PREPRINT NO. 98-1

COMPUTER-INDEXED FILM HANDLING

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PRESENTED AT THE *SMPTE*
98th TECHNICAL CONFERENCE
NOVEMBER 1-5, 1965

Additional preprints may be obtained by sending request and remittance to the:

SOCIETY OF MOTION PICTURE & TELEVISION ENGINEERS INC.
9 East 41st Street New York, N.Y. 10017

Produced in co-operation with BROADCASTING and COMMUNICATIONS

THIS MATERIAL WAS PRINTED IN CANADA

Conference Price
.25
An increased price will be in effect for mail orders.

Computer-Indexed Film Handling

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Abstract

Digital computers can keep track of complicated files of information and can automatically control machinery. They can, therefore, be used with motion pictures: in editing, to keep track of contents of film segments and automatically assemble desired editorial combinations or actual masters; in film libraries or archives, for cross-indexing; and in hyperfilms, a new medium here proposed, to present movies which are variable in content and sequence.

The problem is one of computer programming and file structure; the author suggests his Evolutionary List File for all these purposes.

Before a field can be computerized, its practitioners must be made aware of the sorts of things computers can do there; hence one purpose of this paper is tutorial, to point these out. But beyond that I wish to call attention to some possibilities that may not be obvious either to those who know computers or those who know films. The technical and creative sides of motion pictures have not yet been touched by the computer. They will be. I want to describe some of the possibilities. My own chief interest is in applications of the computer that will further creativity and learning; the systems I will talk about are intended to do both.

The computer revolution has scarcely begun. Yet because of bad explanations and inappropriate publicity, computers are misunderstood by nearly everyone. Computers are not, contrary to legend, enormous or always enormously expensive. Computers get cheaper and faster every year, and this trend will continue for some time to come. Right now a powerful computer that sits on a desk-top can be purchased (without accessories) for $18,000. But for many purposes it is not necessary to own a computer or even have it on the premises. A recent development called time-sharing

permits a big computer located elsewhere to service the entirely different problems of many users at the same time. To use a computer in this way may cost one user only a few hundred dollars a month. For the first applications described here, time-shared usage should be entirely satisfactory.

Computers can do a large number of things. As everyone knows, they can count and do arithmetic. But they can do much more. They can control other devices, i.e., turn them on or off, or change their settings. They can test the outside world, by taking readings from any measuring instrument you may attach. They can store information of any kind, if it is suitably translated. They can copy this information out, on printing machines or even cathode-ray display tubes. And they can branch, changing their course of action on the basis of information fed in by outside devices or discovered by internal calculation. The class of applications to be discussed here involves chiefly the storage of index information and the control of machinery. There are a number of ways that these indexing and control facilities can profoundly influence film techniques.

The applications I want to discuss are different but related; for clarity I will stick to a simple descriptive sequence, without refinements or exotic elaborations. In order of relative complexity, the applications are the indexing of archives, the automatic assembly of optical masters, computer-controlled trial editing, and the hyperfilm.

The first application requires no new equipment and little complex programming. Since the computer can store information about the film, including exact footage/frame counts and edgenumbers, the computer makes it possible and convenient to index film archives in much greater detail than has been possible before. Films could be cross-indexed by subject, director, actors, writers, effects, types of scene, and so on. The information would be kept on magnetic tapes or disks and searched, by a computer, when it was

desired by persons using the film library or archive. While this idea is not surprising, I mention it for its relevance to the techniques described below.

Consider a bidirectional film drive which can be exactly controlled by electrical signals from an outside source. It might work by frame counting, shaft-encoded feedback, or other means. Let us call this two-way remote-control film drive just a "control box" for the rest of this paper. It is at the heart of the applications that follow.

Employing two of these control boxes, a computer-controlled optical printer may be constructed which makes cutting the original unnecessary. The original would go in one chamber and film gate, unexposed stock in another. Between them would be a lens, shutter and light source. The computer can plan the film movements necessary to make a desired print, and ascertain an efficient sequence in which to perform them. Then, because the control box may be hooked to the computer, the computer may actually carry the movements out. The computer would move the source and target films backward and forward independently, latching the shutter closed when appropriate, and even time the print. No human intervention would be required except to change cassettes, and the system would produce a final optical master, according to the specifications of the editor, and without splice-marks, in a few hours. (Double-system sound could be handled identically, with the computer modifying potentiometer settings instead of print time.)

Such an application would require editing decisions to be made beforehand. It would not help or simplify the creative part of the editing process. Presumably a workprint would have to be assembled beforehand, and its final sequence formally transmitted to the computer. However, a slightly more complicated setup will eliminate the workprint as well, give

the editor a flexibility and creative control he has not had before, and help his work go more quickly. For this we will need closed-circuit TV and bidirectional video recorders as well.

Suppose that we set up a closed-circuit video network with several source films and control boxes, and several bidirectional video recorders, all connected to a central crossbar switching matrix. Each of the video recorders may be spaced forward and back an exact number of frames, presumably by counting the sync pulses. This would mean the video recorders could be used as buffers in the computer sense, places of temporary storage from which the images can be read out into other recorders. This would permit video recordings to be copied, sorted and rearranged under automatic control just as financial records are now. (We will ignore the problem of images deteriorating over generations of transfers, since we can restrict the copying process to the number of generations deemed acceptable for a given purpose.)

This setup would make it unnecessary for the film editor to handle film at all. Sitting at his TV monitor, he would simply specify, by hand controls, the points at which he thinks the film should be cut and spliced, and the order in which the sections are to go. The system will then assemble on videotape the sequence he has asked to see. This is done by running the film and recording different sections on different recorders, then rewinding and re-recording all shots in the correct order. In a fraction of the time it would take him to cut the print physically, the sequence he has requested will be ready to view on the monitor. Since he can spend most of his time choosing and viewing, rather than assembling, it will be possible to try out more combinations, and to work faster, than he can now. Moreover, no celluloid workprint need be made at all: a videotape master could be made directly from the negative and electronically reversed in polarity, at a large

saving in cost. And the information derived from the final "cut" on tape could then be automatically transferred to the first machine to generate the optical master. (Actually, the same computer would probably do both jobs, so information transfer would be unnecessary.)

These applications tie in smoothly with the way things are done today, merely replacing certain of today's methods. The following applications, however, depart to a new realm, and their long-range consequences are hard to imagine.

We have observed that a complex of video recorders can be used, under computer control, to prepare a sequence of shots for an individual viewer. There is no reason that the use of such machines should be restricted to film editors. Such systems would make possible automatic film libraries or museums for entertainment and study. A viewer, at a television screen with a control keyboard, could choose for himself from a central catalog the scenes or footage he wanted to see and compare. These could be sequenced as he wants and automatically presented.

This leads us to the final idea of this paper, the hyperfilm. The generalized facility described above-- employing two-way film drives, videotape buffer recorders, an automatically switchable video network and a master control computer-- makes possible an entirely new medium of information and presentation. I would like to call this medium the "hyperfilm." A hyperfilm is a film with no single fixed linear sequence, and over which the viewer has a degree of control. Its contents may be perpetually indexed in a variety of different ways, from which the viewer may select. For example, he could watch newsreels, not in the fixed and single sequences he would see on commercial television or in a theater, but according to his interests and at the level he wished, looking only at the highlights or probing into details as if he were reading a newspaper. On a

grander scale, such an arrangement would make possible a true encyclopedia of film, which could be browsed, studied, and viewed in changed sequences for clarification.

This would not mean the downfall of the editor, but rather a new dimension to his work: that of option. Editing into the film complex the kinds of option that will be useful should call for new kinds of creativity. The increased variety of possible choice in this new medium-- as in the multiscreen films introduced at the recent World's Fair-- demands even more sensitivity, taste and imagination than films require now.

Hyperfilm is the general medium; a hyperfilm would be a single unified production in this medium. The hyperfilm's chief use would presumably be for film materials of a documentary nature. But it is difficult to speculate on the kinds of choices, arrangements and possibilities that could exist. The buffered video network would permit any imaginable permutation of sights and sounds, under full or partial user control. The variety of possible hyperfilms is greater than the variety that exists of either books or films (since the hyperfilm can contain books; see below.) Right now we can only imagine and consider. It will take artists to invent and discover the techniques, much as Griffith invented and discovered so many basic techniques of film.

Hyperfilm rigs would be very expensive. But there would also be important economies of scale-- building a large system would permit more users and reduce idle time on equipment. Decentralization could help spread the investment: dispersed libraries and viewing studios could be connected by coax, creating a city-wide or even national network of visual information.

I have roughly described all the different possible systems I set out to describe. But there is one further ability of computers, not yet mentioned, which promises to be directly useful in these systems. This is

computer-driven display. A computer, hooked to a cathode-ray tube (such as the one in an oscilloscope or TV set), can plot points on the tube's face in sequence, making bright dots appear. By plotting tens of thousands of dots per second, pictures and words can be shown on the screen. Such a display can move or be still. A non-moving display can be captured in a storage tube, where it can be held for several minutes. And cathode-ray displays from computers can be neatly photographed by television cameras; a computer-display-to-TV unit is even commercially available. The addition of such hookups to the buffered video network promises to create an instrument of even greater versatility and power. Titles, subtitles, and documentary information of any kind can be displayed by the computer and mixed into the other picture material. The film editor could keep the script and all his notes inside the system; the hyperfilm could permit long titles and texts, maps and moving diagrams to be be generated as needed, so as not to take up space as film or videotape.

This combined facility would in effect be an automated film-and-text library for all purposes.

The difficulties of such an approach do not lie where most people would think-- in the hardware or the time-shared programming. The problem of designing and programming such a system is like the problem of programming a large computer for different use by many people at the same time; and that problem has been substantially solved. But a large difficulty is the problem of file structure. Conventional files-- and most computer files are conventional-- are fixed in arrangements and purpose, and very hard to expand or change in overall ways. In a recent publication ("A File Structure for the Complex, the Changing and the Indeterminate," in the Association for Computing Machinery: Proceedings of the 20th National Conference, 1965,

84-100) I described a file, the Evolutionary List File, which escapes in certain ways from these restrictions. By storing its contents in a type of sideways-hooking list array, it permits continual expansion and deep change without losing track of things. These features will increase in importance as a hyperfilm library grows, and parts of the same material are put into more and more edited sequences. Maintaining the human comprehensibility of the whole will be important; and the Evolutionary List File, or a related approach, may be the answer.

All the systems I have described are entirely hypothetical. None is ready to run. It should be obvious that the necessary mechanical linkages would be easy, if expensive, to create. But beside the hardware costs, there are the software costs-- the costs of programming, and of correcting and repeatedly modernizing the programs once they are written. Program costs for complex jobs do sometimes cost as much as the physical machinery, but that depends also on what else is to be done simultaneously by the equipment, and many other matters.

One thing is clear in my mind. The art and technique of the film as we know it-- just like the arts and techniques of library science and all education-- can be transformed by the computer into something entirely different and new and wonderful. And as in those fields, this transformation will take money and willingness. In a sense, it's as ready to happen as you are to let it.