UOSH: Archives+ Audio Digitisation Guide

201: Audio Carrier Identification and Preservation Techniques

UOSH produced 20min video:

Understanding Audio Formats, Care & Risk

Available on the 'UOSH NW' YouTube channel

[Summary sheet produced by British Library on *'How to Identify and care for the sound formats in your collection'*]

Script for 'Formats, Care & Risk' video:

"In this video we'll go through how to identify common audio formats, how to hand them and assess what their preservation risk is.

In Part 1 we'll cover analogue discs, Part 2 magnetic tape, and Part 3 Optical Discs.

STORAGE

Just to begin with, here's a basic overview on storage. The usual archival storage conditions apply of clean, out of direct sunlight and cool and dry with minimal fluctuations. Therefore archival storage conditions appropriate to paper-based materials are often fine for sound archives too:

46-50° F / 8-10°C and 30-40% RH; do not store magnetic tape below 46° F / 8°C

Keeping the temperature and humidity stable is the most important factor.

For home collections, we recommend a cool (room temperature or below), relatively dry (about 35-40% relative humidity or RH), clean, and stable environment. So avoid attics, cellars, and other locations with high risk of flood or extremes of temperature.

As for how to store the items on the shelves, all discs and tapes should stand vertically without having to bear weight on them.

Any storage boxes should be made of acid-free paper stock; avoid storage containers that retain static charge.

Airtight containers are also best avoided as these create a microclimate that can encourage mould growth and accelerate degradation.

Mould is a real danger to audio materials and can be difficult to address so it's best to prevent this forming in the first place.

An example of how you can help prevent this is to throw away any plastic bags surrounding reel-to-reel tapes inside their boxes.

Any PVC sleeve in direct contact with a vinyl disc should be removed and replaced with an acid-free paper or polyester sleeve.

Ideally, discs should be housed in a high-density polyethylene sleeve.

The Preservation Self-Assessment Program recommends that 'as a rule of thumb: "bad" plastic sleeves are clear and have a sticky or tacky feel; "good" sleeves are frosted in appearance and have a slippery feel.'

If a box/sleeve does need to be replaced, it is important to document any metadata that they contain, such as content information or technical notes.

Part 1: ANALOGUE DISCS

All grooved disc media is susceptible to warpage, breakage, groove wear, and surface contamination.

As they are prone to wear and tear through repeated playing or handling, you should handle grooved discs by the edge and label areas only. Oils and grease from your fingers can seriously degrade the playing surface of any grooved disc over time so you should avoid touching the grooves.

There are 3 overall formats of analogue discs that you could have in your collections so it's good to identify what are the properties of each as they each have completely different playback equipment and different conservation issues.

For instance, you must never try to play a Shellac record on a vinyl player/stylus as not only will it not sound very good, but it will also likely damage it.

[For more detail https://psap.library.illinois.edu/collection-id-guide/phonodisc

Or quick overview on handling: https://www.loc.gov/preservation/care/record.html]

VINYL

Vinyl will likely be the one we're most familiar with as it has been in production from the 1940s to the present day. It's made of PVA & PVC co-polymer and is usually black and shiny in appearance.

There's the "long playing" (LP) record, "extended play" (EP) record, or "single." These terms are often used interchangeably with the revolutions per minute, or "rpm" required to play the record. So a 12in LP plays at 33⅓ rpm and a 7in single pays at 45rpm and is therefore sometimes called a 45.

Vinyl discs are especially prone to scratches and abrasion due to their relatively soft material.

Also, high humidity and temperatures can adversely affect these discs by creating prime conditions for mould.

High temperatures may also cause the plastics to soften and warp, reducing playability and audio quality. They need to be kept out of direct sunlight. As mentioned before, if they are stored in PVC sleeves it's important for the sleeve not to have contact with the disc (as is often the case with picture discs) as this causes a chemical reaction which results in irreversible, audible damage. Archival paper interior sleaves are advised.

If it's stored well, vinyl is chemically stable and considered a low preservation risk with professional playback equipment readily available.

SHELLAC

Shellac discs were produced from 1890s to 1960s and feel much heavier than vinyl.

As well as being prone to the usual wear and tear, Shellac is particularly prone to breakage as it is brittle and literally will crack under pressure. It's not flexible at all like vinyl is.

Shellac discs are often either 7-inch, 10-inch, 12-inch, and 16-inch. They are typically played back at the following speeds: 30 rpm, 70 rpm, and 78 rpm.

Shellac is often seen as a 10" 78s. Early 78s were often not cut at exactly 78 rotations per minute (rpm), so the correct speed may not be standardized from one disc to the next. Additionally, groove sizes vary, so a variety of different styli are necessary to ensure that the stylus used is not too small or wide, which can adversely affect playback quality and/or irreparably damage the disc.

Therefor Shellac discs are prone to wear & tear through repeated playing or handling however the preservation risk is similarly considered low, as when stored correctly they are chemical stable. The major difference in their preservation status from vinyl, is that specialist playable equipment is not widely available, and a level of expertise is required to play them back correctly.

LACQUER

Lacquer discs are also generally black in appearance but occasionally clear. They were produced from the 1930s onwards and were either made of cellulose nitrate or gelatine resin, surrounding a metal, glass or a card base disc.

To identify them they often have hand-written or typed labels that are glued on rather than the mass-produced printed ones that required no adhesive. This is because they are individually cut so the contents are often unique.

What's significant about these disks is that they should be considered extremely high risk, preservation-wise not just due to their unique content but because their chemical stability is very poor.

Lacquer discs are heavier and more brittle than vinyl but lighter than shellac. The weight depends on the core material. Discs with a metal core weigh more than ones made of card. If the core is metal, it can also feel colder that other analogue discs.

If you look at the central hole at an angle you might be able to see the core material under the resin coating. This could look like a glint of metal or brown, paper-like material. If you shine a light source upwards from beneath the disc and the disc appears translucent, it is most likely glass. If you do this it's essential that the light source you use does not emit heat, as this will damage the lacquer disc surface after only a few seconds exposure.

Conservation issues with Laqueur discs include **delamination** and **plasticiser degradation** which can intersect resulting in audible surface degradation. If stored in humid atmosphere the plasticiser extrudes

from the resin and the surface material contracts leading to delamination. This has the appearance of white dusty coating that looks like mold.

According to the 'Preservation Self-Assessment Program' at Illinois University: The best way to determine if the contamination is mold is to observe the surface under a microscope. If the contaminant looks fuzzy or lattice-like, it is most likely mold. If it has an oilier and/or crystalline appearance, this is likely palmitic or stearic acid that has formed on the disc surface.

The rate of this deterioration is unpredictable, also metal or card base discs are susceptible to bending and glass-base discs are brittle.

Part 2: MAGNETIC TAPE

Magnetic tape has included various formats since its first form which was magnetic wire recording invented in Germany in 1928. In this section we'll be looking closely at 3 common formats that you might have within your collection; Open-Reel, Audio Cassette and DAT.

As well as being stored according to the guidance already given (cool, clean, dry and stable...) all magnetic tape needs to be kept away from potential sources of demagnetisation.

Magnetic fields generated by power supplies, automatic door locks, vacuum cleaners, loudspeakers etc. can negatively affect the magnetic information recorded on the tapes, audibly degrading the content.

OPEN REEL

Open-Reel is a magnetic tape wound onto reels between 3 and 14 inches in diameter, although 5, 7 and 10.5 inch reels are by far the most popular. They are usually on reels with either a centre spindle hole or, with the larger professional reels, an open core.

The tape itself is made up of several layers sandwiched together, the base layer being usually made of Polyester, Acetate or, occasionally, PVC. You can identify this by holding the reel up to the light or viewed on a light box. Acetate will appear translucent and polyester film will be opaque. But please note that this is true for audio only and that the opposite can be seen in film reels.

Handling advice is to hold by the edge of the plastic or metal reel (the flanges) and center hub only and not squeeze the flanges together, which will crush the tape pack in between.

Ideally open reel should be stored in boxes with supports for the hub so that the entire weight of the reel is not on the reel edge.

As for their chemical stability, if polyester-based tapea are stored well it is considered to be chemically stable but the binder layer in tapes made from the 1970s onwards can become sticky and cause irreversible damage if played. This is because it can leave a gummy residue over the machine and the friction can cause the oxide layer that contains the audio signal to literally shed away in small shards. This is often called sticky-shed syndrome and is part of a wider issue called soft binder syndrome.

Acetate tapes can off-gas acetic acid which leads to them smelling of vinegar. This is particularly if they have been stored in humid conditions. The effect of this causes the base layer to become extremely brittle, also the binder layer may shrink, causing the tape to contort into a warped or cupped shape and the tape pack to display a characteristic spoking pattern, all of which has a negative impact on replay sound quality.

The preservation risk for the Open-Reel format is high, with Acetate being considered even higher risk that polyester. Also professional replay equipment has not been made for some time, spare parts are increasingly hard to obtain, and equipment maintenance expertise is hard to find.

In identifying what tape you have it is important to consider that there are a variety of recording speeds, and track layouts including mono or stereo, full, half or quarter track widths. No single machine is capable of replaying all variants.

AUDIO CASSETTE

The Audio Cassette was developed by the company Philips in 1963 and was in regular use up until 2000s. It takes the form of polyester tape held in a protective shell, generally using a single standardised speed and recording format. Widely held in archives both with mass-produced, pre-recorded content, and unique or rare individually-recorded content. Many recordings use proprietary noise reduction technology, such as Dolby, requiring equivalent technology to be used in order to correctly replay the content.

The same chemical issues can affect cassettes as other polyester tape. No professional replay equipment has been made for some time, spare parts are increasingly hard to obtain, and equipment maintenance expertise is hard to find therefore the preservation risk is high.

Over the years manufacturers have produced 4 types of Audio Cassette and it's useful to learn to identify them and update this information in your inventory.

The introduction of each type was a not always successful attempt to improve on the qualities of the previous type.

Each type has completely different chemical properties and audio quality. Just as the choice of a particular format can be a clue to the time of recording, so can the type of audio cassette tape used.

Type I is often the most common type and is often called 'normal' type and is made of ferric oxide. It has small notches on the top corners where the over-recording protection tab. This tab can and should be removed to protect the recording on the tape.

Type II is made from Chromium dioxide is the second most likely type in your archive collections. It has slightly longer notches around that tab. This shape allows for some players to automatically adjust to the setting required for each tape.

Type III is so rare that it's not even pictured in our video! It was an attempt to combine the ferric and chrome that was ultimately not successful. The image in the bottom right corner of the video shows the label from one of these tapes.

Type IV. As for type 4, these cassettes are made using a layer of metal particles. See those two notches more towards the middle of the top side of the cassette shell? They were introduced as an additional method for some players to automatically adjust to the setting required for each tape.

Inside a cassette case

The shell contains several small moving parts and may be subject to degradation including a loss of adhesion in the glue holding the pressure pad, or loss of lubrication in the so-called “slip sheets” allowing the tape to move freely.

This format is particularly prone to wear & tear through repeated playing or handling. Longer-duration cassettes are typically made of thinner base material, increasing the risk of irreversible stretching or becoming tangled within a poorly performing replay device.

Often the most common basic repair is where the tape has become crumpled or twisted. Hand-winding the tape with a biro is still the best method to untangle or smooth out.

Try and be extra careful with repaired tapes. Play from start to finish, with no unnecessary rewinding/fast forwarding.

The next most common repair is to reposition the pressure pad or because the tape has become disconnected from the supply reel. For repairs like these you would need to carefully unscrew the cassette shell and either reposition the part or if broken transfer the tape into a new shell.

Another common issue is for the tape to become detached from the take up reel. If you look closely at this image of the take up reel (in the video) you can see a small detachable part that slides out. You just need to push this out and trap the end of the tape underneath again before sliding the part back in.

Repairs like this require clean hands, desk, some precision screwdrivers and no chance of any passing drafts. Even a big exhale of breath can make the tape unravel out of position!

DAT TAPE

Digital Audio Tape, or DAT, was developed by the Sony Corporation and introduced in 1987

Although digital, the storage of the content is still by magnetic means and is therefore susceptible to the same degradation as all other magnetic tape formats.

DAT Tape is similar in its chemical construction and recording methods to videotape. Infact it is very easy to confuse DAT tape with the slightly smaller MiniDV video tape. As with video, these tapes are highly susceptible to wear & tear through playing and handling. They should be kept clean and in their

original case and the best orientation for a cassette is vertical on its end. Cassettes and cartridges should be stored upright on shelves like books.

The preservation risk for them is considered high as no professional replay equipment has been made for some time, and spare parts to maintain equipment are hard to find.

STENOGRAPH & DICTATION

Grundig developed an early dictation device called the Stenorette in 1954 which in turn became a widely method for businesses-based audio recording throughout the 60s and 70s in the form of cartridge like in this image.

In the late 70s to early 80s their standard device had moved on to the Steno-Cassette 30.

These formats can only really be played back on their original playback machines such as the Grundig Stenorette "R" Dictaphone so this makes them difficult to find working equipment for.

The microcassette was introduced to the consumer market in 1969 by Olympus and is a common format used in voice dictation, answerphones and some oral history collections.

Micro cassettes and mini cassettes are very thin and therefore are highly at risk for stretching and breaking. This means these formats are especially vulnerable during playback, and also at risk from being accidently recorded over. Their repeated playback degrades the audio quality over time.

The exceptionally vulnerable qualities of these tapes means that they are consider to have a projected lifespan of 2-10 years (https://psap.library.illinois.edu/collection-id-guide/audiotape)

Part 3: OPTICAL DISCS

For the general storage and handling of optical Discs, jewel cases are acceptable and any broken holders for the center of the disc should be replaced so as to protect the edges. As you would expect you should handle by the edge and center hole only. Optical discs are particularly vulnerable to scratches and surface damage. You should wipe carefully with a clean lint-free cloth to remove any dust or fingerprints before playback and the direction of this wiping need to be from the center directly outwards towards the edge.

CDs

Audio CDs)also known as Compact Disc Digital Audio (CDDA or CD-DA) have been in use from 1982 until the present day.

They are mass-replicated, with recorded information pressed into the silver-coloured underside.

Initially used to carry audio data in the Compact Disc – Digital Audio (CD-DA) format, later also used to store file-based content of all types.

In general they are chemically stable if stored well however there are some discs that produced in late 1980s/early 1990s used a defective protective surface which has resulted in visible tarnishing or 'bronzing' in the upper surface and a reduced reflectivity of the lower surface. For many of these discs is has rendering them partially or completely unreadable.

Standalone playback equipment and computer optical drives are still available but becoming less common on newer desktops and laptops. So it is advised to invest in good quality external optical drive that you can playback CD on such as those made by Asus and Pioneer and recommend software to rip these CDs like dBPowerAmp.

For Audio CDS the preservation risk is medium, due to likelihood of damage.

CD-Rs

CD-Rs have been produced for the same length of time as CDs however these discs have recordings that are individually burnt into a photosensitive dye layer. And this dye layer is liable to degrade, particularly on exposure to daylight.

These discs were increasingly used for short-run production of commercial music, and can be difficult to distinguish from mass-replicated CDs.

The dye layer is often coloured, either blue-green or a very pale yellow. The upper surface is less likely to contain mass-printed content information.

The legibility of the data burnt into the disc is notoriously hard to determine as poorly burnt discs may only play in certain drives or players or become unreadable in a short lifespan.

As it's incredibly hard to predict the legibility of the date and the degradation of the dye layer the preservation risk for CD-Rs is much higher than that of CDs.

OPTO-MAGNETIC DISCS

MINI DISC

Mini Discs where a propriety format produced by SONY from 1990s to the early 2000s. They take the form of opto-magnetic discs that (with the right software) appear as an external disk drive when linked to a computer. They even have a similar physical appearance to computer floppy discs.

Within archives they will generally be unique individual recordings (often used for music and oral history) but they could be the pre-recorded commercial Mini Discs that were briefly mass produced.

Even though Mini Discs are chemical stable when stored well and have minimal handling issues, it must be consider that their preservation risk is high.

This is because there are significant obsolescence issues as replay equipment is no longer available new and the software Sonic Stage used to decode its ATRAC data format is no longer supported by Sony.

There are some open-source (but still unsupported) workarounds to get the original Sonic Stage software to work on today's PCs

As well as the equipment being difficult to find there are also two different systems within this audio format, Net MD & Hi MD.

NetMD recorders allow music files to be transferred from a computer to a recorder over a USB connection (but not in the other direction).

Hi-MD was introduced in 2004 and it is important to note that Hi-MD media will not play on non-Hi-MD equipment, including NetMD players. Therefore it's best to invest in a Hi-MD player (like a Sony MZ-RH1) as it will play and allow transfer of both Net MD and Hi-MD media.

FURTHER RESOURCES

So that completes our overview on identifying, caring for and assessing the risk of common audio formats with many archives.

We have also published practical user guides on the best practice for digitising open reel tapes, cassettes, DAT tapes and for ripping Audio CD and MiniDiscs.

These are available on the training page on our website:

https://northwestsoundheritage.org/training/

The British Library have produced a handout that gives a summary of the formats and issues inherent with them here: How to care for sound recording collections - The British Library (bl.uk)

Here is a list of more in-depth resources that expanded further into formats, care and risk":

https://www.iasa-web.org/handling-storage-tc05

https://www.iasa-web.org/audio-preservation-tc04