

COMPUTER ASSISTED FILMMAKING:

A REVIEW

Tom Calvert

Computing Science and Kinesiology,  
Simon Fraser University,  
Burnaby, B.C., V5A 1S6

ABSTRACT

Developments in the application of computers to filmmaking are reviewed. Particular attention is given to the use of database systems for overall co-ordination, to the use of preview systems to plan live action and animation, to the problems involved in rendering high quality images and generating realistic motion for animation and to the potential for improved editing.

KEYWORDS: Animation, Images, Computer Graphics, Filmmaking.

Computer based systems are currently being applied to assist filmmaking in a number of ways. The creative drive of innovative directors is combining with the economic pressures generated by the increasing costs of conventional production methods to speed developments in a number of areas. In parallel with the use of computers in making films there are equally rapid advances in applying computers to video program production. This paper reviews the advances that can be expected in the immediate future and deals mainly with software systems. Hardware developments will also have a dramatic impact; when it becomes technically feasible to replace the film medium with digital storage during the production of live-action it will be possible to take advantage of the flexibility of digital image processing in editing and processing film. This requires the development of high quality digital cameras and digital film printers.

Any brief review will necessarily be incomplete. The discussion below will concentrate on the use of database systems for overall co-ordination, on the use of preview systems to plan live action and animation on the problems involved in rendering high quality images and generating realistic motion for animation and on the potential for improved editing.

Database Systems.

The director Francis Ford Coppola has already made extensive use of the database management capabilities of the computer and Lucasfilm's Sprocket Systems Division has a comprehensive database system under development[2]. There is no easy way to summarize this application; the pre-production, production and post-production phases of filmmaking involve the co-ordination of many details. One example is the development of shooting schedules. A script is usually organized in terms of scenes which are in temporal order and which each involve a group of actors in a particular location. However, for economic reasons, shooting is generally organized to minimize setup and movement from one location to another; thus all of the shots in a particular location or even involving a particular actor may be done at one time. Obviously a database system can be set up to routinely provide details of the different props, clothing, lighting etc. which must be used for the different scenes being shot out of sequence at each location. Great economies are possible if better management such as that illustrated in the example can minimize time spent shooting live action.

A data base management system can be equally useful in producing animation. A complex image is synthesized from a number of discrete objects which are shown against an environment or

background which may itself have independent components. To animate a scene the components move in some meaningful and more or less time-continuous fashion. The film is made up of distinct scenes which may or may not have the same objects and the same backgrounds. Although in simple cases the director/ animator can keep track of all of the objects and the conditions under which they are to be viewed, in any complex situation a database system is almost a necessity. It has also been suggested that the dependencies inherent in a database provide a useful basis for image generation.[1]

#### Preview Systems.

Preview systems, sometimes known as "electronic storyboards", are being used by Robert Abel, Digital Productions and others to give relatively crude animation of a scene while it is being planned. Typically the equipment consists of a vector graphics display and a host computer. The objects present in a scene are entered in sufficient detail to produce line drawings which can be manipulated relative to each other in three dimensions. Key-frames may be set up manually by a director using knobs, a joystick or a tablet. Simple animation is then produced to give a real-time display of the movement from key-frame to key-frame. When the director is satisfied with the composition of the key-frames and the movement patterns between them, the co-ordinates and orientations of the objects and the orientation and movement of the cameras can be read out for shooting live action or can be fed directly into a database for production of computer animation. Preview systems of this type greatly increase the opportunities available to a director since he can "play" with the preview of a scene many times before deciding how it will be shot. There are also great savings to be made since shots and setups can be planned in detail in advance so that shooting may be cut down by as much as 50%. Abel has estimated that a full length feature film could be previewed for a cost approximately equal to the cost of one day's live action shooting[2].

#### Animation.

To date, computer animation for feature films has been limited to what are essentially special effects. Examples include sequences in Starwars, Startrek II and Tron[2]. Digital Productions and Sprocket Systems, among others, are working to develop the capability to produce totally realistic high quality images[3,4]. The resolution necessary has been variously estimated to be between 500 and 8000 lines. Possibly an image of 2000x2000 pixels at 24 bits/pixels will be adequate, although it may be that in order to produce high quality images at this resolution frame-buffers of 4000x4000 will be necessary. In order to render images realistically, objects must first have their surfaces represented either with planar polygons or with higher order patches; the very large number required will push the limits of even the largest computers [5,6,7]. Surfaces must be rendered with appropriate color and texture and the problems of transparency, highlights and shadows must be handled [4,8,9,10]. All of this is technically achievable but the process is still very much of an art and depends on the expertise of a very few specialists. Further, as noted above, the rendering of realistic images is limited by the memory size and speed of the computer available. Whitney and Demos at Digital Productions have estimated that their Cray 1S computer could produce one 90 minute feature film per year, for example. While there is probably no feature film which is currently in production for complete rendering by computer, there is certainly work underway to produce increasingly long sequences to be integrated with live action.

In addition to high quality images, realistic animation requires the production of natural movement patterns for any object or character being simulated. While several existing systems provide some capability in this area, particularly for non-articulated objects, none are truly comprehensive and none provide for human animation[6]. The work of

Badler[11], Zeltzer[12,13] and ourselves[14] provides a starting point for human animation. Although the use of computers to produce totally realistic animation of human actors is not yet possible (animation of a close-up of the face is particularly difficult), it is probably quite feasible to animate background characters in crowd scenes, etc. It is interesting that although the 2-dimensional animation required for cartoon characters is really much simpler than 3-dimensional animation with total realism, most cartoon animation is still done by hand[15].

#### Editing.

This is an important phase of conventional film production. While this phase will be integrated into other phases when computer animation systems are used, conventional filmmaking has much to gain from computer assisted editing. Much of the technology is already commercially available for video-tape editing and can be used for film by transferring workprints to video, editing the video and producing a frame keyed set of commands for editing the film negative. Complete computer control of film editing must await the replacement of the film medium with a digital medium and this in turn requires the development of high quality digital cameras and film printers.

#### Conclusions.

There is no question that creative directors and hard economic pressures are together stimulating the rapid development of computer based systems for filmmaking. This development will provide many challenges for the computer scientist, particularly in the areas of image rendering, simulation/animation and artificial intelligence. We can speculate as to whether the ultimate step will ever be taken to replace the "formula plot" of a situation comedy with a computer generated script and thus produce a completely computer generated program or film. However we can certainly expect the development of comprehensive systems which allow the artist to move

easily from a creative idea to a visual representation of this idea in the form of a story told on film or video.

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