

Motion Pictures

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Introduction

Hybrid technology, in which electronics are used to facilitate and enhance the unique imaging properties of silver halide film is one of the ongoing themes of motion picture development. This is seen in systems for production, post-production, and presentation of motion picture films. At the same time, many advances are being made in more conventional film technologies such as optics, silver halide emulsions, and even analog sound. This was the year of *Titanic*, a special effects movie that remained in the theaters for an unheard-of period of time, with many people returning to see it over and over again. It was also the year of two similar movies employing 100% 3-D computer graphics imaging (CGI) techniques—*Antz* and *A Bugs Life*.

Cameras and Accessories

Camera equipment has been enhanced by the use of digital technology for a number of years. Digital simulation of the many different “looks” obtainable is a new application to assist cinematographers while they are shooting. Two systems were announced in 1998:

Eastman Kodak’s PreView System available for rent to cinematographers by Panavision, uses a Kodak professional 520 digital camera, adapted for Panavision Primo lenses, with a 2-megapixel sensor similar in size to a 35mm motion picture frame. Alternatively, the Kodak Digital Science DC 210 zoom camera can be used for lower resolution applications. The digital image is processed using Kodak PreView software to preview the looks of different film types, exposure levels, filters, processing, and printing variations, as well as recording locations, wardrobe, makeup, etc.

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Display of the image can be on a computer monitor or output to a Kodak Digital Science 8650 color printer that produces large-size, photo-quality images to communicate the cinematographer’s ideas to other members of the production team.

Digital simulation was also described in papers presented at SMPTE’s Second Spring Film Conference and the SMPTE Fall Conference 1998 by Dr. Christopher C. Woollard of the University of Greenwich, England. A production workstation enables the producer, director, and cinematographer to analyze the quality of images obtained when using a variety of production tools, from Super-16 and 35mm film to digital video origination. Images can be captured using 35mm still cameras, then scanned at high resolution (12,000 lines/in.) or by using a high-resolution digital camera in the field and having the image transmitted by modem or Internet. Software permits the “looks” of different lighting, filters, lenses, film stocks, and video cameras to be simulated, as well as the effects of M-JPEG and MPEG-2

compression. The latter is particularly important in authoring for DVD and for digital television. Different GoP (group of pictures) structures and cascading of compression systems can be simulated.

Digital Air, Inc., has developed the Timetrack camera system for producing virtual camera movement from a 40-lens still camera. A motion-control shutter system progresses through the camera in linear fashion at frame rates up to 250 frames/per sec as the camera rotates.

A number of manufacturers introduced new lens models. Taylor-Hobson’s Cooke S4 range of T2 prime lenses from 14mm to 100mm have higher resolution, better exposure uniformity from center to edge, reduced spherical aberration, and internal flare. Canon’s 300mm T3.2 Mk IIIB super-telephoto accepts all OpTex universal mounts for 35mm, Super-16, and 16mm motion picture cameras, and 1/2-in. and 3/4--in. video cameras. The Canon 200mm ultra-fast T1.8 telephoto lens is available in two versions, for either 16/35mm film or 2/3-in. video cameras. Claremont Camera’s Squishy Lens has a compressible supplementary lens element that gives creative distortion effects. The central area of the image is a variable clear zone surrounded by an area where the light rays are defocused, producing a tunnel vision effect.

Film Formats

The advent of wide-screen digital television in 1998 gave cinematographers new headaches in formatting their work for compatibility with both 4:3 and 16:9 displays without losing important peripheral scene material in some formats or leaving excessive dead-space at the edges in others. Telecine colorists were faced with related challenges in transferring film images to tape. The revision of the SMPTE 96 standard on Scanned

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Image Areas will help to simplify the number of formats possible. A need remains for clear communication of the format intentions of the cinematographer to the colorist.

Some European film transfers are being made at the compromise aspect ratio of 14:9. The Italian cinematographer Vittorio Storaro, proposed the Univision format for both HDVS and 65/35mm film. This has an aspect ratio of 1:2, described as a perfect balance between that of current 65mm film (1:2.21) and of HDVS (1:1.79). In 35mm film, the image is Super-35 wide with a 3-perforation pull-down. This would also be a release print format employing digital sound only, as the analog soundtrack area is used for part of the picture. For compatibility with European DTV standards the frame rate is 25 frames/sec. On the western side of the Atlantic, the proposal for a digital video production and post-production format of 1080P/24 recognized the large part that 24 frame/sec film will play in television programming for many years ahead, both on its own merits and when intercut with video-originated material.

Wide-screen Technology

The wide-screen market is booming at present and this is forecast to continue. Predicted for the next two years is an increase of 86% in the number of releases for the wide screen: 28 titles in the most popular format, 15-perf/70mm, mostly Imax. This activity is generating new technology as well as an expansion of large format theaters. Imax is planning to build an additional 82 screens on top of their existing base of 171, which consists of 63 2-D screens, 45 3-D screens, and 63 dome theaters. The new Imax SR projector is a smaller unit, capable of filling a screen (only) 56 ft high, compared with the usual 80 ft high screen. Two SR projectors are used for Imax 3-D presentations.

The first of three new Iwerks/Cinema Products cameras should be completed by year-end 1998. This 15/65 camera runs at up to 60 frames/sec and, owing to its carbon-fiber construction, weighs only 38 lb with a 500 ft load of film.

Imax has purchased MSM Design, a camera manufacturer that has developed a camera with a 30-perf pull-down, permitting simultaneous recording of the L and R images for 3-D Imax on the same roll of film. This camera will be used on the International Space Station for a year to produce the Imax *Space Shuttle* film.

Conversions between 2-D and 3-D formats are being achieved in different ways: Imax uses a slip-sync and cut and paste technique, while Imagica USA uses the Xenotech digital conversion process. The alternative format, 8-perf/70mm, is also growing; Megasystems is about to launch a new projection system employing two Geneva movements, one above and one below the gate.

Digital techniques are starting to be used in wide-screen work. The file sizes for these formats are only now becoming practical. Rick Gordon of RPG Productions uses 4K digital scans from an Imagica 65 scanner to provide digital "fixes" to repair otherwise unrecoverable material. David Keighley of Imax predicts that fully digital duplication will match the quality of first generation contact prints within two years.

Film Products

The competitive world of film manufacture continues to benefit cinematographers with improved emulsions. Fuji Photo Film introduced three improved Super-F negatives: daylight-balanced F-64D/8522; tungsten-balanced F-125T/8532; and the high-speed tungsten stock F-500T/8572 with improved granularity and sharpness, exposure latitude, and telecine transfer. Super uniform fine grain (SUF) technology enabled an increase in light sensitivity at the same time as a reduction in the size of the silver halide crystals in high-speed film, and tabular grains were used in all the emulsion layers to improve sharpness. Ilford, Ltd., developed 35mm and 16mm motion picture versions of their black-and-white still films: FP4 Plus, rated at EI 125/22 (daylight) and EI 100/21 (tungsten); and HP5 film, rated at EI 400/27 in daylight and EI 200/24 in tungsten.

Eastman Kodak introduced Kodak Vision 800T film 5289, the first EI 800 tungsten-balanced film. It has grain and sharpness similar to Eastman EXR 500T film 5298, with an extra 2/3 stop of speed for improved depth of field, depth of lighting, and greater available light capability. Kodak SFX-200T film has been introduced to address the needs of the digital special effects community for a film with reduced propensity for colored fringes in digital scanning of blue- and green-screen traveling matte shots. In addition to its first use for special effects by Dream Quest Images in the feature *Mighty Joe Young*, the very high sharpness of SFX-200T film, especially in the red-sensitive layer, is expected to be beneficial to commercials' cinematographers.

X-ray Hazards

A hazard for traveling cinematographers is a new generation of high-powered X-ray security machines being installed in airports worldwide in response to increased terrorist threats to aircraft safety. The Invision CTX-5000SP and related machines employ a primary low-power scan similar to conventional machines. When a suspicious shadow is detected, a secondary high-power (100 to 300mR) pencil beam of X-rays automatically scans the object. In tests by PIMA (the Photographic Industry Marketing Association), all film tested was fogged by the high-power beam, even film of low speeds. Depending on the attitude of the film roll in the beam, the fog image consisted of narrow bars, lines, or sinewaves. Initially, the machines were employed only for checked-in baggage, but they are now being used for hand-carried baggage also, sometimes with little attempt to warn passengers of the risk to their film. An early "victim" was a British documentary crew returning home with many unprocessed rolls of irreplaceable footage.

Telecine

These days, with the need for high-definition scanning for DTV, it is sometimes difficult to distinguish between high-end telecines and digital scanners. One of the criteria is that the

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"telecine" designs operate at higher frame rates, typically in real-time (24 frames/sec), while "scanners" take several seconds to scan each frame.

In preparation for the start of digital television, Cinema Products Corp. developed a high-definition telecine, in collaboration with the Sony High Definition Center, and launched it as the CP TeleScanner. The design combines independently actuated full-fitting pin registration with magnetostrictive pin-actuation technology at speeds up to 60 frames/sec along with a 9-millisecond fast pull-down for image capture, using a Sony HDC 750 high-definition camera. Positional accuracy of +/-0.0002 in. is claimed. Full color control is provided by a Sony additive lamphouse with ferro-electronic LCDs, and electronic shuttering to match the pull-down requirements.

Cintel, Inc., now independent of the Rank Organization, announced that the C-Reality resolution-independent telecine has now been placed in several Beta test sites. The C-Reality employs a newly designed CRT with direct scanning. It is claimed to have noiseless detection through the use of avalanche photodiode (APD) detectors. The HueFX color vector image processor (CVIP) provides full vector manipulation at 14-bit RGB resolution. Scan resolution can be 525/625 or true 2K data, with upgrades promised for real-time high-definition scanning.

CTM (formerly Debrie) has developed the Dixi dailies telecine and analyzer for NTSC/PAL. Images are captured by a standard digital video camera via a mirror galvanometer which tracks each moving frame, flipping to the next frame during the video fly-back. The film is illuminated by a computer-controlled RGB lamphouse that employs no moving parts. This provides color control in transfer and is calibrated in printer lights, allowing it to be used as an analyzer as well as providing PL data to cinematographers with their video dailies.

Film Scanning and Recording

Oxberry introduced the OxScan 2000 film scanner operating at 3 to 4 sec/frame to produce 2K 12-bit files. This machine can provide optional

component video suitable for low-cost offline video post-production.

Imagica Corp. announced the Imager 3000V digital film scanner that can support the Quantel Domino system. Operating at resolutions up to 6K, it employs a trilinear CCD array to scan both 4-perf and 8-perf VistaVision frames.

Arnold and Richter, working with Fraunhofer in Germany, has developed the Arrilaser solid-state laser film recorder, with a film transport based on Arriflex camera design for easy film loading and handling. Scan speeds are 5 sec for a 4K frame and 3.3 sec for a 2K frame.

Soundtracks

New equipment for sound production and post-production include the Nagra Ares-C portable digital tapeless recorder. The recording medium is 20, 40, or 64-MByte memory cards, claimed to be almost indestructible and able to be recorded up to 100,000 times. They have a capacity of 80 min of mono or 40 min of stereo sound recording. Other features include non-linear editing and high-speed file copying. Files can be transmitted via high-speed ISDN lines back to the studio to a corresponding recorder/editor/codec, the Nagra Ares-C-PP.

The new Aaton InDaw low-cost digital audio workstation provides automatic synchronization of sound in the film/video environment, both automatically with AatonCode/ArriCode in-camera time code, and semi-automatically with clapsticks and smart-slates. The InDaw can transfer digital audio signals directly to digital VTRs. The Deva audio hard disk recording system is a nonlinear recorder which, when used with AatonCode, permits effectively single-system telecine transfers of picture and sound, even across camera stops.

Digital sound reproduction in theaters continues to grow. At the

SMPTE Audio Study Group (A12.68) meeting on October 28, 1998, it was reported that for the approximately 30,000 screens in North America, digital equipment manufacturers claimed the following numbers of installed readers (Table 1).

Analog sound use continues to decrease correspondingly, particularly in the newer theaters. As reported last year, the conversion of all theaters to red sound readers capable of reproducing non-redeveloped cyan-dye-only soundtracks is the objective of a group consisting of Dolby Laboratories, Technicolor, and Eastman Kodak, now joined by Deluxe, CFI, and Fotokem laboratories. The "High-Magenta" interim track format, which is fully compatible in terms of cross modulation cancellation with both existing tungsten/infrared readers and red LED readers, was tested in a 100-print partial release of the Warner Bros. feature *City of Angels* printed by Technicolor. Each print was accompanied by a letter explaining the new track format and inviting the projectionist to call an 800 number in the event of problems. No calls were received. A second test will be the 100% High-Magenta release in December 1998 of the feature *You've Got Mail*, also from Warner Bros./Technicolor. If this is successful, it is expected to give distributors and laboratories the confidence to begin a general conversion to High-Magenta tracks and for theaters to complete their conversion to red LED readers. All new theaters built in the past three to four years have included red readers.

Retrofitting existing projectors is progressing more slowly. Ultra Stereo Laboratories introduced the Jaxlight, a low-cost red reader, employing a high-intensity red-LED source as a simple, plug-in replacement for a conventional exciter lamp, along with a line amplifier to provide the necessary additional audio gain. When 85% of screens are

Table 1.

Manufacturer	Worldwide	North America
Dolby SR.D	17,782	7,815
DTS	15,107	8,452
Sony SDDS	6,450	5,332

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converted to red readers, a date for the final switch to cyan dye tracks will be contemplated.

The delivery of closed captions and descriptions for hearing and vision-impaired people in movie theaters has been made possible through the WGBH Motion Picture Access Project. Working with Digital Theater Systems (DTS), General Cinema Theaters, Universal Pictures, and Paramount Pictures, the Rear-Window Captioning System displays reversed captions on a light-emitting diode (LED) text display mounted in the rear of a theater. Patrons use transparent acrylic panels attached to their seats to view the captions so that they appear superimposed on the movie screen. DVS Theatrical delivers descriptive narration via infrared or FM listening systems to headsets, avoiding disturbance of other audience members. Both these systems employ a CD-ROM reader synchronized to the movie using a DTS time code reader mounted on the projector.

Laboratory Operations — Release Prints

With release printing of feature films now converted almost entirely to polyester-base film, conversion of the remaining few percent of cellulose triacetate-base film used for dailies, etc., is expected within a year. New release print stocks are being introduced on non-remjet polyester base only. Eastman Kodak Co. announced two new color print films. Kodak Vision color print film 2383, gives slightly blacker blacks and whiter highlights than Eastman Color Print Film 2386, which it will replace; Kodak Vision Premier color print film 2393 provides much blacker blacks (maximum density over 5.0), higher color saturation, and whiter highlights.

Technicolor, Inc., continued development of its dye transfer process, which had been used for the production of a small number of prints in 1997 using a prototype machine. In 1998 larger limited releases of 50 to 250 dye transfer prints were made, using the first full-size dye transfer machine, for the features *Godzilla*

and *Bulworth*, and the re-releases of *Gone With The Wind* and *The Wizard of Oz*.

The desire of cinematographers for special "looks" has led laboratories to offer additional versions of retained-silver processes, applied not only to release prints but also original negatives, interpositives, and duplicate negatives. These techniques all lead to increases in screen contrast, generally with some desaturation of colors. The process was used by Technicolor to obtain a heavy, depressing feeling in the battlefield scenes in *Saving Private Ryan*.

Environmental Concerns

Environmental regulations continue to become more restrictive to film laboratory operations, particularly for the use and discharge of certain organic solvents. Following its classification as an ozone-depleting chemical, the manufacture of 111-trichloroethane, the most common film cleaning solvent, has been banned, but some laboratories were still using their rapidly-dwindling supplies. In 1998 in California, new restrictions were introduced by the South Coast Air Quality Management District (SCAQMD) on the use of perchloroethylene, the remaining low-cost solvent for film cleaning. There was also major concern about the possible loss of perchloroethylene for its other application — wet-gate printing, for which it is almost unique in its suitability due to its refractive index, which lies between that of the gelatin emulsion and film base.

In film cleaning, the capture and recycling of perchloroethylene had become essential in the design of cleaning machines, with earlier models now unable to meet current regulations. Lipsner-Smith introduced the model CF-7200 film cleaning machine with self-contained solvent recycling using highly-efficient carbon adsorption and a continuous solvent distillation option, allowing simultaneous film cleaning for uninterrupted 24-hr operation. The French company CTM (formerly Debrie) introduced the Ultraclean 2000 solvent-based clean-

ing machine with an optional external vapor recovery system.

Projection

The requirements for increased quality of film projection led to the introduction of a number of improved projectors and accessory devices. Cinema Products 35mm/70mm Electronic Film Projector employs a sprocket-driven electronic pull-down mechanism with precise electronic registration, rather than the traditional Geneva movement. Speeds of 24, 25, 30, 48, and 60 frames/sec can be selected by push-button, along with high-speed forward and reverse running. The Arriflex Loc Pro 35mm projector is a tabletop machine intended to be rented for dailies use on the set. With a very simple threading path, it can run at 1 to 60 frames/sec or high-speed forward and backward shuttling and is absolutely flicker-free at all speeds. It can also be used as a transfer device for video or nonlinear offline editing and will synchronize with DAT or magnetic sound recorders.

Two companies announced automatic control systems for projectors. The Swedish company Autograf Cinema Systems claims its CAF-100 automatic focusing vehicle can detect and correct focus variations the human eye cannot see. The Ultrafocus lamp alignment system, jointly developed by Christie Inc. and Ultra Stereo Laboratories, measures the luminance distribution of light on the cinema screen and automatically aligns the high-intensity xenon lamp in three motorized axes within the lamphouse reflector.

Long-awaited, the advent of digital presentation of movies came closer in 1998. The demonstration of the latest prototype of Texas Instruments' digital light processing (DLP) projector at the SMPTE Fall Conference in Pasadena impressed the audience in a packed hall; however, it was stated that there was still some work to be done to complete the system. In a related paper, Qualcomm, Inc., outlined its plans for direct-to-theater distribution of movies by satellite.