An 8mm Film System for Educational Television

By GEORGE STILLMAN and DON BURGESS

Because of the need for a low-production-cost, mass communications medium for the overseas work of the U.S. State Department and the need for a low-cost film facility at Arizona State University's educational television station, KAET, the use of 8mm, both silent and sound-on-film, was studied. During the six month research project, various audio, video and production methods and equipment were tested for compatibility with the television system. The result was an economical educational television system using 8mm film and TV techniques. The system is feasible and will be tested for a year beginning in January 1966 under the constant demand of a production schedule.

In 1961,* personnel at KPHO-TV in Phoenix, Ariz., made a serious attempt to utilize 8mm sound film for local news coverage as part of standard program material. They had some success considering the limited time available for production prior to program use. The techniques developed at KPHO, however, were abandoned a short time later for various reasons which should be obvious upon consideration of some of the practical aspects and shortcomings of 8mm under the conditions implicit in rapid production. However, their groundwork and cooperation in lending their factory-modified projector to KAET, Channel 8 at Arizona State University, helped considerably during early experiments there.

Criteria and Direction

As is the case with most educational TV channels today, KAET has a limited production budget. Although educational TV has an unlimited potential, studio videotaped productions are likely to become stereotyped and unimaginative, relying heavily on the canned professor-studio-lecture technique. But, considering the difficulties of utilizing remotes, or budgeting for standard 16mm sound-on-film productions, the rationale of straight studio production is easily understood.

In February, 1965, a research project was established at KAET to investigate 8mm sound-on-film for instructional TV and to produce a compatible classroom instructional aid which could be utilized either as film directly in the classroom, or for closed-circuit applications. This technique would then be applicable not only for low-budget educational TV stations in the United States, but would be of immeasurable aid in underdeveloped foreign countries for the dissemination of information where the facilities and conditions do not permit easy access to a given audience.

Some consideration was given to the use of 16mm, but it was felt that utilizing this technique would defeat the original purpose of the project, namely, the development of a low-production-cost mass medium. Six months was allocated for the project, during which we would confront audio, video and production techniques. The work in these various areas could not, of course, be continuous throughout the period inasmuch as normal production at Channel 8 both precluded use of studio equipment and limited our available time. We were able to get at the cameras only between productions and for just a quick run-through of our ideas.

We wished to utilize as quickly as possible on the air material produced with 8mm film to test its compatibility with other program techniques. Once our audio and video were at a sufficient quality level, we began using short inserts of 8mm film with regular production material, and hoped thus to further isolate our remaining problems.

Equipment

It was decided that for the purpose of experimentation, we would not limit ourselves to the one sound-on-film camera available to us (the Fairchild), but would also try to use a high-quality non-sound camera. With two cameras, there would be the advantage of working with an additional production technique, to be described later.

The projector first posed no particular problem, since KPHO-TV had made available a Fairchild Cinephonic 8mm sound projector. This machine had been redesigned with a five-aperture shutter to sync with the scanning of the standard TV camera. A synchronous motor replaced the standard motor and the drive belts were "beefed up" somewhat, for more continuous use. KHPO had, in addition, removed the rheostat dimmer and placed remote controls in parallel with the machine's own control system for ease in cuing the machine from the operating position. A small impedance matching transformer was added off the standard four-ohm audio output to a 600-ohm balanced output which was then padded down for input into the station's audio system. The lens had been changed to half the focal length used for 16mm to facilitate feeding the machine into a video chain.

With all the above modifications, there seemed little more to do than mount the projector in the chain (Fig. 1) and roll. However, utilizing a commercial 8mm black-and-white film, we set the projector into position in the chain and soon discovered that to achieve a relatively sharp image, the condensors also had to be moved to a new operating position. We found that in any position, the quality of the video was undesirable. Grain, dirt and grime appeared, and the projector focus would not stay put. We then started from scratch to isolate our problems without adding the further complications of the chain.

Evaluating an image projected onto a beaded screen, we learned that although we apparently could arrive at critical focus, it was difficult to hold. We compared several other commercial projectors and, although they varied in optical quality, similar difficulties were observed. There were two major contributing factors. First, mounting the drive motor within a light-weight enclosure caused vibration within the projector. Generally, this drive motor was mounted on the side wall close to the film gate, so that even after clamping the base of the projector the vibration remained. Second, the pull-down mechanism was extremely close to the film gate, so that as it was moved into position by an eccentric, it drove the film forward slightly while it was being pulled down. This caused a slight, but noticeable, lack of critical focus on the TV screen. The fault was corrected by careful alignment of the pulldown mechanism.

With the pulldown mechanism adjusted, we were able to project and pick up the video on a studio image-orthicon camera. This, in spite of parallax difficulties, resulted in an acceptable image. However, we could not, even by trying various screens, completely overcome the appearance of a "raster haze."

The most successful screening device proved to be an editing tool (Fig. 2). The film editor was fitted onto the projector and the image projected onto a single surface mirror which then was focused onto a finely ground glass sur-

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* Richard B. Rawls, "8mm sound film: a professional news medium for television," *Jour. SMPTE 71:* 575–577, Aug. 1962.

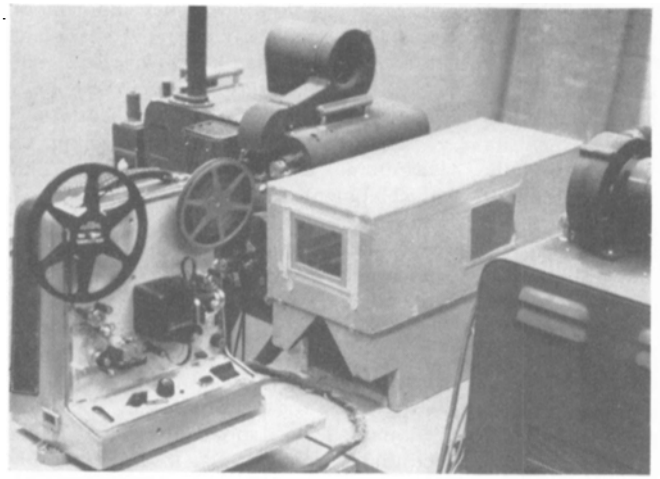

Fig. 1. 8mm projector in position on KAET Channel 8 second film chain.

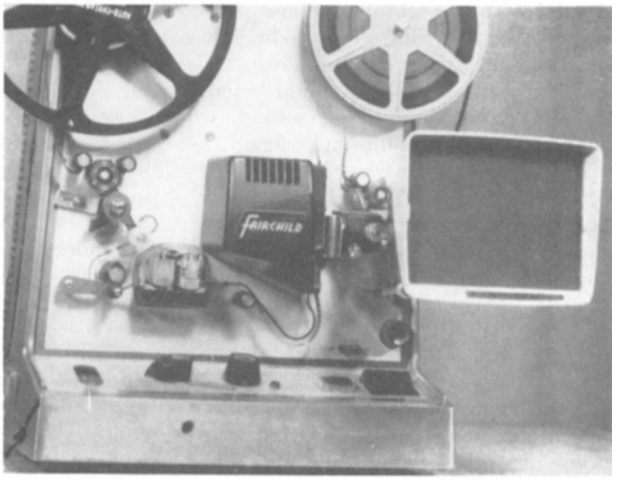

Fig. 2. Projector with "film editor" in place on Fairchild cinephonic sound projector.

face. The resultant image was approximately 4 by 6 in. and quite brilliant. Sufficient light was present to give us considerable latitude for adjustment of the video camera (Fig. 3). Although still plagued by relatively minor adjustment problems, we were able to produce a professionally acceptable image.

Film Stock Availability

The availability of prestriped black-and-white film stock is limited, especially for lower ASA emulsion speeds. One solution to the problem appears to be a "do-it-yourself" operation using a machine costing about $50 to apply sound tape to raw stock or processed film. The cost is something over one cent per foot.

Our tests of several film stocks were limited. Strictly from a research point of view, we would be obligated not to limit ourselves simply to a solution of getting good 8mm on camera, but from a practical point of view that is what we were looking for. Tests were made of several black-and-white as well as color films. Since one of our objectives was to find a compatible classroom-TV tool, color film is much more versatile although somewhat more expensive than black-and-white.

High-speed black-and-white reversal film proved to be unacceptable for our standards. The inherent grain structure and lack of resolution resulted in poor video. Color films, particularly those of lower ASA ratings gave excellent results as far as grain structure and resolution were concerned, but the color quality was not as good as that of Kodachrome II. A compromise had to be made based on cost and function, using the lower-priced color films. Dynachrome and Anscochrome were chosen for our work in production, as well as the slower black-and-white film stock. Utilization of these types of film requires a controlled situation, with sufficient light of the proper spectral quality available on location or in the studio. These requirements are not unusual, even for 16mm or 35mm but with 8mm are more critical.

Audio

Magnetic stripe applied to 8mm, although only 30 mil wide, provides acceptable audio for speech. Reproduction is limited to approximately 80 to 8000 cycles/sec, far from hi-fi but not at all objectionable. Sound is reproduced through a magnetic head located 56 frames ahead of the image. There is sufficient loop between the film gate and the head to allow for smooth playback. Music is distorted, of course, by the limitation imposed by the 8,000-cycle cut off, especially in violins and other treble instruments. Carefully selected music can be used if recorded at a low level and if a voice-over technique is utilized.

It was recognized that editing would present some problems insofar as the audio was concerned, because prestriped film recorded in the camera places the audio 56 frames ahead of the picture. Removal of any portion of the film automatically cuts off audio which relates to other than the image material. Even if no editing is done and more than 50 ft of film is to be used for a production (approximately $2\frac{1}{4}$ min), the spliced-in portion must begin with 56 frames of silence to preserve an image on the screen before audio is possible. There are several solutions to this problem. (1) Production can be planned, as will be described later, for unedited film portions, at the same time filling the "silent gap" with material not requiring lip sync. (2) The audio portion can be considered as a convenient tape recorder and be used to pick off the audio onto a tape recorder which can in turn be dubbed back to the film in sync. Visual-audio sync indications are helpful to aid in keying the tape. (3) A separate audio

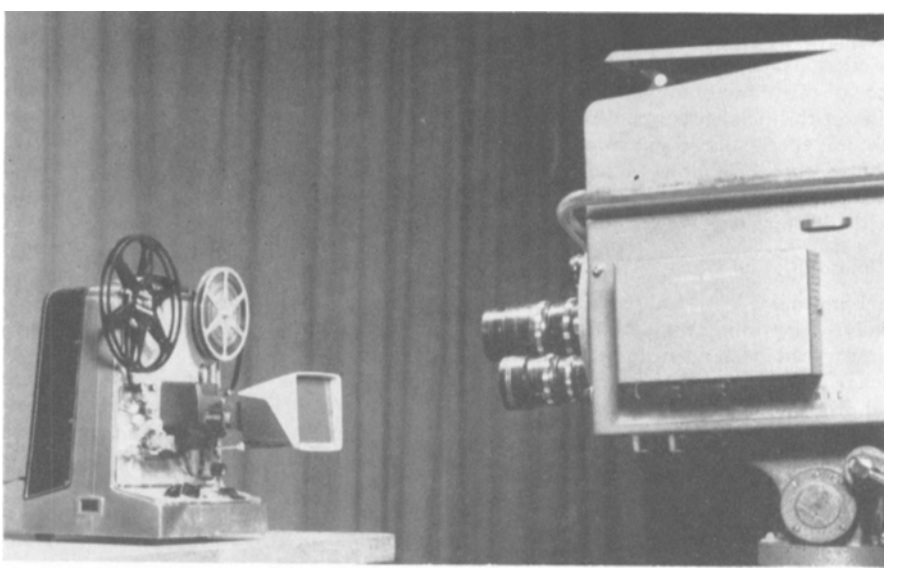

Fig. 3. Model 4PE16A1 1.0. camera with 100mm lens in position and focused on "film editor." Projector is a modified Fairchild as described in text.

recorder can be employed and synchronized to the film after production. The third technique has the advantage of being only second generation sound, while (2) becomes third generation by the time it reaches the film stripe again.

The latter system (3) using a tape recorder was tried. With dimensionally stable audio tape, no difficulty was encountered in producing lip sync, although the process is not easy, especially when editing is required. Furthermore, visual keying can be done only at the beginning of a sequence since editing out any visual clues between sequences adds to the problem. Editing the tape as well as the image is required. We were successful with "sound on" with the Fairchild camera, but the audio is not as good as that dubbed from tape. A sync audio track, even if deficient in quality, is extremely useful as a "cue track" for later dubbing.

Cameras and Related Equipment

The details relating to actual production are often minimized in reporting results. During our research, we often found that the "little things" were extremely important if we were to be successful.

Much amateur equipment (most of 8mm and related equipment falls into this category) is difficult to work with. Not only did we require good optical resolution of our cameras, but vertical and horizontal stability as well. Ideally the camera should run the full length of the film without rewinding — electrically driven cameras have this advantage. In trying to sync sound, in edit, etc., there are sufficient details to worry about without adding wind-up problems.

Because 8mm cameras are lightweight, there is a tendency to think that light tripods can be used for filming. Actually, as the film size is reduced, the problem of camera movement becomes more critical. We adapted one of the smaller standard TV dollies and a large tripod friction head (TD-10 camera pedestal) for use with our 8mm cameras. The action of this head was smooth and could, by use of the large extension arm, be controlled to follow action without the tremble or jitter generally associated with this film size.

Philosophy and Films

Film and TV techniques differ radically. By editing film, time and continuity can be built from seemingly unrelated bits of action to form a meaningful whole. Although video tape can be edited, it is difficult.

At present, 8mm film has some of the same limitations as video tape, especially when working with original positive or reversal film. With 16mm or 35mm, an answer print can provide a certain amount of comfort on the editing table; further dissolves, etc., can be made part of the editing decisions. It is possible and sometimes desirable to print 8mm dupes or even shoot on negative stock and follow the same procedure as used with 16mm, especially if multiple classroom films are required. However, the facilities for producing 8mm prints, especially in black-and-white once split, are limited. Special effects added after filming are far more limited than for 16mm. The advantages of 8mm, however, far outweigh its limitations.

We decided at the outset of this project to try to take advantage of the facilities for 8mm film and TV techniques. Film offers the ease of portability of equipment to locations inaccessible to the low-budget educational TV studio; 8mm cuts the cost of both equipment and film. If then, we were to adapt film techniques as much as possible to TV procedure, editing could be cut to a minimum without sacrificing too much quality.

A series of pilot films were produced to synchronize the shots with the script, similar to the way in which programs are produced on tape at Channel 8. There were a few notable differences. First, the film capacity of our main camera limited us to a little over two minutes running time at 24 frames/sec, requiring a break in continuity not experienced with tape. This problem, though not severe, can be eliminated with multiple cameras. Using a zoom lens, we were able to make single angle shots more interesting. The scenes were timed to move camera position within the two-minute interval. As a result, the film change at the end of each film was not noticeable. Each scene was accurately timed as a precaution against running out of film before a scene ended.

Our first pilots required lip sync. We utilized the Fairchild camera and dubbed the last 56 frames of any given complete film run (2 min and 45 sec) with the first 56 frames of the next run. Though editing is always possible, even with this technique, for safety's sake a complete audio tape was made simultaneously. This gave us the added security of editing both audio and film without using the strip as the master audio source. It is our experience that this "insurance" is a necessity.

Future Equipment Design Considerations and Film Services

Adaptation of equipment to the TV medium requires design changes. Much time and effort is wasted in adapting a product to a process for which it was never intended. Even professional company adaptations often do not recognize a function change when equipment is to be used in the TV medium. Projectors sit upright as if the image were to be projected onto a screen, whereas a console film feed would be more realistic and far easier to thread and control. The limited market for specialized equipment makes equipment development in this field unattractive to the manufacturer, but there is reason to believe that some experimentation along these lines might lead to commercial applications.

There are indications that 8mm is beginning to be taken seriously. The development of "Super 8" by Kodak and "Format M" by John Maurer of JM Developments, Inc., along with adequate provisions for optical and magnetic sound, indicates that the shortage of film services in this area will soon disappear. Much of the difficulty, for example, in synchronizing sound by the "hunt-and-peck" system could be eliminated by sprocketed 8mm tape editing methods similar to those used for 16mm. Both Fairchild and Technicolor 8mm cartridge film projectors have improved film use in the classroom.

Portability of Equipment

The portability of equipment is a major factor in determining whether a television station films something or not, especially if sound on film is required. The task of loading a 16mm magazine for sound on film, the toting of the camera, sound accessories and power cord sometimes become large problems. A battery-operated sound-on-film 8mm with no sound equipment except a head set and a microphone greatly simplify the transportation of equipment to any desired location. We packed the 8mm sound-on-film camera $5\frac{1}{2}$ miles into the Superstition Mountains to record two old prospectors. If we had had to use a 16mm sound-on-film camera, we would never have shot the film. In addition, the sound is of comparable quality to single-system sound recorded on a 16mm sound-on-film camera, plus the advantages of editing, redubbing, and the addition of sound effects as explained earlier in this paper. On 16mm, the redubbing or the addition of sound effects would be impossible except by the time-consuming preparation of an optical track in a film laboratory or by the addition of a sprocketed 16mm magnetic tape to a magnetic track.

Additional Advantages of 8mm for ETV

In the fall, KAET-TV will produce a series of programs on the history, folklore and people of Arizona. We plan to utilize the 8mm camera a great deal in this series. On earlier programs of this nature, the school systems have requested showings. Programs were usually on video tape. So little film was used that only by using the video-tape recorder in special viewing sessions for 30 or 40 people have we been able to replay them. Upon completion of the new series, the film segments could easily be spliced together, narration added to the magnetic striped film, and the films be made available to school systems for use in classes. Sound on film and color would

greatly increase their value and utility. Attempting to use 16mm in this manner would be out of the question economically.

Editing Film with TV Switcher

With the purchase of two 8mm sound-on-film projectors synchronized and modified for the TV system, a special type of editing could be used. For example, if a person who is scheduled for an interview doesn't have the time to make a special trip to the studio, he can be interviewed on film. If he makes references to landmarks, buildings, etc., corresponding scenes can be shot. If there is not time to edit cut-away segments into the film, redub the sound, etc., the sound-on-film interview is put in one projector, which can be part of the film chain; and the cut-away scenes are put on a studio camera. Watching both images, the director can choose between them at will. What might result in an otherwise monotonous interview can be made immeasurably more interesting.

Compatible Utilization of Film-TV in an Instructional Situation — Evaluation Requirements

Solving some of the more critical 8mm TV technical problems is only the beginning. The usefulness of 8mm production material as it relates to ETV and other instructional situations must be evaluated. Much research has already been done on the effectiveness of educational audio-visual techniques, and we feel little need to prove further the effectiveness of TV or the motion picture as a teaching medium. But in spite of this research, practical applications must still be investigated.

How to utilize known, effective ETV techniques economically is the question. Educational motion pictures or TV must be highly accessible and they must be versatile enough to be called upon to do a teaching job at a moment's notice. Through use in closed- and open-circuit TV, 8mm, along with continuous-loop cartridge projection, shows promise of filling the bill. Practical solutions remain to be researched.

Double-System 8mm Sound Cinematography in Education

By ARTHUR G. EVANS

A double-system 8mm recording capability has been devised and is in use at Orange Coast College. With this method, costs have been reduced to about 50¢/min, including materials and labor. Complete equipment was developed for about $5,000. The system is used to record lectures in large class groups after which the films are placed in the library. Students who have missed a lecture, or wish to review, can view the films at look-listen stations. A research program is in progress to assess the effectiveness in terms of increased learning.

A NEED HAD ARISEN at Orange Coast College for an inexpensive sychronous sound and picture capability. To cope with the growing number of college students, some classes are extremely large. For a number of years, some of these lectures have been sound tape recorded. Several listening stations equipped with playback machines and earphones are located in the library. Students who miss a lecture, enroll late or wish to review may check out tapes and listen to them. This arrangement has proven highly successful in terms of increased instructional effectiveness, although an obvious drawback of this method was the lack of visual recording.

Large group instruction, lends itself to audio-visual techniques. Presentations, largely visual, negate the effectiveness of mere sound recording, and psychological experiments have shown that the largest percentage of human learning occurs through the sense of sight.

Development

Criteria for such a sight-sound synchronous recording system included: (1) continuous recording of at least 50 minutes (normal length of a college class), (2) low cost in terms of materials, (3) ease in transport, (4) relative quiet during operation, (5) inexpensive and simple playback facilities for individual student use, (6) trouble-free operation, (7) low initial equipment cost, (8) equipment capable of operation and maintenance by technicians with no more than two years of formal training (junior college level), (9) no additional room lighting and (10) color if necessary to make instructional points.

An initial reaction to such criteria might be to use videotape; however, television fails to meet the criteria. Cost of playback is high. Each playback station would cost at least $12,000. The cost of color for this application would be prohibitive. Additional room lighting and resulting instructor discomfort would probably be necessary without the use of image orthicon cameras. While television and videotape recording is certainly possible, it was eliminated from consideration for this application.

This left film; 16mm single systems were investigated. The college had two single system 16mm cameras. All criteria could be met, more or less, with 16mm. The college also has its own black-and-white film processing facility; therefore, the per-minute cost of single system 16mm optical recording is reasonable. But while inexpensive for many purposes, costs would mount rapidly when many hours each week were required.

In terms of film cost and ease of playback, 8mm seemed to be ideal. Black-and-white 8mm film with a magnetic sound stripe can be produced, without editing, for less than fifty cents per minute.

The problem remained that there was no equipment on the market that met all the criteria. Playback was no problem. A number of excellent 8mm magnetic machines are on the market. One even provides cartridge loading. The problem was the 8mm synchronous filming capability.

The one single system camera available failed to meet the critiera. It is capable of only short continuous runs. The cost of prestriped film is high.

Because of the cost of applying magnetic coating to raw stock, and because of the unavailability of an optical sound system of any sort in 8mm, a double system utilizing magnetic sound was decided on.

(*1*) *Camera:* An 8mm H-8 Bolex Rex (reflex) was purchased. The body of this camera is almost identical to the 16mm model. The 16mm cameras have often been modified to accept magazines. It was no trouble to adapt the H-8 to accept Mitchell magazines. A 1,200 ft magazine is used and more than meets the time requirement. At 24 frames/sec, 8mm consumes only 18 ft of film per minute. A magazine load yields over 65 min; 1200 ft of 16mm film perforated

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