Videotape Condition Issues

"Several common audiovisual archiving problems are associated with magnetic recording tape used by video recorders. Awareness of these concerns may help archivists prioritize their migration plans as well as detect and mitigate problems as they occur. "

Dropouts

Videotape problems can occur at any time in the life cycle of the video tape. While it is common for deterioration to occur due to age or improper storage, this is not always the case. Many problems occur early in a videotape's lifecycle, and can occur when a tape is used for the first time or even during the manufacturing process.

The most common problem associated with videotape is known as a *dropout*. A dropout is a loss of *information* which can be detected when a videotape is played. This loss of information may be extremely brief or disastrously long. When playing a videotape, a short dropout may appear as a bright dot or a short thin streak that is gone almost as quickly as the eye can detect it. Longer dropouts look like a horizontal bar extending all the way across the image whose thickness may be very thin or may occupy a significant portion of the image's height. Very long dropouts may completely obliterate the picture for seconds or longer, and there is no limit to the length of the dropout.

When a videotape is being played or recorded, a *signal* is either being picked up from the tape or laid down onto the tape by components of the recorder called *video heads*. Video heads must be in direct contact with the videotape in order to retrieve the signal or imprint it on the tape. If that contact is interrupted then the signal will also be interrupted. Brief dropouts are commonly caused by some form of contamination momentarily intervening between the tape and a head. If this occurs during recording, the resulting information loss is permanent and the dropout will be detected at exactly the same point on the videotape every time it is played. This contamination may have been present on the tape all along, or it may have migrated to the tape from a dirty component of the recorder which came into contact with the tape. Permanent dropouts might also be caused by defects in the thin magnetizable layer of the tape itself.

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Brief dropouts may also be the result of contamination that momentarily intervenes at the time of playback. These dropouts are not permanent and most likely will not reoccur the next time the tape is played. If a noticeable dropout occurs while content is being transferred as part of an archiving process, it should be determined whether or not the dropout is permanent. If it's not permanent, additional playback attempts will likely eliminate the problem.

Dropout Compensation

Whether or not a dropout is permanent, a video recorder may be able to mask its appearance or aid other equipment in doing so. A technique known as *dropout compensation* causes a dropout to be less visible by filling the empty gap with information from an adjacent area of the image, usually just above the location of the dropout. The use of dropout compensation will not necessarily make a dropout invisible, but it will make it significantly less objectionable.

It's an easy matter for a video recorder to electronically detect a dropout, no matter how brief it may be. When a dropout is detected, the recorder directs the dropout compensator to fill the gap with information held in memory until the dropout ends. If no dropout compensator is used when a videotape is copied to another videotape, any visual defects caused by dropout events during playback of the original will be transferred to the copy as part of the image. When the copy is played, these visual defects will be visible; however, dropout compensation will no longer be able to mask them. The copy's visual defects at these points are not the result of dropouts, but are a permanent part of the copy's recorded image.

Longer dropouts appearing as horizontal bars occur when contamination momentarily adheres to the video heads. This causes the duration of the dropout to increase. If a dropout compensator is in use, it fills in the entire horizontal bar using a sliver of the picture from just above the bar. This sliver is copied over and over again until the dropout has ended. As a result, the interior of the horizontal bar will appear as a vertical smear. While dropout compensation helps make such an event less objectionable, it is unable to effectively mask the information loss and the smear will be evident.

Head Clogs

Long dropouts occur when the contamination semi-permanently adheres to the video heads. This is commonly referred to as a *head clog*. In this case, the ability of the heads to function properly is not only hindered by a loss of contact with the tape, but also by the interruption of their magnetic capability.

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The shape of these tiny video heads includes an air gap in their configuration. A video head can be visualized as having the same shape as a doughnut. This doughnut is positioned so that the tape touches the outer side of the doughnut at one point. The air gap is like a small bite taken out of the doughnut right at the point where the doughnut touches the tape.

The magnetic field that is picked up by a video head during playback or emitted from a head during recording flows in a circle around the inside of the doughnut. The air gap is a tiny space through which the magnetic field existing on a recorded tape enters the inside of the doughnut during playback. It's also the space through which the magnetic field inside the doughnut extends out to reach the tape during recording. This air gap is therefore essential to the operation of the heads. When some form of contamination fills the gap, or "clogs the heads", the magnetic field on a recorded tape cannot be picked up by the heads. Likewise, the magnetic field created by the heads during recording cannot extend out to the tape. The heads become magnetically isolated and therefore inert.

This makes it clear why video recorders and players must be kept very clean. This is particularly true of the video heads, but it is also true of all the rollers, guides, and other parts which come in contact with the tape. It's important to avoid exposing videotapes and recorders to dust, smoke or other airborne particles that may adhere to their surfaces. Similarly, exposing them to liquids, dirt, or any other form of contamination will cause severe problems.

Once a video head becomes clogged, it must be cleaned to restore it to functioning condition. This can be done without the aid of a technician by using a videotape specially designed to clean the heads. These cleaning tapes are mildly abrasive and will polish away the contamination. Unfortunately, a cleaning tape's abrasiveness will also physically wear down the video heads. When a video head becomes thoroughly worn, it will no longer contact a tape well enough to either play or record. Therefore, cleaning tapes must be used sparingly and only by carefully following the correct procedure.

Another disadvantage to the use of cleaning tapes is that they only clean the heads and do not address the other points inside a video recorder that periodically need cleaning. Additionally, cleaning tapes won't always unclog a head. Sometimes it is necessary to clean the heads and other parts of a recorder by hand using fine-weave low-lint wipes in such a way that no parts, especially the fragile video heads, are damaged. This method of cleaning is best left to someone who has the appropriate supplies and knowledge.

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Self-Contamination

One of worst contamination problems occurs when the source of the contamination is the container of the tape itself. Cassette tape construction will be discussed further on, but for now consider the open reel. A reel is constructed of three major pieces, the hub at the center, a top flange and a bottom flange. The tape is wrapped around the hub and is confined between the two flanges.

For a brief time, manufacturers of videotape thought it would be a good idea to line the inside of the top flange with a thin layer of foam. This was meant to protect the tape by placing it in contact with a soft cushion. Unfortunately, over time, the glue used to adhere the foam to the flange starts to soften and liquefy. This liquefied glue seeps through the foam, onto the tape, and eventually in-between the wrapped layers of tape. This glues the wraps of tape together forming a solid block. An unfortunate aspect of this situation is that the outermost wraps of tape escape the glue. This becomes a problem when an unsuspecting individual attempts to play the tape. As the tape is *threaded* onto the player, the free outer wraps of tape warn of no problem, however when the tape is played to the point where the glue is encountered, the tape can no longer unwind and it suddenly tears and breaks.

Archives containing reels of videotape can be surveyed to determine if such reel flanges with foam are present. If the glue remains intact, the tape can be immediately digitized or transferred to a different reel. If the glue has liquefied and contaminated the tape, the tape can be cleaned. If the wraps of tape have adhered to one another, the unwrapping and cleaning process will be very slow and correspondingly expensive, but if expertly done, the tape can be restored to playable condition.

Tape Path and Interchange

Another category of videotape related problems concerns a tape's journey through a recorder. As a videotape threads, it winds its way through a recorder following a complex route that involves many twists and turns. On its way, it comes in contact with guides, rollers and drums that help steer the tape from the supply reel, though the recorder to the take-up reel. This route and its associated steering components are collectively known as the *tape path*. Everything involved in the tape path must be precisely positioned. The procedure for correctly positioning each component is called *tape path alignment* and can be a tricky procedure to perform.

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As guides and rollers wear with age, movement of a tape through the path will become altered. If this is not compensated for by replacing worn parts and realigning the tape path, playback and recording problems will develop. The tape path for each recording format is standardized so that players made by any manufacturer can play tapes from recorders of any other manufacturer. A tape's interoperability between one recorder and another is referred to as *interchange*. Minor tape path misalignment will lead to interchange problems. If a tape will only play correctly on the recorder that recorded it, that recorder has a tape path alignment problem and the tape will be difficult to play on any other player. If a tape plays well on several players except one, the problematic player has an alignment problem.

Edge Damage

More extensive tape path alignment issues lead to problems of greater consequence. When a tape goes significantly off course, the edge of the tape will start to rub against parts of the recorder and possibly against reel flanges. This may cause the edge of the tape to become wrinkled, which is known as *edge damage* and can lead to significant playback problems.

Playback of sound recorded on edge damaged tapes may suffer because many video formats record sound information along the edge of a videotape. Another element of a video recording which is often placed at a tape's edge is the *control track*. The control track allows a video recorder to coordinate the movement of all its moving parts. The control track is therefore essential to the reproduction of a stable image. A damaged control track will cause a video player to produce a jumbled and rolling picture.

Edge damage may even reach far enough beyond the edge of a tape to impact the recovery of video information. When this occurs, the top or bottom edge of an image will be distorted or unstable. Depending on its severity, remediation by restoration experts may reduce edge damage injury sufficiently to permit successful playback.

Wrinkles

Mechanical failure of a video recorder can cause significant injury to a tape. A severely wrinkled segment of tape can be the result of a variety of malfunctions. One of the most heart-wrenching moments anyone handling a valuable videocassette can experience is when the videocassette fails to eject from a recorder. This moment is frequently preceded by some rather unpleasant noises from within the recorder. While an experienced technician can extract a tape from a recorder, the tape will almost certainly have sustained some very unfortunate damage.

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Although wrinkled sections of tape can in some cases still be played, the picture will contain dropouts, distortions, and instability. Even though expert remediation may help reduce the effects of wrinkles, great care should be taken when playing a wrinkled tape. Wrinkles might cause a player to mishandle the tape causing further tape damage, and they may also damage fragile video heads. The smaller the width of a tape, the smaller and more fragile the video heads will be, so placing wrinkled ¼" or 8mm tapes in a player is risky because the possibility of damaging the player is significant.

Wrinkled tape sections can be removed by cutting and splicing, however splices are potentially just as damaging to fragile heads as wrinkles. An approach to handling wrinkled or spliced tape is to skip over the damaged section. The tape inside a cassette can be manually moved forward or backward outside of a recorder. If a damaged section is at the beginning of a tape, the tape can be manually advanced to a point beyond the damage, and playback initiated from that point without risk. If the damage is at any other point, some means of identifying the problematic location must be found. An easily recognizable point in the content or a tape counter may be used to alert an operator that the damaged section is approaching and that playback must be stopped. The tape is then ejected, manually advanced past the damage, and playback resumed.

Videocassette Construction

Some knowledge of the construction of a videocassette is helpful when manually advancing a tape. The plastic housing containing the supply and take-up reels is the *shell*. Many videocassette formats use two shell sizes. Small shell cassettes are intended for use with portable recorders and hold a limited amount of tape. Large shell cassettes are designed for studio recorders and hold enough tape for a full-length program. The large flat surface of the shell forming its top is called the *face*. The manufacture may have its markings on the face and there will usually be an area reserved for a label. The label may also be placed on the *spine,* the narrow edge at the rear of the cassette that faces the operator when the cassette is inserted into a recorder.

The narrow edge of the shell opposite the spine is the first side to enter a video recorder when being inserted. This side is entirely or partly composed of a movable flap. The flap automatically opens when the cassette is inserted providing an opening through which the tape can enter and exit the shell. The flap automatically closes and locks shut when the cassette is ejected protecting the tape from dust and damage. Some cassettes employ two flaps on this edge, one in front of and one behind the tape. When closed, the two flaps completely enclose the tape for maximum protection.

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Many cassette tapes have brakes which limit the rotation of the reels when the cassette is outside a recorder. The tape inside such cassettes cannot be advanced without first releasing these brakes. The brakes can be released in one of two ways depending on the construction of the cassette. Some cassettes have a hole in the bottom of the shell near the spine. When the cassette is seated inside a recorder, an upward extending finger inside the recorder will press against a release actuator inside the hole to free the brakes. Alternately, a cassette's brakes may be automatically released when the front flap opens. In this case, the flaps are unlocked by one or two fingers inside the recorder pressing against release actuators at the front, bottom, or sides of the shell. By using small clean objects to manually unlock and open the flap, or to operate the brake release actuator, the reels can become manually rotated outside a recorder. Care should be exercised to prevent the tape between the reels from becoming slack when rotating the reels manually.

Ironically, the two-flap design utilized by small cassettes for maximum tape protection is a common cause of tape damage. This two-flap configuration is most frequently employed by ¼" and 8mm tape formats whose small size makes them particularly vulnerable to dust. The inner flap of these shells is guided by small tracks on each side of the flap. Unfortunately, the inner flap can become dislodged from its track. It's unclear why this happens, but small cassettes are most easily dropped and the resulting mechanical shock is probably sufficient to cause the problem. When the inner flap becomes dislodged from its track, the two flaps cannot open fully, which in turn prevents the cassette from being properly seated inside the video recorder. When the cassette is improperly seated and the flaps remain partially closed, significant tape damage will occur when the recorder attempts to thread the tape. Furthermore, the tape usually cannot be ejected following a failed threading attempt. It is therefore very important to check the condition of the inner flap before inserting such cassettes into recorders.

There is yet another problem related to the outer flap on these small cassettes. The area reserved for a label on the face of these cassettes is limited by the size of the shell. Consequently, the available labeling space may be insufficient for the desired labeling information. In such cases, oversized labels might be applied which extend outside the reserved area. These labels may occupy the front surface of the face close to the edge of the shell where the flap is located. When the outer flap opens, it moves up and back, closely over the front portion of the face. Labels which are too thick or are peeling away from the face will impede the movement of the outer flap, preventing the flap from fully opening and the cassette from properly seating. This leads to the same potential for tape damage as when the inner flap is dislodged from its track. It's therefore also necessary to carefully inspect the face labels of such cassettes before inserting them into a recorder.

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Creases

When a mechanical problem occurs adversely affecting the way a recorder handles a videotape, one possible result is that the tape between the supply and take-up reels becomes slack. If a slack loop of tape forms within the flanges of a reel and the tape is suddenly pulled, the slack loop may get caught between wraps of tape. These trapped loops form tightly pressed folds where the tape reverses direction. A permanent *crease* will form at these locations which will persist even after the loop is removed and a normal wrap is reestablished. When a crease is formed as described above, it will typically be oriented perpendicular to the length of tape. Perpendicular creases can be easily recognized when a tape is played. They appear as a narrow horizontal distortion extending across the full width of the image. This distortion will start at the top of the image and will slowly move down to the bottom of the image over the course of several seconds as the crease moves through the tape path. A crude tape splice will also typically take the form of a perpendicular linear disturbance across the surface of a tape and will produce a similar visual distortion, but because the picture information on either side of a splice may be radically different, greater instability and image discontinuity may be apparent when compared with a crease. Careful correction by a restoration expert may reduce or eliminate the effects of a crease.

Scratches

Another form of tape damage is a *scratch*. A tape may become scratched when it moves across the surface of a guide that has been accidentally scarred by a technician working with metal tools. All of the components that are part of the tape path are finely polished in order to avoid scratching a tape and any roughness of these surfaces caused by even minor contact with a hard object may cause a tape to become scratched as it rubs across the rough surface. A sufficiently hard contaminant that has adhered to a smooth surface may also be rough enough to cause a scratch. As a tape moves across the rough surface, the resulting damage will be a scratch which runs parallel to the length of the tape. When a scratched tape is played, a narrow horizontal distortion will appear extending across the full width of the image. Unlike the distortion caused by a crease, the distortion caused by a scratch will remain at a fixed position somewhere between the top and bottom of the image. Unfortunately, the effects of a scratch are permanent and cannot be eliminated. A scratch creates a permanent dropout and dropout compensation is the only means of reducing its affect.

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If a tape scratch appears, it should be assumed that the tape player is producing the scratch. Playback should immediately be stopped and the use of that player discontinued until it has been thoroughly checked. If it is established that this player is not scratching tapes, an effort should be made to identify the equipment producing the scratches so additional damage can be avoided.

Broken Shells and Mold

A damaged shell may also injure a tape. Shells may become warped or cracked, which can prevent the reels from turning freely, distort the reels, or force them out of position. The release actuators which unlock the front flaps and brakes can also cease to function correctly. As a result, tapes may become stretched, wrinkled, broken or tangled. In cases where the tape has not suffered damage, or has suffered damage that can be remedied, shell related problems can be overcome by transferring the reels to a new shell.

Mold growing on videotapes is a common problem archivists may encounter. Mold grows on videotape when it has been stored in a warm humid environment. While mold looks ugly, it’s rarely a catastrophic problem, as it can be cleaned from a videotape. The worst problem associated with mold is the mess it can make inside a recorder when a moldy tape is played without being cleaned, although this mess can be removed by an experienced and well equipped technician.

Hydrolysis

All videotapes, but particularly UMATIC videocassettes, are vulnerable to humidity, and not just because of mold. Magnetic recording tape is formed in layers. A long narrow strip of plastic film serves as a substrate, giving the tape its physical form. A backing layer may be added to the back side of the substrate to reduce friction and the accumulation of static electricity. The front side of the substrate is coated with a thin magnetizable layer composed of a binding agent, magnetic particles, and a lubricant. The binding agent acts as an adhesive holding the magnetic particles and lubricant together on the substrate.

UMATIC tapes have proven to be consistently affected by a process called *hydrolysis*. A magnetic tape’s binding agent slowly absorbs water from the air. As humidity increases, its tendency to absorb water also increases. Hydrolysis is a chemical reaction which causes the absorbed water to diminish the integrity of the binder. The binder then softens and no longer firmly holds the magnetic layer to the substrate.

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When a tape which has been subjected to hydrolysis is played, some of the magnetic layer will separate from the substrate and migrate to the recorder as contamination. This contamination accumulates throughout the tape path and invariably clogs the video heads. This development also has a damaging effect on the videotape as its magnetic layer gets rubbed away.

Fortunately the effect of hydrolysis can be temporarily mitigated. Placing a videotape in a dry warm environment will drive enough moisture out of the tape to temporarily restore the binder's integrity. This drying process must be performed under carefully controlled conditions as excessive heat will permanently damage magnetic tape. While this drying process is often colloquially referred to as "baking", it cannot be successfully performed in a conventional oven. However, once complete, a tape will be restored to usable condition for a period of time long enough for its contents to be migrated to another tape or file.

Cling Wrap Effect

8mm videotapes are also infamous for another age related problem. There are two types of 8mm videotape: metal particle and metal evaporated tape. Metal evaporated tape is formed using a sophisticated process that allows the highest possible density of magnetic particles. As a result, it performs better than metal particle tape. However, over time, the effectiveness of the lubricant in its magnetic layer becomes significantly reduced. When this happens, metal evaporated tape behaves like the plastic cling-wrap used to seal food containers. As a result, the tape tends to stick to smooth surfaces like those found throughout a tape path. Many players will be unable to move a tape in this condition though the tape path.

Sadly, magnetic tape is not as robust as it ideally could be. As a consequence, overcoming problems associated with videotape has become routine for many of its users and experience handling videotape issues has been gained "the hard way" over time. This learning process is far from over however many solutions and techniques have evolved which can help the informed archivist cope with many of these problems today.

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