

MAGNETIC TAPE CARE & RESTORATION

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ABSTRACT

For the past thirty years, many people around the world have been engaged in studies to determine how long tape will last. We have learned how to extend the life of tapes but no one has come up with a method for predicting the life of a tape.

This paper will summarize the present-day recommended practices for tape care and storage and will also describe the most common tape problems and how to overcome them.

The most common problem with playing an old tape is finding a machine to play it. Machine obsolescence is probably a bigger problem than tape degradation.

Key Words

Tape, archival, long-life, obsolete, restore

Introduction

Many people have the belief that magnetic tape will not last very long. This is based partly on the idea that tapes can be erased and partly on the fact that flimsy audio cassettes don't survive on the dash of a car very long. The problems with playing old tapes have to do with how the tape was manufactured, how it has been stored, how well the playback machines are maintained and the basic format itself.

The first magnetic recording of voice was by a Danish Physicist named Vlademar Poulsen in 1898. By 1900, Poulsen was producing wire recorders but the Edison Cylinder had already won the first Format War. In 1934, the German mega-company, IG Farbin, decided to develop magnetic tape at its BASF facility, and AEG (the German version of GE) agreed to make a tape recorder. The product was the Magnetophon. After WWII, a couple of U.S. Army officers took some Magnetophon machines and tapes back to the United States. This resulted in U.S. companies making tapes and tape recorders by 1947. The Magnetophon used 6.5 mm wide tape running at 77 cm per second. Harold Lindsay, the engineer who built the first Ampex tape recorder, thought the Magnetophon tapes were recorded on 1/4" (6.35 mm) wide tape running at 30 ips (77 cm/sec=29.6 ips), so those are the

parameters he used. Close enough! It's amazing how this became the basic standard for audio, video and instrumentation tape recorders.

I have 31 of these Magnetophon tapes which were made in 1943. You can see pictures of three of them on-line at "www.richardhess.com". Although some of these tapes looked like they were in bad shape, a little work on them made them all play just fine. These are recordings of some ABC Bing Crosby shows and the Philco hour with Burl Ives made in 1947 and 1948. They are probably the oldest High Fidelity recordings in the world.

The point here is that the actual tapes are 59 years old and still play at proper levels. So, the age of the tape is not the major factor. These tapes have been kept at normal room environments since 1945, so the environment was not critical for them.

The factors that have saved these recordings are:

- These tapes were well made by BASF/Agfa.
- The format is robust.
- 1/4" pro audio tape recorders are still being used all over the world and are still being manufactured.

Extending the life of your tapes

We now know that some tapes can last several decades but how can we be sure that we can play our present tapes in ten or twenty years? Here are some suggestions for making that very likely:

1. Because you have no idea how well your tapes were made, it is best to store them in a cool/dry environment. 60-70 degrees Fahrenheit and around 25 percent Relative Humidity are ideal.
2. Keep your playback machines maintained and buy a couple for spare parts.
3. Be sure that you have all the technical manuals for the machines and that you know where to get hold of a knowledgeable repairman.
4. Read the brief Dos and Don'ts in the attached List. These are generic and were written for audio and video tapes but they give you the basic ideas.

The major problems with tapes

Since mag tape first started being produced in large quantities in 1948, there have been several different types of basefilms, magnetic particles, and binders. Combine that with ever-changing formulations by all of the tape manufacturers, and we have a very difficult task in establishing a few general guidelines to restore tapes with problems.

The most common problems with tapes are:

1. Sticky-shed

2. Edge damage
3. Poor interchange
4. Lubricant loss
5. Erasure
6. Fungus
7. Water damage

1--Sticky-shed

This shows up as a powder that clogs heads or as a sticky residue that stops the tape from playing. It can be countered by placing the tape in a zip-lock bag with desiccant for a few weeks. Isolate the tape from the desiccant. I place tapes in my refrigerator (not the freezer) to speed up the process. This rejuvenation may last only a few weeks but it can be repeated many times.

Sticky-shed is caused by binders that react with water, causing long-chain molecules to break down and float to the surface of the tape. Removing the water re-builds long molecules that cross-link so that the binder is rejuvenated.

2--Tape edge damage

The good news about polyester basefilm is that its shape can be changed. A tape with a stretched edge should be spooled onto a reel at a speed between 20 and 50 ips. At these speeds, air film between layers should be minimal but enough to pack the tape flat on the take-up reel. Once the tape is fully on the take-up reel, check that the edges of the tape are now flat. Then place it on a slab of wood about 4" x 4" and place both in an oven at 100-110 degrees Fahrenheit. After a few hours, turn the oven off and let the tape cool to room temperature for a few hours. The basefilm should be flat. If not, repeat the process using another tape machine.

3--Poor Interchange

This may be just a matter of adjusting the tracking control or finding a machine that will play the tape properly. In a worse case, tape guides may have to be realigned especially for this tape.

4--Lubricant loss

This usually occurs only with tapes made in the fifties. Loss of lubricant will cause the tape to squeal or stop. A tape suffering from binder breakdown (sticky-shed) will also squeal or stop. To determine which it is, play the tape for a few minutes, stop the tape and look at the fixed heads. If they have a lot of sticky gunk, the cause is binder breakdown--sticky shed. If the heads are reasonably clean, the problem is lack of lubricant.

For fixed-head machines, a lubricant made by the LAST Factory in Pleasanton, Calif can be used. For rotary-head machines, the LAST lubricant must be placed on fixed heads located after the rotary heads to prevent the rotary heads from wiping the lubricant off. Also for rotary-head formats, try the tape on different machines and use the one with the lowest tape-path friction. Also, try lowering the tape tension.

5--Erasure

No cure for this problem. We still don't know what was erased on the 18 1/2 minute section of the Nixon White House tapes. Make sure that it won't happen again by using a key-lock to prevent the machine from recording.

6--Fungus

This is uncommon in the U.S. except for tapes that have been in water. Some fungi are dangerous and should be handled only by a tape restoration expert. Call the Association of Moving Image Archivists (AMIA) in Hollywood for names of tape restoration companies in the U.S.

7--Water damage

Do not play a water damaged tape on a machine until the tape has been thoroughly dried because the tape will stick to guides and can rip off the magnetic coating.

If a Metal Particle (MP) tape has contacted water, rinse it in cold, distilled water.

Other types of tape are not harmed by the chlorine in the water so distilled water is not required, but is recommended. If the tapes have been soaked in water, it is best to rinse the debris off them and keep them in cold water. They will survive for years if the temperature is less than 43 degrees Fahrenheit. The reason for keeping wet tapes wet is to prevent fungus from growing until the tapes can be dried.

ASAP, contact a tape restoration company to dry the tapes.

Obsolescence

Tapes, DVDs, CDs, and HDDs, each have their niche markets. Hard Drives can now store 400 GBytes on a single disk, DataTapes can store 200 GB and the latest DVD format can store 25 GB. All of these media will be around for a long time, but formats will continue to change. Evolution is the nature of the high-tech industry. Ten years ago, I was still using 5 1/2" floppies. Then it was 3" floppies, then CD-ROM, and now it's DVD-ROM and Flash Memory. That's five popular formats in only ten years!

Equipment obsolescence is a major archival issue. In my opinion, having a playable tape in 20 years is far more likely than having a properly functioning machine to play it on. If you plan to keep old format tapes for a long time then you had better develop a plan for maintaining the playback equipment. This is true for software as well as hardware.

Problems with recent tape formats and Long-life

Just because a tape produces a nice picture or low error rate today does not give assurance that it will perform okay a few years from now. Besides the basics like how the tape was made and how it was stored, you must also consider the following.

The biggest problem is the thin basefilms being used today. Yes, they are stronger than Mylar but the "Saran Wrap quality" makes it very difficult for a tape restorer if the tape is ever damaged. I can work with 12 micron tape but not with 8 micron.

Compression can be a problem in recovering data from a damaged tape. This depends on the type of compression and whether tricks like error concealment are used. With the higher packing density media now available, compression is not always required.

Another possible problem is the high packing densities being used. This is a format and/or machine manufacturer issue. If the format has been carefully developed and the manufacturer is using a clever tracking method, this should not be a problem.

Conclusion

Develop a plan for maintaining your equipment and keeping old software.

Read and follow the Dos and Don'ts.

In my 40 years as a tape and tape recorder design/test engineer, I have never had a tape that I could not play. The fact is, tape is very durable and cheap. It is hard to beat the price of blank VHS tape at \$2 for six hours of video.

Tape will be used in several niche markets for many more years.

Dos and Don'ts

Do

- Learn and use correct procedures for operating equipment.
- Handle tapes gently.
- Keep tapes in protective cases when not in use.
- Keep tapes vertical when not in use.
- Make sure machine alignment is correct before use.
- Clean tapes before playback if they show any evidence of dirt or contamination.
- Ensure that the tape is properly seated in the machine before use.
- Wind tape at low speed (library wind) entirely onto one reel after use.
- Leave analog audio tapes on the take-up reel after use (tails out).
- Secure tape ends on open reel tapes.
- Package tapes adequately for protection before shipment or transport.
- Use only new tape when recording an archival tape.
- Activate the Record Protection feature of all master cassettes immediately after they have been recorded.
- Inspect tapes for damage or contamination before use.
- Seek experienced help as soon as possible in the case of a disaster.
- Protect both tapes and machinery from dust and debris.
- Keep tapes in a stable temperature and humidity.
- Acclimatize tapes before use if they are hot or cold.
- Store tapes in a cool and dry place; see ISO 18923 or SMPTE RP-103.

Don't

- Do not touch tape surfaces with bare hands.
- Do not put pressure on reel flanges.
- Do not stack or place objects on top of unprotected tapes.
- Do not force tapes into cases or machines.
- Do not drop or throw tapes.
- Do not splice any portion of a video tape.
- Do not place tapes on or near sources of magnetic fields.
- Do not play or spool tapes that are dirty, contaminated or wet.
- Do not play or spool tapes on a dirty, misaligned or malfunctioning machine.
- Do not store tapes in an area subject to dampness or possible pipe leaks (e.g., basements).
- Do not expose tapes to food or beverages.
- Do not expose tapes to temperature extremes.
- Do not expose tapes to UV radiation, including the sun, for extended periods.
- Do not attempt to clean tapes contaminated with adhesives, fungi or unknown substances unless you have the necessary experience or training.
- Do not expose tapes to high power biological decontamination scanners. High levels of radiation can produce sufficient heat which can melt or deform tapes or their plastic containers.