MOVING IMAGE AND SOUND: BASIC

Instructor: Ann Harris

Student: Julio Cabrio

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Image 1[1].

> "The changes occurring in film technology and practice and their influence on film archives has highlighted that archives are undergoing radical changes in their practices. This is due to the many technological, social and cultural transformations related to the transition to digital and, since such changes are ongoing and it is not clear yet where they will lead, archives have a unique chance to rethink role and tasks *in medias res*". [2]

Introduction

By the final quarter of the twentieth century, the technology used to deliver moving images as a mass medium had relocated from public buildings to private homes. The technologies of film and television are historically and closely linked but, as Leo Enticknap said, "there are also fundamental differences, both in the

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1 Image from: http://www.elmousa.com/sites/default/files/TRV-16H_TRV-35H_brochure.pdf

2 Fossati, Giovanna. *From grain to pixel*. Amsterdam University Press, Amsterdam, 2009, page 255.

technologies themselves and in the cultural, political and economic frameworks through which they were developed, established and sold”[3].

Also Enticknap added a clarification on the nature of both kinds of images saying “film records images through the use of chemical compounds that react to the presence of light, and in which the results of that reaction can be made visible to the naked eye. Television and video recording work by representing a visual image as a series of changing electrical modulation which can either be transmitted by radio, TV or recorded onto magnetic tape. Later the changing electrical modulations were replaced by representing the image as a digital data which is encoded and decoded by a computer” (Enticknap, L. 2005; page 160).

This is the case for transition technologies with moving image and sound in general, and especially on the transition from film into video formats. For this reason, is important to consider the main issues and differences about the transfer between different audiovisual materiality. As Stuart Blake Jones mentions “From the beginning, the successful transfer of film to video has been an uphill battle. Not only does each medium have its own physical characteristics, but each also has a unique look and range of expression. Furthermore, each has evolved a characteristic viewing environment”[4].

The first major user of video, the television broadcast industry, fostered this particular kind of transfer promoting the development of several equipment with the same goal. One example of that is ELMO, a United States corporation that has been dedicated to quality, innovation and service by developing unique technologies for image and sound, and to make positive contributions on the audiovisual field for the last 90 years. Over the early 80s, *ELMO Corp* came up with *ELMO TRV Series*, also named as *ELMO TransVideo* that consist in a set of two products: *ELMO TRV-16H* and *ELMO TRV-35H*. Both products involve a system to convert film image and sound into electronic image and sound. *ELMO TRV-16H* was the name of the ELMO device to transfer 16mm film into video and *ELMO TRV-35* was the name of the ELMO model to convert 35mm slides into an electronic video signal. Also both devices *ELMO TRV-16H*

[3] Enticknap, Leo. Moving image technology. Wallflower Press, London, 2005, page 159.
[4] Jones, Stuart Blake. Film into video. Focal Press, Boston, 2000, page 39.

and *ELMO TRV-35H* were manufactured in Japan and internationally distributed in the US, Canada, Japan and Germany until 1999.

Telecine Process

This paper will be focused on the process of ELMO TRV-16H, one of the first enterprises and the most professional equipment at the 80s trying to convert 16mm film into video formats. Then, lets answer the question, what is *ELMO TRV-16H*? It is not a format; it is basically an artifact that performs the Telecine process to transfer film image and sound into electronic video signal. The simplest Telecine consist of a film projector, which focuses an image on the screen of a video camera. It looks like a projector because in some way it is a projector. As it is explained by the own builders, "the ELMO TRANSVIDEO SERIES is a system to convert your film image into electronic image by means of a projector equipped with a built-in video camera"[5]. As well as the image, the sound is also converted from both optical and magnetic film sound into an electronic audio signal.

Also, the technical specifications and the technology involved help us to understand the ELMO TRV-16H mechanism and its Telecine process. Some of the ELMO TRV-16H characteristics to highlight are:

a) Dimensions are 350mm(W) x 220mm(D) x 290mm(H).
b) Weight is 13kgs (it is a pretty portable device).
c) Film gauge is 16mm (involves the 16mm projector technology).
d) Projection speed is 24 frames per second.
e) Synchronous control for image and sound.
f) Video TV System is NTSC compatible,
g) Image device is a charge-coupled device (CCD)
h) Picture elements are 811(H) x 508 (V).
i) Definition is 410,000 pixels approximate.
j) Audio system has either optical and magnetic sound playback.
k) Optical system with F1.8, f=25mm lens, iris and focus adjustments.

[5] ELMO CO. *Service Manual, Transvideo TRV-16*. Published by Elmo Co. Ltd, Nagoya, 1986, page 1.

In that sense, also the description of ELMO TRV-16H switchers can be helpful:

- The main switch turns on/off the power supply to the projector.
- The M-O switch to select the audio recording system.
- The framing lever for adjusting the screen.
- The master control knob is used for forward, reverse and stop the projector.

A workflow diagram can easily explain the equipment chain to be set up:

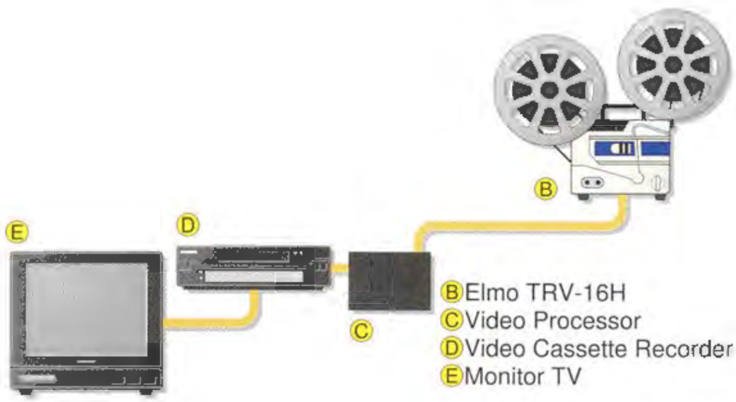

Image 2[6].

In all of the Telecine artifacts, light is projected through the film (whether negative or positive image) onto a pick-up device that translates the image into an electronic (or digital) video signal. This also allows the electronic (or digital) video signal to be processed and altered. In this process there are two basic components: a flying spot scanner (FSS) and a charge-coupled device (CCD).

An efficient explanation of a FSS describes: "In a flying spot scanner (FSS) or cathode-ray tube (CRT) Telecine, a pixel-sized light beam is projected through exposed and developed motion picture film (either negative or positive) at a phosphor-coated envelope. This beam of light *scans* across the film image from left to right to record the vertical frame information. Horizontal scanning of the frame was then accomplished by moving the film past the CRT beam. This beam passes through the film image, projecting it pixel-by-pixel onto the pickup (phosphor-coated envelope). The light from the CRT passes through the film and is separated by dichroic mirrors and filters into

[6] Image from: http://www.elmousa.com/sites/default/files/TRV-16H_TRV-35H_brochure.pdf

red, green and blue bands. Photomultiplier tubes or avalanche photodiodes convert the light into separate red, green & blue electrical signals for further electronic processing"[7].

The parts of a FSS in every Telecine are:

A) Cathode-ray tube (CRT).

B) Photon beam.

C) Dichroic mirrors.

D) Red, green and blue (RGB) sensitive photomultipliers.

As for the FSS, there is a solid description that says: "In a charge-coupled device (CCD) Telecine, a *white* light is shone through the exposed film image into a prism, which separates out the image into the three primary colors, red, green and blue. Each beam of colored light is then projected at a different CCD, one for each color. The CCD converts the light into electrical impulses, which the Telecine electronics modulate into a video signal, which can then be recorded onto videotape or broadcast"[8].

The parts of a CCD camera are:

A) Xenon bulb;

B) Film plane;

C) Prisms and/or dichroic mirrors;

D) RGB sensitive CCDs.

This process involved the challenge of adapting the behavior of the film image and sound into video system. As Dominic Case explains "In the American 60-field per second television system frames are scanned alternately twice and three times, corresponding to the basic 24 frames per second (fps) film speed"[9]. This frame rate differences shows the need of a process to adjust the film speed of 24 fps with the video speed, 25 fps for PAL/SECAM or 29,97 fps for NTSC video standards.

The most complex part of a Telecine is the synchronization of the mechanical film motion and the electronic video signal. Every time the video component of the

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[7] Jones, Stuart Blake. Film into video. Focal Press, Boston, 2000, page 48.

[8] Jones, Stuart Blake. Film into video. Focal Press, Boston, 2000, page 49.

[9] Case, Dominic. *Motion picture film processing*. Butterworth & Co. Ltd, Boston, 1985, page 160.

Telecine samples the light electronically, the film component of the Telecine must have a frame in perfect registration and ready to photograph. This is relatively easy when the film is photographed at the same frame rate as the video camera will sample, but when this is not true, a sophisticated procedure is required to change the frame rate.

On one hand, in countries where the PAL or SECAM video standards are used, film destined for television is photographed at 25 frames per second. The PAL video standard broadcasts at 25 fps, so the transfer from film to video is pretty simple; for every film frame, one video frame is captured. The frame rate difference of 1 fps is imperceptible to the human eye. On the other hand, in the United States and other countries like Japan that uses the NTSC television standard, film is generally photographed at 24 fps. Color NTSC video is broadcast at 29,97 fps. For the film's motion to be accurately rendered on the video signal, an NTSC Telecine must use a technique called the *3:2 Pulldown* to convert from 24 to 29,97 fps.

The term “pulldown” comes from the mechanical process of pulling the film down to advance it from one frame to the next at a repetitive rate (nominally 24 fps). This is accomplished in two steps. The first step is to slow down the film motion by 1/1.001. This speed change is unnoticeable to the viewer, and makes the film travel at 23,976 fps. The second step of the *Pulldown* is the 3:2. This means that at 23,976 fps, there are four frames of film for every five frames of NTSC video, which can be demonstrated by simple mathematics: 23,976 / 29,97 is equal to 4 / 5.

As it is explained by Dominic Case, “These four frames are *stretched* into five by exploiting the interlaced nature of NTSC video. For every NTSC frame, there are actually two complete images or fields, one for the odd-numbered lines of the image, and one for the even- numbered lines. There are, therefore, ten fields for every 4 film frames, and the Telecine alternately places one film frame across two fields, the next across three, the next across two, and so on. The cycle repeats itself completely after four film frames have been exposed, and in the Telecine cycle these are called the A, B, C, and D frames. The patterns generated by this cycle are identical except that are shifted by one frame. In other words there is no difference between the two patterns, it is only a matter of reference”[10]. Then, this relation established between the frames on film and the fields on video can solve the frame rate differences.

Pros and Cons

One of the advantages of the ELMO TRV-16 was the cost. It was at the time and it is already a very cheap device to transfer film into video. The current prices are around 1000 and 1500 USD. Another advantages are the dimension and the weight. It can be easily transported by hand.

The main disadvantage of ELMO TRV-16H was the use of CCD first generation camera with very low definition. Then, with the evolution of the video definition at the end of the 90s and the prevalence of digital formats at the 21st century, it became obsolete pretty quickly.

Variations and Alternatives

However, there are some contemporary adaptations of the ELMO projectors into a Telecine system with HD and UHD cameras racing 2K and 4K definition standards. The following image shows an example of these adaptations.

Image 5[11].

[10] Case, Dominic. *Motion picture film processing*. Butterworth & Co. Ltd, Boston, 1985, page 162.

[11] Image from: http://www.ebay.com/itm/Elmo-Movie-Projector-Video-Transfer-Unit-Dual-8-Built-In-Sony-4K-UHD-Camera/141729993378?_trksid=p2054897.c100204.m3164&_trkparms=aid%3D222007%26algo%3DSIC.MBE%26ao%3D1%26asc%3D20140407115239%26meid%3D4d00636149244c99954327b2b07dbc01%26pid%3D100204%26rk%3D10%26rkt%3D15%26sd%3D130987751554

It involves an ELMO K-100 SM projector for dual 8 (Regular 8mm and Super 8), with a video transfer system including a flying spot scanner adapted to a built-in Sony 4K Ultra-HD camera. It is a “real time” transfer process, which means that it will transfer typical 50 foot reels of 8mm film in 4 minutes. This process race the 4K high definition standards and it price is around 3000 USD. It allows an excellent image quality on capture but it doesn’t allow sound capture because is a silent system. An important factor in this kind of adaptations is that the capture must be done in a completely dark room because the FSS and the camera are external devices and light sources outside the projector can cause image distortions.

Some film archives are using these new adaptations of Telecine process to digitize their films making digital master copies for preservation proposes and access duplicates. For those repositories, this represents a huge economic advantage in comparison with the expensive film scanners.

The University General Archive (UGA) in Uruguay has adapted a Kodak Pageant AV-126-TR 16mm projector with a FSS into a Panasonic AC-1000 2K Full-HD Camera. The digital image from the camera is transmitted through an Aja Kona digital board into a PC by a SDI connector. The digital image at the PC is capture by using the Final Cut Pro software. The set up of this Telecine process allows the UGA to provide HD for digital preservation masters and access copies. Although, the 2K definition doesn’t get the excellence on digital standards, it plays a significant role on preservation through avoiding the handling of the original films. The following picture shows the Telecine station at the UGA (Uruguay).

Another interesting direction for this project could be to compare the Telecine processes with the film scanners technology but unfortunately these aspects are not cover in this paper.