

Digital Processing of Video Signals

Montreal, February 9, 1984 — Maison Radio-Canada

This one-day tutorial precedes the 1984 SMPTE Television Conference but is arranged independently by the Canadian Broadcasting Corp., Bell Northern Research, and INRS Telecommunications from the University of Quebec.

This tutorial covers many of the fundamental and applied aspects of digital processing of video signals. It is intended for engineers and technical managers who need to familiarize themselves with different aspects of the emerging digital video signal processing techniques and technologies.

Tutorial Outline

I. Introduction

II. Sampling and Quantization

Multi-dimensional spectrum

Sampling and reconstruction of video signals

- Sampling frequencies and patterns

- 3-D spectrum of sampled video signals

- Multi-dimensional digital filtering for reconstruction

Quantization

- Viewer's properties
- Uniform and nonuniform quantization
- Quantization noise spectrum shaping

III. Digital Television Systems

- Digital composite signal format
- Digital component signal format
- Higher resolution systems
- Digital processing techniques for quality enhancement

IV. Digital Transmission and Distribution of Video Signals

Digital networks

- Digital transmission hierarchy and bit rates

- Digital transmission facilities

Bit rate reduction techniques

- Interframe and intraframe predictive coding techniques

- Transform coding techniques

- Hybrid predictive/transform techniques

- Examples of bit rate reduction systems

- Impact of bit rate reduction

V. Digital Video Processing Hardware Systems

General purpose computer simulation systems

Real-time programmable hardware systems

The tutorial will be given by several experts in the digital video field:

Dr. S. Sabri, *Bell Northern Research*
Dr. E. Dubois, *INRS Telecommunications*

Dr. E. Tarnai, *Bell Northern Research*

Mr. K. Davies, *Canadian Broadcasting Corp.*

Registration forms will be available in November. For further information, please contact:

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3 Place du Commerce
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(514) 761-5831

SMPTE Report

BKSTS '83

BKSTS '83, the eighth Film and Television Technology Conference and Exhibition organized by the British Kinematograph, Sound and Television Society (BKSTS), opened on June 27 in the Royal Lancaster Hotel for a week of technical sessions, a technical visits program (studios, laboratories, TV stations, equipment manufacturers), and other exciting events.

Technical Papers Program

The opening address was given by BKSTS President, Alan Hirst. The first session, entitled "How Far Have We Come," consisted of three papers on the significant advances that have recently been made in film, video, and sound technology. In the first paper,

"Opticals in Harmony with Motion Control," author Gary Pearlman, Camera Effects, noted that over the past decade special optical effects have allowed designers and directors greater and greater scope. Specially designed computer guidance systems, he said, offer precision control over a range of movements previously unattainable.

"Sound in the Eighties," presented by Tony Faulkner, described some of the challenges to professional sound recordists, resulting from digital audio.

Mike Luckwell, The Moving Picture Company, author of the third paper, "Creativity Meets Computer," said, "The unlikely combination of artist and computer is fusing to provide

us not only with new images but with new and challenging mediums." He cited the main areas of applications as: electronic and video effects; digital picture manipulation; character generators and paint boxes; 3-D computer imaging; and motion control.

The first session dealt with what has actually been accomplished. The closing session on July 1, fittingly dealt with "The Shape of Things to Come." The first paper in that session, "The Future of Film," by Roy Jeffreys, Kodak Ltd., provided an optimistic outlook on what can be expected of film in the future. "Feature Films — The End or the Beginning," by John Chambers, Goldcrest Films and



Leonard Coleman, SMPTE President, gave a presentation on Datakode Magnetic Control Surface developed by Eastman Kodak.

Television, provided a provocative forecast, based on current trends. The author noted a continuing need for the "big screen," and he also provided some highlights on "satellite TV — and beyond." Other expectations for the future were expressed in "DBS — Its Promise and Its Problems," by Peter Rainger, BBC; in "Future Prospects of High Definition Video Systems," by Yumiliko Suzuki, Sony; and in "Cable Television," by Donald Wray, British Telecom.

Returning to June 27, the six papers presented at the afternoon session on "Audiovisual Technology" covered multi-projector slide shows ("The Making of Britain," by Sarah Reed, Edco-Reed International Products), multi-media shows, computer graphics, color films for audiovisual applications, and other audiovisual techniques. Other papers presented at Session 2, and the authors, were: "Multimedia in Public Entertainments," Bob Simpson, Electrosonic; "Off-Line Stills Programming," Bob Auger, Molinare; "A Computer Graphics Systems," Alan Norman, Myriad Audio-Visual; "Color Films for Audiovisual Productions," Colin Hughes, Kodak Ltd.; and "Two BKSTS Test Aids," Michael Ray, Electrosonic.

Twenty-one papers, presented at the all-day session on June 28, covered almost every aspect of film and production technology. An especially interesting paper, "The SMPTE Theater

Quality Evaluation Program," was presented by Roland Zavada, Eastman Kodak. This program is implemented by the Inter-Society Committee for the Enhancement of Theatrical Presentation, with the cooperation of the SMPTE. The chairman is former SMPTE President Kenneth Mason. The program is voluntary. SMPTE members attending theaters are asked to fill out comprehensive evaluation forms and share their technical opinions and expertise with the theater's management on a confidential basis.

Other papers presented at the session covered recent developments in lighting and films and other advancements in film and production technology. Papers and authors included: "Recent Developments in MEL Lamps," Angus Dixon, General Electric Co.; "The EC-35 Camera and Electronic Cinematography," L. John Williams, FWO Bauch Ltd., and Michito Motoki, Ikegami Electronics; "The New Eastman Color Negative Films," Dennis Kimbley and John Croft, Kodak Ltd., and Frank Reinking and Richard Sehlin, Eastman Kodak; "Two New Fujicolor Motion Picture Camera Negatives," Kojo Noguchi, Fuji Photo Film; and "A New Color Reversal Print Film Gevachrome Type 782," Valerius Danckaert and Walter Markie, Agfa Gevaert.

A paper on "Film Stock Used for Optical Special Effects," presented by Roy Field, Optical Film Effects, and

Tony Iles, Kodak Ltd., was illustrated by clips from *The Dark Crystal*, *Ghandi*, and *Outland*.

"Motion Graphics and Robotics," by Andre Proulx, Optical Art Camera Corp., described the combined use of digital robotics, multi-level projection, printing, and animation techniques in the production of motion graphic sequences on color film from black-and-white intermediates.

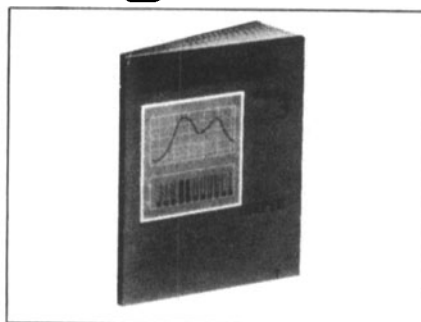
Other papers on various aspects of film and post-production technology included "Fiber Optics in Our Industry," Bernard Bush, Fibre Optics Links Ltd.; "Moving Stills," Alan White, CPL; "The Impact of Computerized Editing and Graphics on Film Production," Joseph Roizen, Telegen. "Clear Time Recording in Practice," Christopher Smith and Stephen Mellor, Independent Camera Equipment, described the Aaton CTR system designed to convert the 1/4-in. time code into a video compatible SMPTE code; and "Magnetic Control Surface Technology — Enhancing the Efficiency of Film Post-Production," Leonard Coleman, Eastman Kodak Co., described Datakode and its potential applications.

"The Ultimate Approach to Video Sound Post-Production," as explained by author Wolf-Ruediger Otto, Steenbeck, consists of a Steenbeck editing table with an integral video player and monitor, together with an electronic synchronizer.

Bob Herrick, Tyne Tees Television Ltd., author of "But Will it Help to Make Better Programs?" told the audience that his paper was originally conceived as "a lighthearted look at the relationship between new technology and television production values." But in the months since then, he said, liaison between the program maker and the innovative engineer has become more crucial. He admitted, however, that his viewpoint is highly individual.

Other papers: "Considering the Source, Film as Medium for Image Origination," William Koch, Eastman Kodak; "Super-16: The British Are Coming," Paul Collard, Kay Laboratories, which reviewed recent developments in the use of super-16 in the UK; "Psychophysical Relationship of Image Quality Characteristics of Motion-Picture Color Films," Wilfred Liekens, Agfa-Gevaert, presented the results of a psychometric evaluation of the image quality characteristics of a series of motion-picture color films, compared with data obtained by

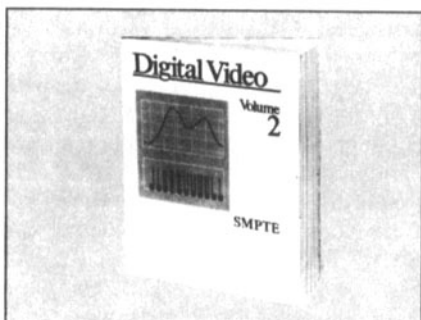
SMPTE's Best Selling Books on Television's Rapidly Developing Technology:
Digital Video—Volumes 1, 2, 3



Digital Video—Volume 3

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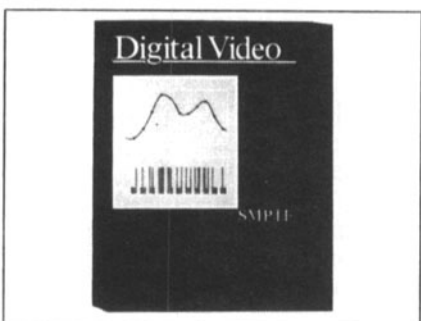
232 pp. 8½ x 11 softbound Price \$25.00*



Digital Video—Volume 2

Published 1979. The book gives readers an excellent insight into the techniques and applications of digital technology and equipment. Its 14 chapters cover almost every corner of digital technology, including Teletext, Digital Special Effects, Computer Animation, and Digital Video Recording. Includes a transcript of discussion on Digital Video Recording by a panel of digital video experts.

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Digital Video—Volume 1

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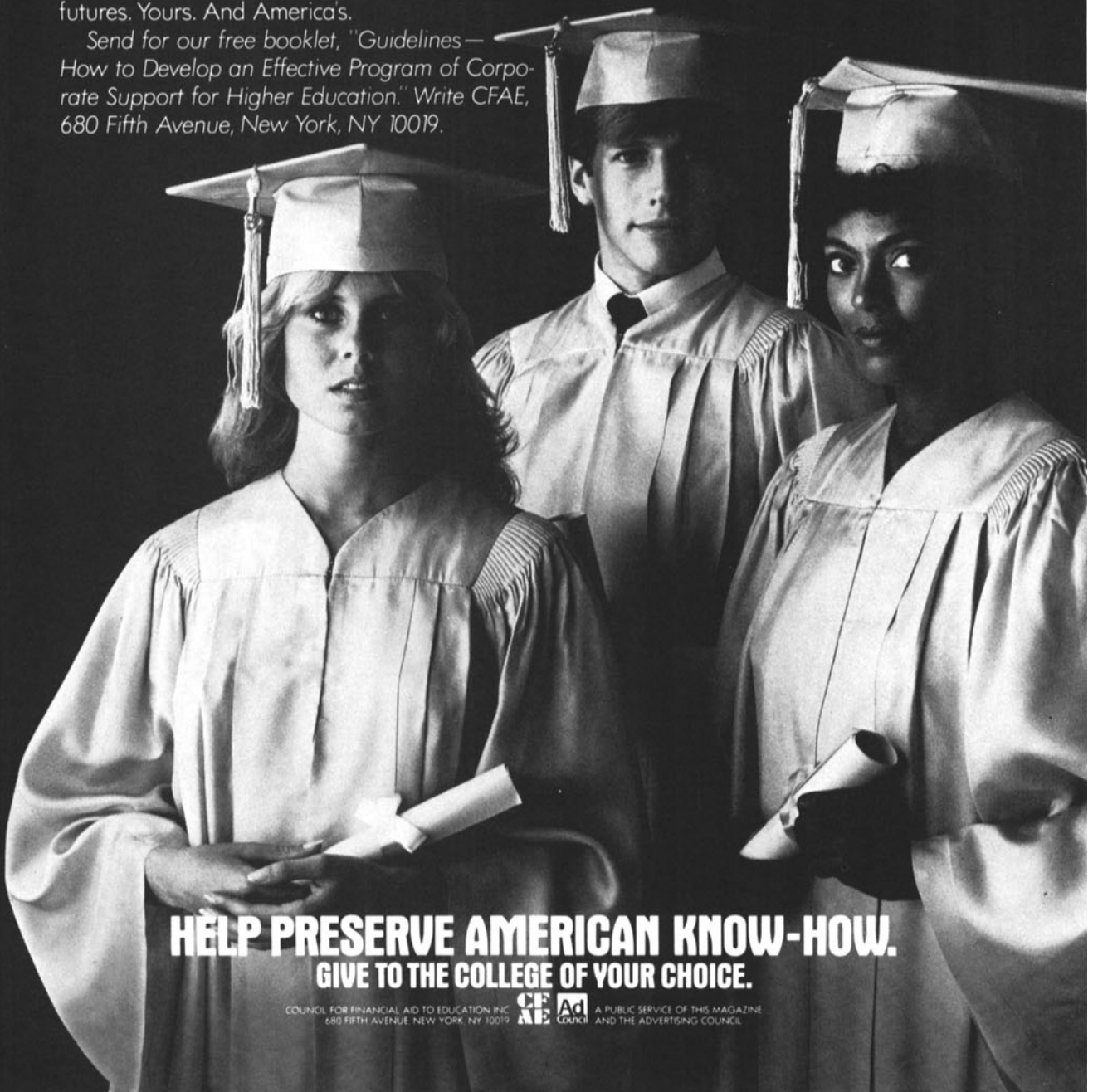
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physical measurements of corresponding image quality parameters.

In "Motion Pictures From Another Angle," Isaac Ben Yehuda, Ben Film Productions, explained Split 35. Using this format, the 35-mm frame is divided vertically and each half is exposed in successive passes through the camera.

"An Inexpensive Method for the Long-Term Storage of Color Films," Gert Moberg, Roland Gooes, and Hans Evert Bloman, Swedish Film

Institute, described storage methods used in Sweden. "Revival of the Cinema," Hans Bonnesen, Agfa-Gevaert, described the evolution of cinemas in general, and in Denmark in particular.

Session 4 on June 29, an all-day session on television and video technology, opened with "Electronic News Gathering," Peter Ward and William Reay, ITN. Other papers included "An Electronic System to Replace Slide Scanners in Television Studios,"

Michael Croll and Ian Stewart, BBC; "Fundamental and Products Training for Film and Television Engineers," Leonid Strashun, Sony Broadcast; "Choosing Video Equipment on a Cost-Effective Basis," Ross Watson, Bell & Howell AV; "Compatible Enhanced Definition Television," Baron Sewter, IBA; and "Today's Photographic Imaging for Tomorrow's HDTV System," Mike Kriss, Eastman Kodak.

The session continued with "Three-Dimensional Color Television Using Video Cameras," Patrick Neale and David Clarke, Cine-Build/London University; "Three-Dimensional Television by the Anaglyph Process," Charles Smith, Stereo Image Techniques and R.S.V.P. Ltd.; "A Video and Film Macroscopy Studio for BBC Natural History Unit," Paul Townsend, BBC; and "A Portable Television-Production Package," Robert Gold, Samuelson Video, and Terence Moss, Link Electronics.

The papers presented at Session 4 covered a number of interesting developments in television and video technology. In addition to those already mentioned were: "Generation of Animated Sequences for Television Using an Electronic Rostrum Camera and Digital Storage System," Victor Devereux, David Kirby, and Michael Wolfe, BBC; "Video Exposure and Color Balance Meter," Ted Crowley, Invotron; and "Automatic Chromaticity Measurement of Color Monitors



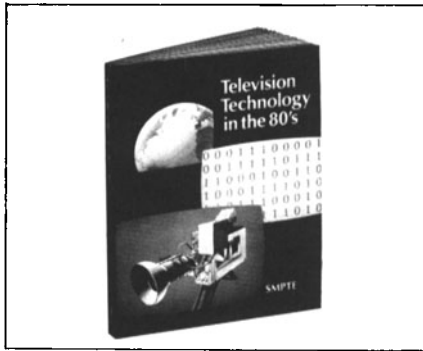
The SMPTE Table. (L) Bill Hogan, Program Chairman for the 125th SMPTE Conference; Irwin Freedman, Agfa-Gevaert; and Lynne Robinson.



A meeting of the International Relations Committee. (L) John Barry, John Barry Group, Australia; Paul Yang, Paul Yang & Associates, California; S. Sun, Beijing; and Harold Eady, Novo Communications.

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Contributors to this book are acknowledged to be the leading

CONTENTS	
A New Channel Code for Magnetic Digital Recording, Max Artigalas, Thomson CSF, Gennevilliers, France	A New High Resolution Plumbicon Tube, A Franken, Philips, Eindhoven, Holland
Recent Developments In Error Concealment Techniques, M-J Colaitis and D. Nasse, CCETT, France	Lag Reduction and Lag Characteristics of Television Camera Tube Signals, R. G. Neuhauser, RCA Corp., Lancaster, Penn.
A Format for Digital Television Tape Recording, John L. E. Baldwin, Independent Broadcasting Authority, Winchester, England	Multiplex Sound Television Broadcasting in Japan, Kiyomi Iizuka, Tokyo Broadcasting System, Inc., Tokyo, Japan
Digital Video Tape Recording with Increased Packing Density—Progress Report, Masahiko Morizono, Hirofumi Yoshida, Yoshitaka Hashimoto and Takeo Eguchi, Sony Corp., Kanagawa, Japan	Questions on the Orientation of Research in High Definition TV in the 80's, M. Joseph Polonsky, Thomson CSF, Gennevilliers, France
Aspects and Considerations About the Mechanical Format of Digital VTRs, Dieter K.E. Pohl, Robert Bosch GmbH, Darmstadt, West Germany	High Definition TV Studies on Compatible Basis with Present Standards, Prof. B. Wendland, Dortmund University, Dortmund, Germany
Mechanical Tape Format Considerations for Digital Television Recording, C. Robert Thompson, RCA, Camden, N.J.	The NHK High-Resolution Wide-Screen Television System, Dr. Takashi Fujio, NHK, Tokyo, Japan
Formats for Digital Video Tape Recorders, D. Dolby, M. Lemoine, M. Felix, Ampex Corp., Redwood City, Calif.	Systems Engineering Considerations in the All Digital Television Production and Transmission Center, Michael S. Tooms, Protel Broadcast Services, Ltd., Surrey, England
DVTR Editing Considerations for Multiplexed Audio Versus Separate Audio Edge Tracks, Kenneth Clunis, 3M/Mincom Div., Camarillo, Calif.	Digital Decoding of PAL and NTSC Signals Using Field Delay Comb Filters and Line-Locked Sampling, C. K. P. Clarke, British Broadcasting Corp., Surrey, England
Digital Television Error Correction Without Overhead Bits, A. A. Goldberg and John P. Rossi, CBS Technology Center, Stamford, Conn.	Test Signals in the Digital Domain, J. Judge, Tektronix, Inc., Beaverton, Ore.
Reflections of a Camera Designer, L. Germany, PYE TVT, Ltd., Cambridge, England, H. Blom and E. Tienkamp, Philips, Eindhoven, Holland	Worldwide Standardization—Now or Never, Thomas Robson, Independent Broadcasting Authority, Winchester, England
A Super Camera Using Saticon & Built-in Computer Control System, Takashi Sueoka, Japan Broadcasting Co., Tokyo, Japan	Panel Discussion on Digital Video Component Tests Performed by the SMPTE Committee on New Technology, Chairmen: Frank Davidoff, Frank Davidoff, Inc.; William G. Connolly, CBS Television; Kenneth B. Davies, Canadian Broadcasting Corp.; Charles A Ginsburg, Ampex Corp.; Robert S. Hopkins, RCA Corp.
Advances in EFP Camera Design, John O. Ryan, Ampex Corp., Redwood City, Calif.	

experts in their areas of interest. Take a look at the contents on this page and you will see why this book is one that everyone who has even the slightest interest in

television will want for his or her personal or company library. Order your copy today.
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Fellows and awards winners. See story on p. 1094.

and Cameras," Peter King and Peter Marshall, IBA.

After a tea break, five papers were presented: "New Facilities for Line Array Telecine Using Digital Storage," Richard Sanders and Ian Childs, BBC; "Full Immersion Wet-gate System for Telecine," Christoph Geyer, Geyer-Werke; "EFC/Relabel — A New Tool to Produce Videograms," Tomas Dyfverman, Profilm Co. AB, and Bengt Orhall, AB-Film-Teknik; "Comparing the Potential of Film Edge Numbers, Time Codes, and Markings for Tape-to-Tape Conforming," Tomas Dyfverman, Profilm Co. AB; and "The Development of a C-Format Video Tape Recorder Weighing Less than 15 Lb," Stefan Kudelski, Kudelski SA.

Session 5, a morning session on Sound Technology, June 30, opened with a paper on "A New Look at 70-mm Sound," presented by John Mosely. The following presentations included "New Factors in Loudspeaker Design for Theaters," Tomlinson Holman, Lucasfilm; "Ferrit Separate Magnetic Sound Follower," Mark Portlock, Rank Cintel; and "A New 16/35-mm High-Speed Dubbing Projector," presented by Norman Chapman, Perfectone Products, S.A., for the author, Jean-Jaques Bessire, Perfectone Products, S.A.

Five papers were presented following a coffee break: "Experience With a Custom Built Automated Mixing Console," Geoffrey Labram, Pinewood Studios; "Digital Audio Mixing for Sound Production and Post-Production," Michael H. Jones, Neve Electronics International;

"Wordfit — A Digital Audio Signal Processing System for Automatic Time Alignment of Post-Synced Dialog," Garth D. Marshall and Jeffrey Bloom, Audio Magic; "Magnetic Film vs Multitrack Magnetic Tape for Audio Post-Production of Film and Video," Willy Hungerbuhler, Sondor; and "Double System With Video," Claude Cellier, Nagra Kudelski.

Session 6, held the afternoon of June 30, was on Laboratory Technology. The first paper, "A New Low-Contrast Eastman Color Print Film," was presented by John Croft, Eastman Kodak, and Christian Didier and Bernard Gagney, Kodak-Pathé. Other papers presented at Session 6 included "A Method for Obtaining Optimum Duplicates From Color Prints," Roger Huybrechts and Henry Stappaerts,

Agfa-Gevaert NV, Belgium; "A Computerized Film Laboratory — Economic Reality or Futuristic Dream?" Nigel Varian, Cine Lab Services; "A Computerized System for Conforming Negative to Work Prints in the Optical Camera," Irwin Young, DuArt Laboratories; "A Printer Control Unit Developed at Rank Film Laboratories," Jeffrey Gear, Rank Film Laboratories; "An Improved Design for More Efficient Programming and Cost Control of Printer Operations in Film Laboratories," John H. Sage-Johns, Sage-Johns Ltd.; and "The Beginning of the End for Paper Tape — A Centralized Data Collection/Distribution Computer," Michael V. Chewey III, Systems Unlimited.

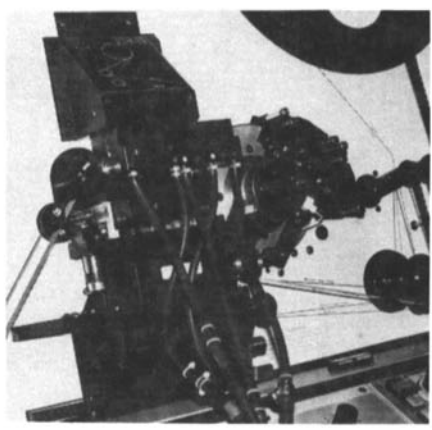
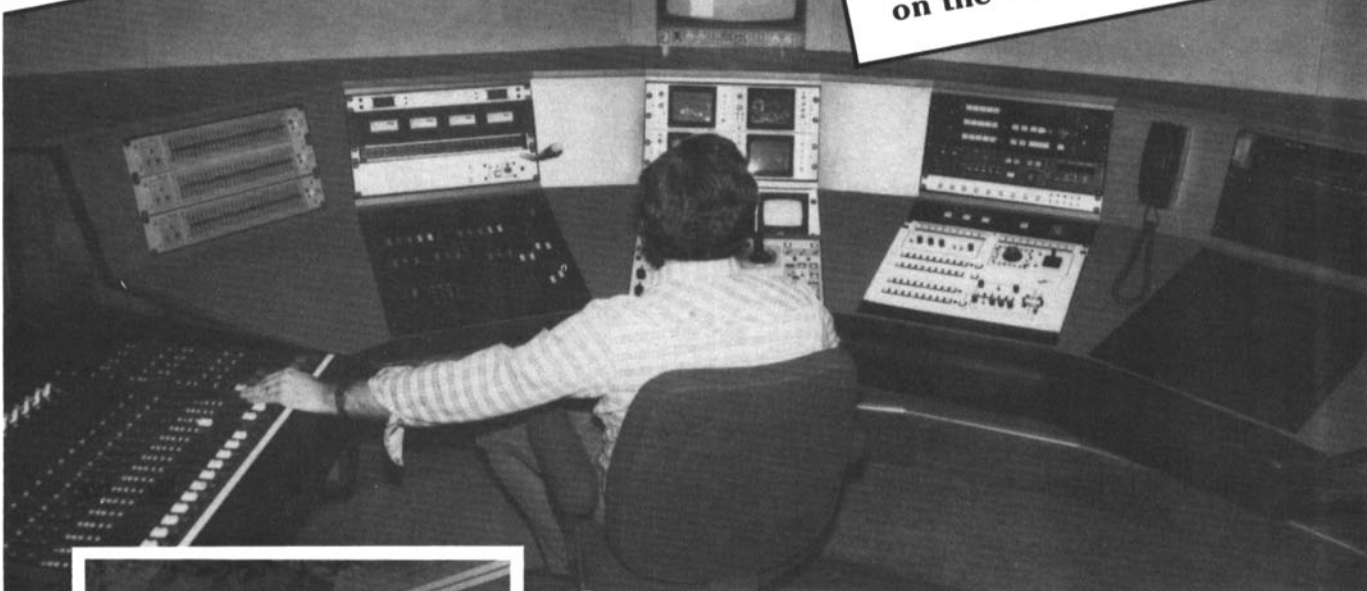
Following a tea break, six papers



BKSTS President Alan Hirst (L) and SMPTE President Leonard Coleman.

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were presented: "The Quiet Art of Film Restoration," Arnold C. Schie-man, Restoration House Film Group; "Full Immersion Rotary Buffer Film Cleaner," Andrew Balint and Chuck Zichterman, Peterson Enterprises; "Cine Laboratory Pollution Control and Resources Recycling," Gordon Wilson, Wilson Process Systems; "Chemelec Silver Recovery," Denise Tomlinson, Bewt (Water Engineers) Ltd.; "Dust and Static in the Film Industry," Fred French and Fred Hillyer, Meech Static Eliminators; and "A Longer Length (4000-m/13,000-ft) Printing System," Colin Mossman, Rank Film Laboratories.

The final program (Session 7, July 1) on "The Shape of Things to Come," has been described above because of its relevance to Session 1 on "How Far Have We Come."

BKSTS '83 Conference Committee

Chairman, John Aldred; *Deputy Chairman*, Rex Ebbetts; *Coordinator*, William Pay; *Papers*, Steve Jaggs; *AV Facilities*, Keith Spillet; *Exhibition*, Harry Treasaden; *Technical Visits*, Peter Milson; *Concourse*, Martin

Shortall; *Publicity*, Peter Richardson; *Hotels*, Joan Harrison; *Treasurer*, Nick Simpson; *Social Events*, Peter Richardson; *Registration*, Jill Wade; *Ladies' Program*, Sandra Ebbetts; *Seminar*, Colin Mossman.

Session Chairmen and Organizers

Session 1, *Chairman and Organizer*, Peter MacCrimmon, Kodak Ltd.; Session 2, *Chairman*, Mike Ray, Electrosonic, *Organizer*, Lee Seaman, Molinare; Session 3, *Chairman and Organizer*, Tony Iles, Kodak Ltd.; Session 4, *Chairmen*, Peter Turner, Media Resources Centre, and Roger Appleton, London Weekend Television, *Organizer*, Richard Marsden, BBC; Session 5, *Chairman*, Peter Harris, CTS, *Organizer*, Ian Magowan, Filmatic; Session 6, *Chairman*, Bernard Happé, *Organizers*, Dick Goodey, Colour Film Services, Dave Pope, Technicolor; Session 7, *Chairman*, Alan Hirst, BKSTS President; *Organizer*, Steve Jaggas, Agfa-Gevaert.

SMPTE Table

The SMPTE table in the concourse

area was the center of a whirlpool of activity, with SMPTE Executive Secretary Lynne Robinson providing membership information and assisting U.S. delegates with information about directions, schedules, and events on the program. Among SMPTE officers visiting the table and, incidentally, giving Ms. Robinson support and encouragement, were SMPTE President Leonard Coleman, Eastman Kodak; Executive Vice-President Harold Eady, Novo Communications; and SMPTE Treasurer Julian Hopkinson, Agfa-Gevaert.

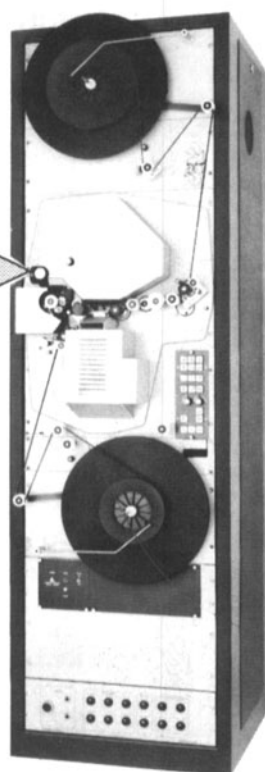
Social Events

In addition to the technical papers program, there was a full slate of social events including a "Cockney Party" at Cafe Royal on June 29, and the BKSTS '83 Banquet at Grosvenor House Hotel on July 1. The Ladies' Program, arranged by Mrs. Sandra Ebbetts, Chairman, and committee members Mrs. Doreen Kimbley and Mrs. Kay Croft, provided some memorable experiences including a visit to the House of Commons, Chartwell in Kent (former home of Winston

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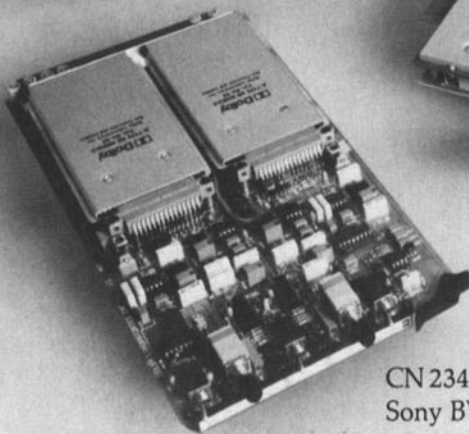
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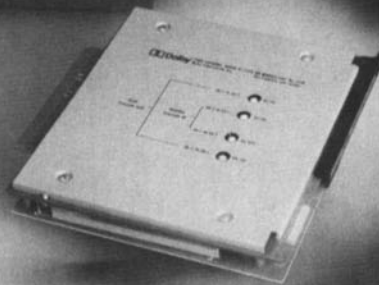
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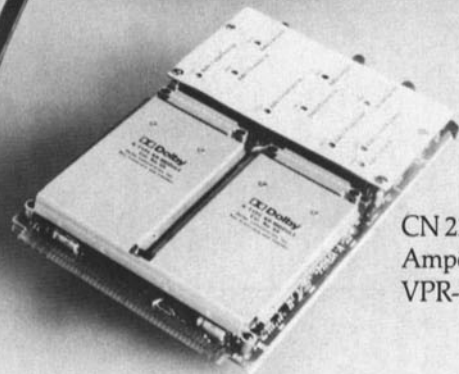
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Churchill), and to Leeds Castle. The ladies also had a choice of a visit to the Royal Horticultural Society Gardens in Surrey, or a canal trip in a luxury canal boat through the London Zoo and Regents Park. On June 30, they were taken to Cambridge University where they toured one of the colleges.

While not, strictly speaking, a social event, the technical visits program, arranged by Peter Milson and associates, was one of the most popular happenings during the week. Visits to studios, television stations, laboratories, and major equipment manufacturers were of special interest.

Scene Today Symposium

Scene Today, a symposium reviewing today's activity in film and video, was held immediately prior to BKSTS '83 on June 25. High-definition images and the techniques of manipulating such images were discussed. Reports on the Australian scene, by Murray Forrest, Colorfilm Pty. Ltd.; the European scene, by Mario Calzini, Cinecitta, Italy, and Roger Huybrechts, Agfa-Gevaert N.V., Belgium; and the Far East scene, by Noboru Tura, provided a comprehensive international view of the industry.

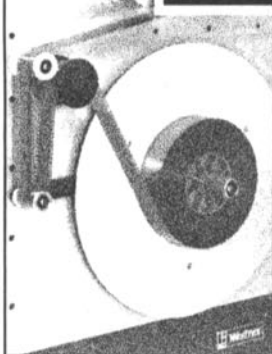
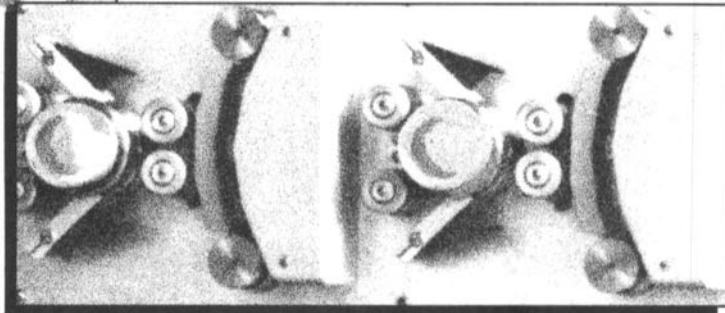
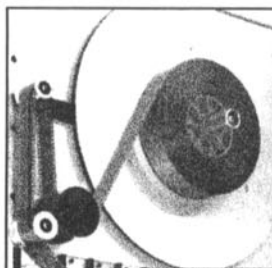
International Relations

SMPTE Executive Vice-President Harold Eady, Novo Communications, acting at the request of Jeffrey Meadows, Chairman of the International Relations Committee, met with SMPTE members from several countries for the purpose of discussing mutual goals.

Among these attending were: SMPTE Treasurer Julian Hopkinson, Agfa-Gevaert; former SMPTE President Robert M. Smith, Du Art Film Laboratories, New York; Governor-at-Large Bengt Orhall, AB Film-Teknik, Sweden; Governor, Canadian Region, Leonard Green, National Film Board of Canada; Governor, New York Region, Irwin Young, Du Art Film Laboratories, New York; Section Chairman Murray Forrest, Colorfilm Pty Ltd., Australia; Governor-at-Large John Barry, John Barry Group, Australia; Assistant to SMPTE Sections Vice-President Paul Yang, Paul Yang & Associates, California; S. Sun, Beijing, PRC; BKSTS President Alan Hirst, Great Britain; H. Grasso, The Netherlands, and SMPTE Executive Secretary Lynne Robinson.

— Rae Hargrave

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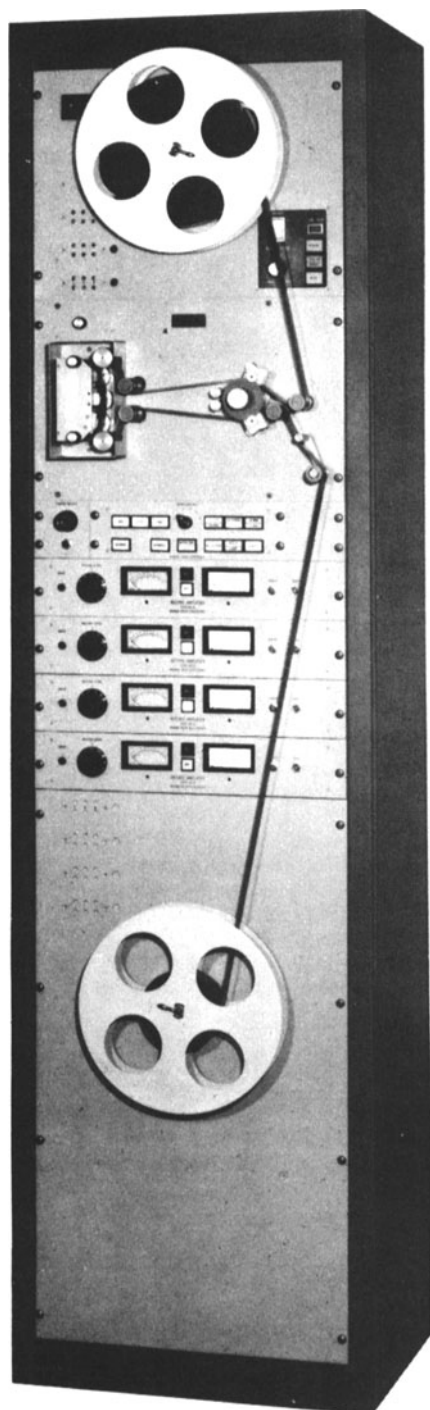
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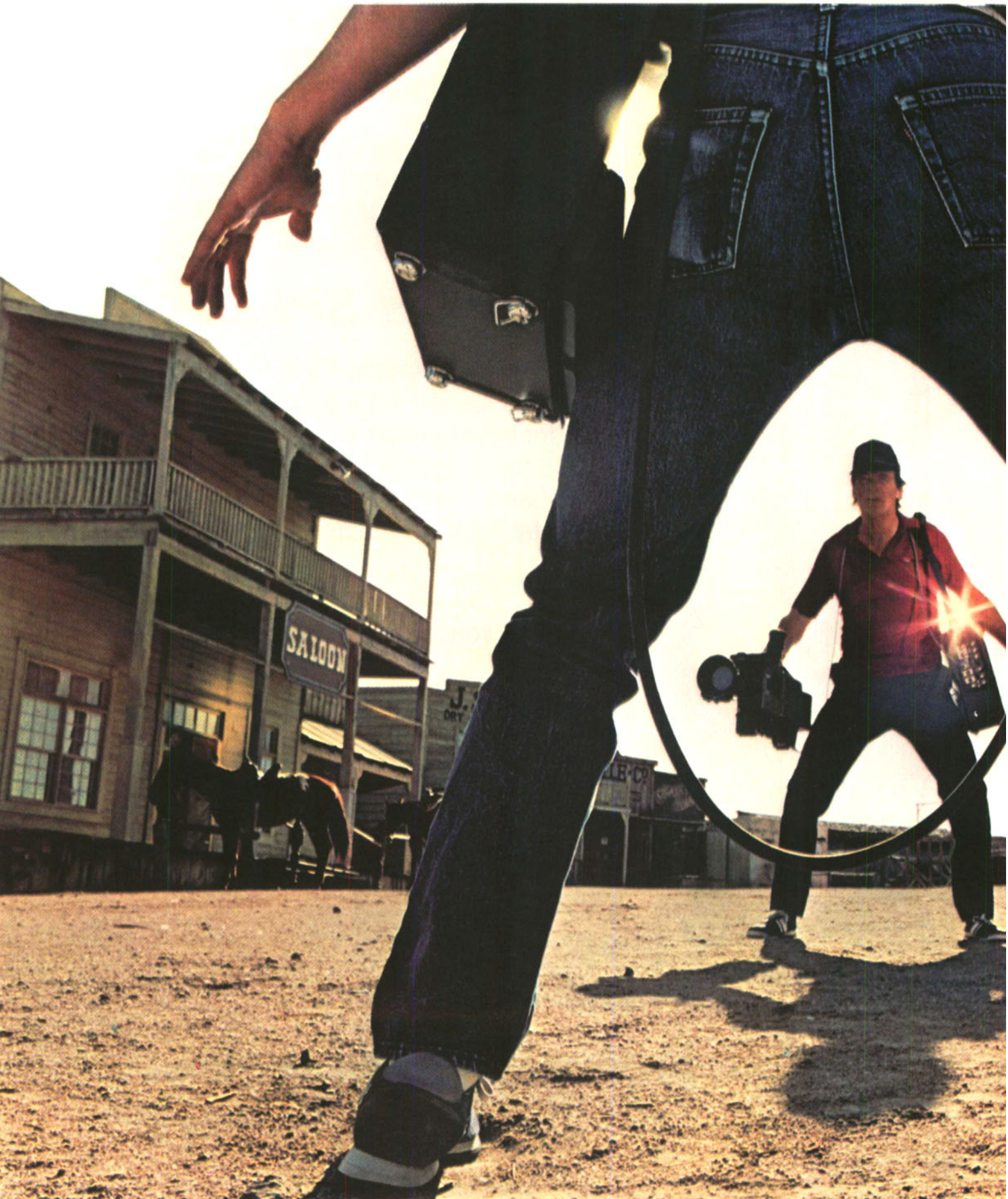
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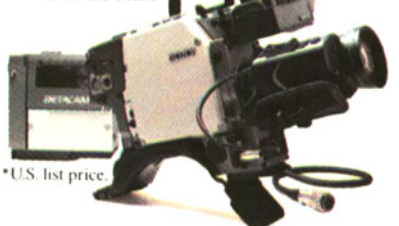
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