Current Comments

The Science Research Film: A Moving Picture is Sometimes Worth a Thousand Words

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A fascinating development in twentieth-century science is the use of cinematography in research. For many researchers today their movie cameras are stock "tools of the trade."

According to my old friend Anthony Michaelis, the editor of *Interdisciplinary Science Reviews*, scientists often use the films they create as the original data sources on which they base their journal articles.[1] Sometimes they obtain information from their films which otherwise would be unavailable. Films are important in certain kinds of scientific research because they extend the capabilities of the human eye. They also provide an objective record of events.[2]

In the forward to Michaelis's book, *Research Films*, physicist Sir Robert Watson-Watt writes about the camera's advantages over the human eye:

> The cinematographic camera can be an undisturbing, indefatigable, continuously alert observer, often observing from viewpoints inaccessible to the human eye. It has persistence of vision without confusion of image; and it is a time machine, with forward and reverse gears, capable of expanding or compressing time scales at will. It is impartially precise in its simultaneous clarity of vision over a wide field, such as can be scanned only successively by the restless human eye, but can be held continuously and uniformly by the camera eye. It is this characteristic that enables the camera to act as a continuous correlator among physical quantities, relating one or more processes to a common time scale, or relating one process to another.[1] (p. VII)

Furthermore, since film is exposed frame by frame, scientists can stop the action at any time to examine specific frames. Film also allows researchers to study a phenomenon time and time again, without restaging the experiment. Comparing two films of the same phenomenon taken at different times allows scientists to observe changes that have occurred over time. And even those who did not participate in the original research can see it as it was performed.

Obviously, some of the same qualities of film that make it advantageous in studying certain phenomena can be viewed as disadvantages.[3] Scientists and science film makers must take extreme care

that the making of the film does not distort the phenomenon studied. If color is added, it must be carefully documented. If images are slowed down, if they are enlarged, if special techniques are used—these changes must be made clear in accompanying texts or narration.

The variety of disciplines to which scientific cinematography can be applied is bounded only by the imagination. Research films run the gamut from astronomy to zoology. Using cameras, anthropologists can study human cultures in a less disrupting manner than possible otherwise. Psychologists can observe human actions without interfering in their spontaneity. Botanists can study plant growth without disturbing natural environments. Time lapse photography is possibly one of the most spectacular tools of the modern plant scientist. And ethologists can study animal behavior without introducing the human element. A telescopic lens makes it possible to enter dangerous places that would be inaccessible otherwise.

Some concrete examples of research areas which have been significantly enhanced by film making follow:

The Activity Characteristics of Gibbons[4] is a film which documents behavioral components of play in young adult gibbons (tailless apes), including wrestling, chasing, surprise approaches, and copulation. It illustrates the behavior of nonhuman primates in a natural environment.

Arc Welding of Metal with Coated Rod-Electrodes[4] fascinated me, as I once worked as a welder in a shipyard. The slow motion camera shows the transfer of metal from coated rod-electrodes during the arc welding process. The film was taken at 8,000 frames per second in very strong backlight.

Extraction of Anesthetic Gases from Operating Theatres[4] shows how a vacuum extractor removes traces of anesthetic during the patient's expiration cycle. The subject was backlit on a dark background to show the gases as a light gray cloud.

Investigation of Mastication by Means of X-Ray Cinematography and Single Frame Analysis[5] shows mastication movements with partial or full dentures. The researchers conducted frame-by-frame graphical and numerical analyses of the picture sequences. From these, they could identify each component of movement during mastication.

Science research films have been around as long as motion picture technology.[6] An inventor of one of the first motion picture cameras was a scientist who needed the tool to study human and animal locomotion. In 1882, Etienne-Jules Marey, a French physiologist, took the first motion picture with a single camera in order to study the flight of birds. The device he invented contained a circular glass plate covered with photographic emulsion. It was able to receive twelve consecutive images in a second.[1] (p. 5)

Marey's invention was heavy and could record images only briefly. He continued to work on his device and in 1888 described to the French Academy of Sciences[7] a camera

that used light-sensitive paper moving intermittently past an optical lens. In his classic book, *Movement,* published in 1895, Marey revealed the cinematographic techniques he used and explained the research he conducted with his apparatus.[8]

Since Marey's time, thousands of scientists have become interested in film making and in using the newly developing technology for their special purposes. Photographic technology now allows scientists to see infrared and ultraviolet light on film and to view moving x-rays. Using a zoom lens attached to a microscope, researchers can make very small organisms appear large enough for group viewing when the film is projected. Mirror lenses with long focal lengths record dimly lit objects at long distances. And electronic lenses provide researchers with a way to view and record to the macromolecular level.[3]

Film is employed as a research tool by scientific institutions throughout the world.[6] Science film making activities have a high priority in the USSR where at least one university, Lomonosov State University in Moscow, has a special department of scientific cinematography. In Australia, a major part of the research film activity is carried out by the Commonwealth Scientific and Industrial Research Organization.

The Scientific Research Film Service in France has been incorporated into the French Office of Modern Educational Techniques. The office supplies scientists with the technical help they need to allow them to use film as a research tool. It also distributes the resulting films.

The Federal Republic of Germany has a national research film making organization which acts as a resource center for scientists whose own organizations do not have science film capabilities. The Institut für den Wissenschaftlichen Film employs specialists who combine expertise in science with in-depth knowledge of motion picture technology. Other countries like the US, Britain, and Japan have highly decentralized film-making capabilities.

In the US, research movies are made in government institutes, private laboratories, and universities. More than 650,000 feet of 16 mm science film is shot each year in American universities alone.[6] The money for science research films often comes from government or foundation research grants. Government agencies such as the National Aeronautics and Space Administration and the Commerce Department's US Weather Service sponsor many research films within their own organizations. The National Library of Medicine's National Medical Audiovisual Center in Atlanta produces educational films for health science professionals.

According to the *Directory of Science Communication Courses and Programs,*[9] fewer than ten US universities offer courses in science film making. However, according to Elizabeth Flory, president of BEE Cross-Media, Inc. of Rochester, NY, an active member

of the American Science Film Association, the number may be as high as 200.[10] Courses in science film making can be difficult for the student to find. Professors who make science research films as part of their own work may occasionally offer special courses on this subject. John M. Buchanan, director of the science communication program at MIT, says the university offers a graduate program in science film making.[11]

In some universities research films are produced in film production units funded from the school's budget. Most colleges do have documentary film courses where students can get an introduction to the special technologies they must master in order to shoot many types of research films.

Like printed publications, science research films must be cataloged and kept in libraries to assure proper access to them by scientists. Those that are copyrighted are deposited with the Library of Congress. In the US, over 2,000 research films are housed in a collection called the *Encyclopaedia Cinematographica*[12] at Pennsylvania State University. The collection was founded in the Federal Republic of Germany in 1952 by Dr. Gotthard Wolf, former director of the Institut für den Wissenschaftlichen Film. The films in this collection are not narrated or interpreted in any way. Each deals with only one well-defined process or phenomenon. They are usually accompanied by a detailed text explaining the procedures used in the research.

Other branches of the *Encyclopaedia* are located in the Federal Republic of Germany, at the Institut für den Wissenschaftlichen Film, 34 Gottingen, Nonnesteig 72 (its headquarters), Japan, Austria, and the Netherlands. They each house up to 2,500 research films. Films kept in the archive are selected by an editorial board made up of people associated with the collection and scientific film makers.[12] The films fall into three categories—biological, technical, and anthropological sciences.

Films from the US *Encyclopaedia* are available to classroom teachers and research scientists for a small rental fee. Scientists can view the films at special facilities in the archive at no charge. The archive handles about 1,000 circulations each year. A catalog of films in the archive is published every two years and is free of charge.

According to Robert Allen, director of the US collection, the *Encyclopaedia* is underused.[13] He would like to see more scientists take advantage of this unique resource. Interested researchers can reach Allen at Pennsylvania State University, Audiovisual Services, University Park, PA 16802.

One by-product of science film making for research is the recycling of the material for educational or popular science audiences. For example, ethological research films are easily adapted for university courses on animal behavior. With some animation and narration added, the same footage could be incorporated into a TV science documentary.

The International Scientific Film Association (ISFA) promotes all types of science films—educational, popular, and research. Founded in 1947, ISFA maintains an archive of science films at 15 Rue . Vautier, 31, B-1040 in Brussels, Belgium. This archive, the International Science Film Library, holds films deposited by the organization's national affiliates and offers facilities for viewing them.

ISFA will hold its next annual meeting in Tokyo in April. Its US affiliate, the American Science Film Association (ASFA), headquartered in Philadelphia, will hold its next bi-annual meeting in Washington, DC, in October 1980. A highlight of both the international and national meeting is the screening of the best films. You can purchase a catalog of the films shown at ASFA's 1978 meeting for $5. The catalog provides the names and addresses of the producers or distributors of the films. ASFA is located at 3624 Market St., Phila., PA 19104. This happens to be located in the University City Science Center where ISI® is moving this fall. Randall M. Whaley, president of the Science Center, is also president of ASFA.

As science film making increases, scientists will one day face the problem of keeping up with films—just as they do now with journal articles. Presently two publications by ISFA—*Research Film* (co-sponsored by the *Encyclopaedia Cinematographica*) and *Science Film*—try to keep scientists informed about films, techniques, and resources available. The American Association for the Advancement of Science publishes a quarterly called *Science Books & Films* which lists educational films in the sciences.

This year we'll be studying how we might include information on current films in *Current Contents®* . Like TV and audio cassettes, films are another non-print medium helping to shape the information revolution.

I would be remiss if I did not mention a recent entry into the science film arena. Computer-generated films are now a reality.[14] At least one company I know of has done considerable research in this area. For further information contact Leon Malin, Mathematical Applications Group, Inc. (MAGI, Inc.), Three Westchester Plaza, Elmsford, NY 10523.

REFERENCES

1. **Michaelis A R.** *Research films.* New York: Academic Press, 1955. 490 p.
2. **Ruhe D S.** Visual literature of medicine. *J. Med. Educ.* 30:540-2, 1955.
3. **Wolf G.** *The authenticity of the scientific film.* Munchen: Goethe Institut Munchen, 1978. 17 p.

4. *Showcase collection catalogue.* Philadelphia: International Scientific Film Association/American Science Film Association, 1976. 168 p.
5. **Arnold M & Ernst F D.** Röntgenkinematographische untersuchung und einzelbildanalyse der kaubewegung. (Investigation of mastication by means of x-ray cinematography and single-frame-analysis.) *Res. Film* 8:309-15, 1974.
6. **Tosi V.** *Cinematography and scientific research.* Paris: UNESCO, 1977. 60 p.
7. **Marey E J.** Technique physiologique: décomposition des phases d'un mouvement au moyen d'images photographiques successives receuillies sur une bandé de papier sensible qui se déroule. (Physiological technique: analysis of the stages of a movement by means of successive photographic images recorded on an unrolling strip of sensitive paper.) *C.R. Acad. Sci.* 107:677-8, 1888.
8. ----------. *Movement.* New York: Arno Press, Inc., 1972. 323 p.
9. **Friedman S M, Goodell R & Verbit L.** *Directory of science communication courses and programs.* Binghamton, NY: Department of Chemistry, State Univ. of NY at Binghamton, 1978. 46 p.
10. **Flory E.** Personal communication. 13 March 1979.
11. **Buchanan J M.** Personal communication. 14 March 1979.
12. **Wolf G.** *Encyclopaedia Cinematographica. (Catalog) 1952-1972.* University Park, PA: Pennsylvania State University, 1973. 208 p.
13. **Allen R.** Personal communication. 28 February 1979.
14. **Elin L.** Synthavision: serendipity from the nuclear age (Leavitt R, ed.) *Artist and computer.* New York: Crown, 1976. p. 109-11.