Technical Paper by James Hoagland, Peter Hull, and Carolyn Gimian

This paper investigates new methods in the conservation and transfer of 1/2 inch Black-and-White open reel video tapes. It was written in 1995 in connection with the Shambhala Archives Video Recovery Project, during which over two hundred video tapes were recovered using the methods described below.

Introduction

The biggest overall problem in working with aging video tapes is that magnetic media as currently recorded have a comparatively short life span.

Our immediate problem was the recovery of several groups of 1/2 inch reel to reel video tapes recorded in the 1970's. These included several hundred hours of video recorded at the Naropa Institute in Boulder, Colorado, as well as a group of tapes produced by the Video Theater of Halifax, including a number of National Film Board productions.

Goal of Video Recovery Project: to achieve playback with minimal degradation of the image or loss of the image, in order to transfer information on the tapes to a new format. Note that this is a different view of preservation: preserving the information rather than the original artifact.

A particular difficulty in working with this material is that it was not possible to pre-view it. The tapes might be so fragile that we presumed and were advised that we might have only one opportunity for playback and transfer.

Elements of a successful video transfer.

1. Playback Equipment

In order to undertake conservation, one has to have working equipment to serve as a transport for the original tapes. This is a bigger problem than might be imagined: what was the standard for video in 1970 is now rare and no longer manufactured. The rate of obsolescence with video equipment makes it imperative to archive equipment as well as the tapes themselves.

2. The Condition of the Original Tapes

Many problems in achieving playback will be related to the tape. We will return to this area in a moment.

3. The equipment and the tape that you are transferring the material to:

You have to consider what current format you will put the information on. There are several aspects to that. First you have to decide whether you will be encoding the information digitally or analogue. If you opt for an analogue recording, as we did, then you have a number of further choices, starting with all of the magnetic tape formats that are available. You might also want to investigate alternatives such as a laser disc recording, optical disc, etc.
In selecting tape, it is imperative that you use the best tape that you can afford. In our case, we are using 3M Broadcast quality tape. Broadcast quality tape conforms to higher standards of manufacturing and must meet more stringent tolerances. It has better packing and packaging and is of a consistently higher quality. It is important to stay with one kind of tape, because different tapes will wear the heads of the equipment differently.

4. The Storage and Work Environment

Factors such as humidity and temperature fluctuations, as well as the presence of dust in the atmosphere, will have an effect on the success of playback. Therefore, it is good to work in a temperature and humidity controlled environment, with minimal dust and other contaminants. If tapes are stored in a controlled environment but worked on in an uncontrolled space, this could have adverse effects on the transfer.

Problems associated the tape itself and possible solutions to those problems.

First, we need to briefly look at the nature of magnetic tape and the recording process. Magnetic particles are suspended in a medium with binder and lubricant. Diagram In this case the magnetic medium is iron oxide. When the tape passes over the recording head, the particles are magnetized on the tape in such a way that the video signal is encoded onto the tape.

Many factors can cause deterioration in the recording and the tape itself, or cause problems with playback and transfer:

1. factors in the original formulation and manufacture
2. factors in how tape was recorded, (equipment in good working order, tracking problems with original equipment, audio or video levels recorded too high or low,)
3. treatment/care tape has received, including
    1. environmental factors, (temperature, humidity, exposure to dust and other pollutants in the air, stable environment or one that changes drastically)
    2. Storage (stored vertical/horizontal, what kind of case)
    3. handling and playback history (tapes played a lot or a little, fingerprints, rewound from time to time, rough handling).
4. Aging

These factors, acting singly or in combination, can cause one or many of the following problems:

1. loss or deterioration of signal
2. loss of lubricant or binder
3. oxide shedding
4. dirt on the tape
5. edge damage
6. cinching or buckling
7. tracking problems

A footnote to the above: Even if one is able to address problems with loss of signal and mechanical problems in achieving playback, one may also find problems in the original recording such as poor lighting, framing or mixing. It may be possible in some cases, if it is deemed advisable, to undertake later enhancement of the original recording to compensate for poor lighting or some other problems with the recording. In other cases, there is not much that can be done to remedy poor recordings.

Our presentation today focuses on the technologies and the methodologies we have employed to solve certain technical problems in the video transfer process.

To begin with, we should note that, if we find serious problems with loss of lubricant or binder or if we encounter significant contamination such as mildew, we do not attempt transfer. These tapes are set aside, to be dealt with

later. This has only been deemed necessary with about a half dozen tapes, one of which had severe mildew; the remainder were all Silverchrome and showed severe loss of binder.

The first problem area we want to discuss is loss of oxide and accumulation of dirt, which cause head clog. This is a very common problem encountered in the playback of video. Diagram. Anecdotal information told us that we could expect severe head clog with our video tapes.

Accordingly, we investigated how other technicians had handled head clog. Some methods have been to:

1. Play until the tape clogs/stop tape and clean/ play again till it clogs again/ stop and clean/ etc. then re-edit the segments together
2. Utilize cleaning methods to prevent head clog
    1. Ruby knife–edge precisely adjusted to shave off the oxide and other debris that could contaminate tape; problem with this method–besides obvious danger if the angle were misadjusted–is potential damage to tape from buildup of residue from the tape on the edge of the knife, which can gouge the tape
    2. Use of cloth tape–used to clean, burnish the tape.

The two methods mentioned above are frequently used in recycling of tape by broadcasters, where there is less concern for preservation of the information and more concern with achieving a smooth, clean surface for a new recording.

The method that we implemented: vacuum cleaning of the tape to remove excess dirt and loose oxide. Peter Hull had the idea of investigating vacuum cleaning; James Wheeler concurred that this was a fruitful approach to pursue. (Mr. Wheeler had developed and used this system in several Videofile machines, one of which was used by Scotland Yard in the 1960's)

The success of a vacuum cleaning system depends on precise control of the air pressure, to ensure that too much oxide is not removed nor is the tape stopped by excessive suction. Constant, rather than oscillating, suction is necessary.

We finally settled on a Gast 1/4 horsepower oil-less rotary vane vacuum pump.

A key feature in a vacuum cleaning system is that one needs an extremely smooth surface over which the video tape passes–a surface that won't damage tape.

Mr. Wheeler suggested that the screen on a microscreen shaver is full of holes cut by a laser–so there are no burrs or anything to scratch the tape; he suggested that we use a shaver screen, rather than having to have one specially manufactured. He in fact had used a similar screen manufactured for him by Remington in the Videofile machines mentioned above.

James Hoagland converted a 1/2 inch video player to a cleaning machine.

First, he removed and hollowed out the erase head, which on this video player already was placed next to the tape. Second, using silicon and parts from an auto supply store, he replaced the back of the erase head with a connector to which was connected a flexible plastic tube leading to the vacuum. Third, he attached a piece of foil from a Braun microshaver to the front surface of what had been the erase head.

Purely out of curiosity, we decided to experiment, to see if it was possible to clean and play a tape at the same time. This turned out to be an extremely successful experiment. In fact, vacuuming the tape and playing it simultaneously seemed to stabilize the tape from mechanically induced wow and flutter coming off of the old reels. It also produces better head contact with the tape.

This became our standard procedure for the transfer of the black-and-white tapes: combining cleaning and transferring in one operation. Has proved very successful; we haven't had a single instance of head clog that has stopped the transfer (although we have put aside several tapes that showed obvious loss of lubricant or binder).

Other standard procedures

The following procedures, conducted before transferring the tapes, help minimize print through and tracking errors.

1. Visual inspection: we inspect the condition of each tape, look for problems such as wrinkles, cinching, loss of lubricant–any physical damage. If an excessive problem with mildew or loss of lubricant exists, we set the tape aside.
2. Breaking the Pack: Each tape is exercised (fast forward and rewind) on a 1/4 inch audio reel to reel deck which has been adapted for playing the 1/2 inch video tapes.

Two nylon roller guides from a 1/2 inch home video player (VCR) have been added to the audio deck as guides for the video tape. Only rotating nylon guides should be used for this purpose; solid metal guides are less desirable. In exercising our tapes, only the rewind motor is being used. With white cotton gloves on, we apply slight back pressure to the source reel so that it doesn't go too fast.

On fast forward the tape passes through only one guide — the guide touches only the back of the tape, not the oxide. However, after the fast forward, some small ridges are still left. So, on rewind, tape is threaded through both guides. One aligns it on the oxide side, which allows a very smooth wind, no ridges at all. We have not been able to perceive any damage to the tape from coming into contact with this guide.

The result of exercising the tapes in this way is that tracking does not need adjustment during transfer, unless it was changed on the original recording.

The problem of drop out

Dropout is loss of signal or loss of information that appears as a horizontal white line on the video monitor. Dropout is a very common problem with video recordings. Dropouts vary substantially in length and width. Dropouts occur when the video head does not receive any magnetic signal from a portion of the tape. This can be caused either by loss of magnetic material or by masking of the signal from dirt or debris on the tape.

Cleaning the tape helps to solve some dropout problems caused by the presence of dirt or debris on the tape. Beyond that, however, there are a number of dropout compensators, most of which identify dropout through a loss of signal, or loss of RF, radio frequency. The problem in recovering old black and white video is that the original reel to reel video machines do not have RF output.

Very luckily for us, a Canadian company, Digital Processing Systems, developed a dropout compensator as part of their TBC which does not require RF. Instead, their dropout compensator uses a mathematical formula to describe what a dropout looks like. When, using this formula, the dropout compensator identifies a dropout, it fills in the missing information based on information stored in memory. It looks at the previous frame of video as well as the

information just above and below the drop out and then fills in the missing information with an educated guess of what should be there.

The other advantage of this dropout compensator is that, unlike those requiring RF output, this compensator can correct previously recorded dropouts on a copy of a tape.

As an aside, the TBC mentioned above is a Time Based Corrector, which corrects time based errors in the recording. A TBC is necessary in any video tape restoration.

As a further aside, many of today's TBC's also have the ability to provide noise reduction. We are not doing noise reduction on our initial transfers. We reserve noise reduction for later copies made off of the new "masters".

Summary and Conclusions

To date, we have transferred approximately 75 tapes, with mostly excellent results. We hope that our work will prove useful to others with similar collections and similar problems.

Our work provides only a temporary solution to the problems of the long term storage and conservation of video tape. We have saved the information, but the storage medium that we are using is still temporary. In the future, we hope to find an economical and supportable medium that is closer to chiseled stone–perhaps optical discs made of glass and gold?

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