Experience counts: Assessing the condition of an archival audio collection

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(with considerable input from Jim Thurn)

Abstract:

This paper reviews some of the challenges encountered while assessing the condition of a collection of reel-to-reel and cassette audiotapes. In November, 2003, Rick Taylor and Jim Thurn conducted a survey of the University of Texas at Austin Folklore Center Archives. A statistical sample of the collection was evaluated for signs of deterioration. The absence of a body of literature describing audio surveys necessitated the creation of a glossary of terms and not a little bit of experiential education. Findings and recommendations were documented in a Preservation Needs Assessment report.

Introduction

Stories abound in Texas, as they do in every part of the world: histories, and biographies, and jokes, and songs, and sermons that can’t be heard anyplace else. In Texas, the stories might be about cowboys, or the oil industry, or they might be about Mexican-Americans, and life on the border. Scholars such as John Avery Lomax and Americo Paredes have devoted entire careers to the collection of cultural and regional folklore. Lomax preserved for all-time the words to “Home On the Range” and the music of Huddie Ledbetter – better known as Leadbelly. Paredes rewrote Texas history by challenging the Anglo-dominated cultural record. In 1957, Americo Paredes founded the University of Texas Folklore Center, whose archives includes recordings of Texas fiddle contests, Gulf Coast oral histories, mariachis and border ballads, dubs of old cylinder recordings and race records, Mexican ghost stories, lullabies, Creole culture from the British Honduras (Belize), and music from California to Ecuador to the Caribbean.

The UT Folklore Center Archives discontinued its acquisitions in 1981. The collection is currently maintained by the Center for American History on the campus of the University of Texas at Austin. In November, 2003, Jim Thurn and I surveyed the condition of more than 2,000 cassette and reel-to-reel audiotapes included in the Archives, based on a sample drawn at random. From that survey, we prepared a Preservation Needs Assessment outlining our findings and recommendations. This paper attempts to weave elements of the original needs assessment together with elaborations on some of the issues we encountered during the project. Jim Thurn, a first-year conservation student at UT Austin, deserves much of the credit for “professionalizing” the language of the original document. During the course of this presentation, if I should occasionally lapse
into informal and anecdotal storytelling mode, the fault is entirely mine.

**Survey Design**

The collection is housed in a climate-controlled storage area of Sid Richardson Hall. The storage area contains printed matter as well as audiovisual media, but in general, the optimum conditions for storing magnetic tape are comparable to those for paper. A study by Edward F. Cuddihy (1989) found that a constant temperature of 68 degrees with a stable relative humidity of 40% is sufficient to prevent chemical deterioration. At the same time, it “is close to nominal tape operating conditions and encompasses comfortable human environments.”

![3rd Floor Storage Area in Sid Richardson Hall](image)

According to available finding aids, the UT Folklore Center Archives contains 2,017 audiotapes. The tapes are stored in 44 banker’s boxes on metal shelves. Our survey design called for a random selection of 22 boxes, which were loaded six at a time onto a cart and transported to an office where playback machines are located. For each box selected, we counted and consecutively numbered the tapes. We then obtained five random numbers from a random number table (Beyer 1968) and selected the corresponding tapes. Twenty-two boxes at five samples per box gave us a sample size of 110 tapes.

Our pilot study consisted of evaluating the first ten tapes selected. Based on the pilot study, we expanded the survey key to include more potential responses to questions. We based our survey instrument upon a form compiled by Hannah Frost of the Stanford University Libraries (Frost 2003). For each sample, we recorded the sample number, tape number, brand of tape, base material, gauge (i.e., tape width), reel size, and inspection results.
The pilot study helped us to refine our processes as well as our definitions. But the truth is, throughout the survey we continually found new evidence of potential problems: things we hadn’t seen or heard or even thought about before. For instance, we discovered a kind of a plastic clip that was occasionally used to keep reels of tape from unfurling. You’ve got to wedge it in between the flanges and the tape pack. This is like scraping your fingernail against the edge of a text block on a book that doesn’t have any margins – every time you do it, you run the risk of obliterating a portion of the text. We never saw such a thing until about 40 tapes into our survey, and then they came in a bunch.

**Survey Implementation**

For each sample, we conducted visual observations of the tape, the reel or cassette, and the housing. We looked for the presence of dust, mold or fungus, water stains, and chemical contamination. The housings – usually a cardboard box for the reel tapes and a plastic case for the cassettes – were inspected for cracks, tears, loose labels, broken or torn hinges, and the presence of loose papers and brittle tape. The pH of the cardboard housings was tested with an Abbey pH pen, along with any note papers found inside the housing. Any odor emanating from the tape or housing was noted. A vinegar smell is a sure sign of deterioration in some of the older tapes, which are backed with cellulose acetate.

Our visual observations continued with inspections of the reel or cassette. A cracked or nicked reel might have a jagged edge that could damage the tape as it plays. A cassette might have loose parts or a detached pressure pad that could interfere with playback.

And of course, the tape pack itself was examined. A good open reel tape pack is perfectly aligned at just the right tension. Problems include popped strands (in which a single wind of tape sticks out beyond the edge of the pack), step pack (in which whole sections of tape are out of alignment with the rest of the pack), and flange pack (in which the entire tape pack is resting against one of the flanges). Popped strands and step packs leave more of the tape surface exposed to possible hydrolytic reactions. They also invite edge damage, as do flange packs.
Other problems include spoking, which indicates that the pack is wound too tightly. A tightly wound pack can lead to a deformed substrate and subsequent distortion of the audio signal. Gaps are an indicator that something is amiss. It could be an object in the wind, or it could be that the tape has folded over on itself, allowing a sliver of daylight to show through when you look at the pack edgewise. Oftentimes, we couldn’t determine what caused the gap – at least, not without playing or fast-forwarding the tape all the way to that spot, and we didn’t want to do that both for lack of time and for the extra wear it would put on the tape. Gaps are also a sign that the tape is wound too loosely, which can allow the tape to absorb moisture and expand. We tested for loose pack by holding the reel by the hub and pulling gently on the end of the tape. If the pack spins, it is considered a loose wind. Cassette tapes are prone to exhibit most of the same deficiencies. In addition, they need to be rewound completely; failure to do so exposes the tape to dust and other contaminants, and may allow the exposed section to stretch or curl.

Lastly, our survey included an aural evaluation. We loaded each sample onto a playback
machine and listened for one or two minutes. By the way, do you know what causes popped strands and step packs? Stopping and starting the tape player. Worn or poorly adjusted tape guides could also affect the alignment (Smolian 1987). Still, by not playing the tapes through to the end, our survey probably contributed to the pack problems. But we didn’t have time to play through and rewind all the samples, and since the majority of reels already had non-uniform tape packs, we consoled ourselves with the knowledge that regardless of our own actions, our final report would include a recommendation to re-tension all the tapes in the collection.

We found that it was important to keep an eye on the tape as it played; if it tended to stick to itself, that might be a sign that hydrolytic reactions are causing the binder layer to degrade. This is called “sticky shed” syndrome: the binder turns gummy and bits of it flake away from the backing. If the tape wobbled back and forth as it moved away from the supply reel, it was evidence of a deformed substrate. Either of these occurrences could inhibit uniform contact with the playback head, resulting in dropouts and distortion.

We recognized that a worn-out audiotape will deteriorate faster with use, but it is also true that the condition of audio recordings cannot be ascertained without playing them (Frost 2003). A visual inspection can reveal a great deal about the condition of the item, but a tape that looks to be in good shape might actually be blank. Perhaps it was stored for years in close proximity to a loudspeaker or an electric motor, until eventually the magnetic field generated by the device erased the tape (AES 1997). One sample in our survey appeared to be perfectly normal – except that when played, we heard long stretches of silence punctuated by faint bursts of what sounded like voices talking backwards. We tried turning the tape over and playing the other side, but we got the same results. It is possible that the tape was recorded on a ___ track recorder, whereas we only had a ___ track playback machine. In any case, we never solved the mystery, and marked the tape down as inaudible.

The truth is, no matter how many books and articles you’ve read, it’s hard to tell a poorly made recording from a deteriorating one, unless you’ve got trained ears. For example, a dropout is defined as a sudden loss of signal strength due to the flaking of oxide layer. If you hear dropouts, you generally assume that hydrolysis is attacking the bond that attaches the binder layer to the substrate, resulting in oxide shed. But these recordings were made in the field, with handheld microphones, and sometimes the mics were moved around and sometimes the people moved around, and how do you tell a dropout from a speaker who suddenly moves off-mic?

The answer is, experience. Critical listening requires practice; I would say this is the most important lesson we learned during the course of our study. Neither Jim nor I had had extensive experience working with reel-to-reel tape, although I’d done some field recording and knew something about the things that go wrong at the moment of capture. But mostly we learned on the job. Speaking of which, we broke two tapes. That isn’t in our final report. The Sound Archivist at the Center for American History wasn’t terribly worried about it – tapes do break from time to time. Anyway, it gave us both an opportunity to learn how to splice tape.
Survey Findings

Of the 110 randomly-selected samples, 99 were reel-to-reel tapes, and 11 were cassettes. Therefore, we calculated that approximately 90% of the tapes in the collection were reels, and the remaining 10% were cassettes. We tabulated the survey results separately for each category because inherent differences in the two formats would have rendered a combined analysis meaningless.

Reel-to-Reel Tapes

Approximately 68% of the reel-to-reel tapes are backed with a polyester-based substrate, and the remaining 32% are backed with cellulose acetate. I recently heard a speaker explain that the way you can tell a polyester tape from acetate is by grabbing the tape with both hands and pulling hard. He said the acetate tape will snap cleanly, while the polyester tape will stretch and stretch. This is true, but there’s a much easier, non-destructive way to tell the difference: hold the reel up to the light edgewise, and try to see through it. A polyester reel of tape is opaque; an acetate reel is translucent. We opted for this test rather than the stretch test.

A major finding of the survey is the presence of acidic banker's boxes and housings. All of the boxes and housings are acidic, based on results of testing with an Abbey pH Pen. Acidic note paper and brittle adhesive tape is present inside 38% of the housings. One of the sampled tapes exhibited a yellowish residue. A possible source of the residue is the brittle tape, which adheres a note paper to the inside of the box. One of the cellulose acetate tapes also emitted a slight vinegar odor, indicating a chemical breakdown of the base material.
Several problems were observed in the audiotape material. The most common problems encountered were loose wind (61%), popped strands (57%), step pack (29%), gaps (23%), and splices or objects in the wind (12%). Loose wind (also called loose pack) can lead to elongation or deformation of the substrate. Popped strands and step pack can result in uneven stresses on the tape. Some tapes exhibited more than one of these traits.

During the aural evaluation, dropouts were noticed in 9% of the tapes, and squeal was present in 4% of the tapes. Dropouts are usually the result of loss of oxide particles from the surface of the tape. Squeal may result from breakdown and movement of binder material, increasing friction between the tape and the capstan or pinch rollers.

Plastic clips keep the tape ends on a small number of tapes from unraveling. Adhesives are used for the same purpose on other tapes. Plastic clips are potentially damaging to tape edges, particularly when popped strands are present. Adhesives may also cause chemical damage to the tape.

Cassette Tapes

Not surprisingly, all of the cassette tapes are backed by a polyester substrate. The cassette format was introduced in 1963, several years after polyester backing began to replace cellulose acetate in reel tapes. Of the cassettes surveyed, about 45% are 60-minute tapes, while 55% are 90-minute tapes. The length is significant because the longer a tape is, the thinner it is, and thinner tapes are more susceptible to stretching and print-through. However, a 90-minute tape – while not as stable as a 60-minute tape – is considered acceptable by archival standards. No tape surveyed was longer than 90 minutes.

Eighteen percent of the cassettes were not protected by housings, and 18% were contained in cracked housings. From these findings, we extrapolated that 36% of the tapes in the collection are susceptible to potentially damaging dust particles and other atmospheric pollutants. Dust particles can cause abrasion when the tapes are played, and atmospheric pollutants such as sulfur dioxide and nitrogen oxides can combine with moisture in the air to form sulfuric acid and nitric acid, respectively. Even trace amounts of acid are known to catalyze hydrolysis reactions, causing scission of polyester molecules. I should reiterate that this 36% represents only four tapes out of a very small sample size (11 total cassettes). But casual observation of the number of unsurveyed tapes without housings reinforced our finding that unprotected cassettes are a significant problem.

Approximately 64% of the cassette tapes are in good condition. A fairly large percentage of tapes (36%) had not been re-wound, which may lead to deformation. About 18% of the tapes exhibited a deformed substrate, and 9% contained visible gaps in the tape pack.

No aural problems were noticed in 91% of the tapes when they were played. The remaining 9% (that is, one tape) yielded a low signal strength when played. It was
It is difficult to determine whether low record levels or tape degradation (e.g. demagnetization) was to blame.

**Recommendations**

Overall, we found that the recorded media component of the UT Folklore Center Archives was in reasonably good condition. Most of the deficiencies we discovered are correctable: cassettes can be rewound, and those without cases can be rehoused. Plastic clips and adhesive tape used to keep reels from unwinding can be removed. Acidic boxes can be replaced with archival storage containers, and notes can be photocopied onto acid-free paper. It should be acknowledged that the original housings often contain invaluable information, and one expert recommends that “original housings should never be discarded without studying and documenting them thoroughly,” although there is no guarantee that the current housing is the original one (Frost 2003).

We also recommended that the tapes be exercised – that is, they should be re-wound and played through at normal speed. This will re-tension the tapes and result in a uniform tape pack. Some experts currently advise against periodic re-tensioning of magnetic tapes to avoid unnecessary wear. But many of the reels included in our survey exhibited loose packs, which can lead to stretching or deformation of the substrate. Other samples had an irregular tape pack (i.e., popped strands or step pack), which can put an uneven stress on the tape. For these reasons, we suggested that a one-time effort to exercise all the tapes would help minimize future problems. This would also provide an opportunity to check for rampant degradation of individual tapes, and to schedule those tapes for immediate reformatting.

Perhaps one flaw in our survey design is that we did not include a yes-or-no value for each sample that addressed the question of whether or not to reformat. The ratio thus obtained would have given us a quantitative measure upon which to base our recommendation. Still, we felt that with a few exceptions (for example, the acetate tape emitting the vinegar odor), the collection as a whole was not in need of reformatting at this time. But it should be noted that by some estimates, the lifespan of audiotape could be as low as 10 to 30 years, depending on usage and storage conditions. Deterioration of magnetic media is unavoidable; at some point, reformatting will be necessary (Van Bogart, 1995). We recommended that a follow-up survey be conducted in three to five years.

**Works Cited and Other Sources:**


