24–30 inches).

While the cost of launching high-power satellites and providing multiple channels of programming is astronomical, it is expected that the viewer will only have to spend around \$300 for a complete receiver system. It is projected that, most likely, DBS will operate on a pay-per-view principle, with the viewer selecting just what he wants to see. Properly implemented, this concept will mean lower pay programming costs to the viewer compared with the cost for similar services today.

It is proposed that DBS service will include both pay and free access channels. In all probability, the pay channels will outnumber the free channels on DBS. However, the potential for a large audience delivery capacity makes it likely that even new movie premieres and major sports events could all be available for a nominal fee only on DBS. The advent of DBS may well generate a "software war" as the various services competing for the television audience will position themselves for the most attractive programs. Presumably, this competi-

tion for programming will improve the general quality of what is available.

The excitement generated by the prospect of DBS is also due to the many added benefits envisioned in the use of the new technology. The interface of television receivers to stereo systems to reproduce high quality digital stereo audio is one such benefit. Other possible benefits include the distribution of computer data as part of the television signal (not visible), the mass distribution of movies and special productions specifically intended for recording on home VTR systems, a generally improved television picture quality, and possibly the means of receiving future HDTV television. Another important benefit could very well be the "narrowcasting" of special programming targeted towards "special interest" audiences, i.e. cultural events such as classical concerts and operas, special programs for financial markets, and medical training and educational programs.

Although the high-power satellites proposed for DBS would not be operational until late 1985 or early 1986, DBS-like service could be offered to consumers in the northeastern quarter of the United States as early as mid-1983 via what has become known as "Early Entry Projects." However, these early entry services will require significantly larger receiving antennae, due to the use of existing low-power satellites. The nature of the programming to be offered in these early systems is not clear. The promise of DBS on a large, economical, and fully capable basis is, however, with the spacecraft of 1985–86 timing.

In the final analysis, the question of

whether or not DBS will become the next major electronics distribution revolution lies squarely in the consumer acceptance of the medium, based on what benefits DBS offers versus the existing sources of television entertainment.

117. New Generation of Long-Range Antenna ENG Systems — Skypod and Superscan. By Erik Stromsted and Mike Kosmicki, Video Systems Inc., Burlington, Mass.

A new long-range antenna pod for airborne use, as well as auto tracking antennas for terrestrial use, are outlined by the author.

Explanations are given concerning the use of these antennas both separately and in combination with each other.

Design details, including inherent system problems that had to be overcome are fully discussed.

Extensive use of slides is made to explain the array of antennas housed in the new airborne unit called Skypod. The unique circular, steerable, pencil-beam antenna arrangement is compared to existing systems. The antenna pattern and its effect on extended range coverage is also detailed.

Switching selectability, disconnect procedures, plus new solid-state components used in the unit are discussed.

A brief history of ENG auto tracking antenna design prefaces the outlining of two separate auto tracking terrestrial antennas. Performance specifications and characteristics of



Robert Lund was Chairman of the Film-to-Tape Interface session.

the two systems are fully covered.

Placement of the units and environmental factors are discussed.

118. New High-Powered Miniature 2-GHz Portable ENG. By Erik Stromsted and Mike Kosmicki, Video Systems Inc., Burlington, Mass.

The authors briefly chronicle the development of portable microwave systems pointing out the trend toward decreasing size while increasing power output. The equipment is tailored to news car ENG applications.

Details are given of the prototype design of M/A-COM Video Systems' new 2-GHz Super 2MX in one 12-W microwave miniature package transmitter, heat sink, miniature disc rod antenna, and snap-on tripod mount. Design considerations for miniaturization of this type of device are discussed, including the effect upon high performance, heat dissipation, and other concerns involved in fast ENG News coverage.

Specifications are outlined and comparisons made between present and past systems.

The performance of various systems is covered for both terrestrial and airborne uses. Complete explanations of audio, video, frequency selection, power versatility, weathertight controls, and unique new antenna concepts and design are included.

The authors use slides to illustrate design features of this miniature system.

119. Perceptual Requirements for High Definition Television. By Curtis R. Carlson, RCA Laboratories, Princeton, N.J.

Historically, new displays were designed using empirical rules-of-thumb to characterize the human observer. Recently, however, advances in the visual sciences have led to the beginning of a quantitative basis for display design. One new useful analytic tool is "just-noticeable-difference" analysis, which provides an integrated approach for evaluating different displays. The basis for this analysis is a signal-detection model for the human visual system, which has proven to accurately predict just-noticeable differences in displayed information.¹

It is the purpose of this paper to apply this model to the problem of determining the perceptual requirements for high definition television systems. Among the specific examples considered is the problem of deter-



Ted Dunn presents a paper at the TV Post-Production session.

mining the change in display bandwidth necessary for observers to see a noticeable improvement in displayed image sharpness. It is shown that as the bandwidth of a display is improved, larger bandwidth changes are required to produce the same perceptual effect. Specifically, for NTSC bandwidth images at a viewing distance of six picture-widths, a just-noticeable change in image sharpness requires a bandwidth increase of roughly 10%. For images with twice the horizontal NTSC bandwidth at the same viewing distance, a just-noticeable change in image sharpness requires a bandwidth increase of roughly 30%. Perhaps as important, it is shown how these conclusions are modified when using different images, display signal-to-noise ratios, and mean display luminances. Finally, the display performance of the current NTSC system is compared with the performance of a "perceptually-perfect" display.

1. C. R. Carlson and R. W. Cohen, "A Simple Model for Predicting the Visibility of Displayed Information," *Proc. SID*, 21, pp. 229-246 (1980).

120. Dual Video Transmission Utilizing Horizontal Time Sharing. By R. Dennis Fraser, NEC America, Inc, Elk Grove Village, Ill.

The objective of this paper is to introduce a new concept and approach to the multiplexing of two discrete television video signals into one standard video bandwidth channel. The paper further presents an actual, field-tested product as a result of this new concept application in the Japanese domestic broadcast market. Pertinent diagrams, charts, and explanation of the digital processing involved is presented as visual material. A videotape showing

actual performance in broadcast use is incorporated.

The past few years have seen an increasing interest in the multiplexing of video signals to conserve spectrum. Conservation of this type has been of interest to broadcasters, transponder users, and industrial concerns alike. Previous concepts for such multiplexing have concentrated on vertical interlacing of alternate television fields or the compression and expansion of the vertical domain of the signal. These approaches have involved either a serious compromise in resolution of the image or an apparent "flicker" of motion in the picture.

A new product from Nippon Electric Company, Ltd., the DV-10, represents the digital compression in horizontal domain of two images for transmission. This technique results in both signals having reproduction quality in excess of U-Matic VTR's while meeting FCC transmission specifications. The design principle allows for the complete time-base correction of both incoming signals, thereby permitting a logical application in ENG broadcast utilization. The concept has been in use in the operations of TBS (Tokyo Broadcasting System) for almost one year and is used regularly on microwave as well as long-line applications.

Specific attention is paid to the techniques involved in the digital compression, expansion, and enhancement filter techniques to minimize the horizontal loss of detail in application of the system.

The final area explored is the existing tariff arguments in Japan based upon two program sources appearing on one long-line channel. The American tariffs are examined in light of the availability of this type of system.