Preserving ¾" U-matic Tapes:
A Case Study of Best Practice of Squeaky Wheel's Axlegrease Video Collection

About the Project:

Upon its establishment in 1985, Squeaky Wheel has been a champion of independent media art. In the 1980s and 1990s, Squeaky Wheel saw the potential for democratizing mass media culture by intervening in the dominant entertainment system of the time– television, with a weekly public access cable TV show called *Axlegrease*. Launched in 1987 *Axlegrease* exposed mass audiences to alternative content in the form of experimental video art and documentary films featuring previously unheard stories, ideas and voices. Most of these video and films were recorded on ¾ u-matic tapes, then the available recording media at that time, and have been stored in the basement at the Squeaky Wheel ever since. Early and rare work by notable local, national, and international artists such as: Allan Jamieson, Ellen Spire, Eve Heller, Igor Vamos, Barbara Lattanzi, Jody LaFond, Peter Weibel, and coalitions such as Media Coalition For Reproductive Rights, Buffalo Against So Called Operation Save America, and Buffalo Artists Against Repression & Censorship. In the past, various efforts were made to digitalize small portions on a case-by-case basis through programs like Migrating Media, and whenever small amounts of support to do so became available. And the Squeaky Wheel's Archive Committee has been working in kind to organize, assess, digitize and preserve the collection. From 2019-2020, because of the generous support provided by The Council for Library Information Resources (CLIR) Recordings at Risk program, all Axlegrease episodes stored on ¾" U-matic tapes are digitalized and are accessible by the public from https://squeaky.org/wp-content/uploads/2020/04/Squeaky-Wheel-Axle-Grease-Archive-Metadata-2020.pdf.

What is a ¾ U-matic Tape?

Introduced to the market in September 1971, ¾ U-matic video tape was the first videotape to be housed inside a plastic cassette instead of open-reel film and was in used until year of 2000. The name came from its ¾ inch tape width (Figure 1) and the U-letter shape of the tape path when the tape lacing around the drum head during playback (Figure 2). U-matic tapes have magnetic particles as the recording held together with a binder, mostly polyurethane (Figure 3).

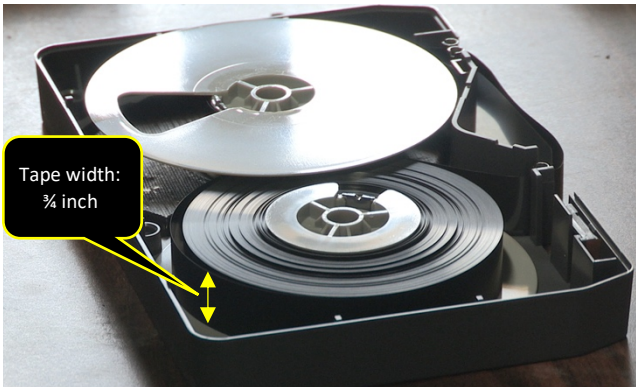

Figure 1: cassette opened, showing tape inside. The tape is ¾ inches wide.

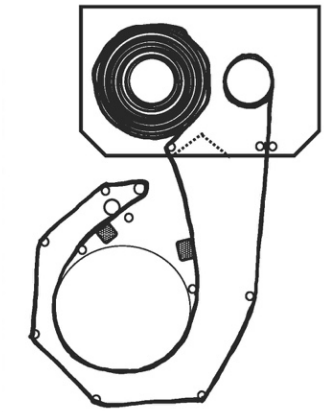

Figure 2: A schematic drawing of how the U-matic tape is loaded in the playback machine, resembling the letter U.

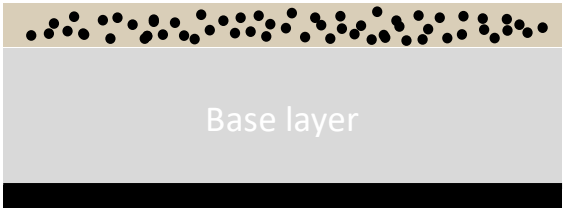

Figure 3: A schematic three-layered structure of magnetic tape-based analog video cassettes. The top layer is composed of magnetic particles glued and held in a binder, mostly polyurethane, that is coated onto a polyester base. A back coating might be added to facilitate tape movement and static charge during recording and playback.

The ¾ U-matic format was primarily developed for industrial and education markets. In the 1970s and 1980s, it was widely used for news gathering, particularly for on-location news gathering due to its portability and instant playback. At the time, U-matic tapes were the cheap, well specified, and hardwearing format for many broadcast and non-broadcast institutions to produce television programing on an accessible budget. It was also a primary format for many artist, community activists, academic institutions, and production houses up through the 1990s. As a result, many art and community videos are in this format.

Full size cassette can record up to 60 minutes content, while small cassettes can hold up to 20 minutes of content. U-matic SP (Superior performance, introduced in 1986) used chrome tape and offered an improvement in performance over previous generation. Though U-matic tapes were introduced by Sony, other manufactures released their versions afterwards.

Why in Need of Digitization?

The most urgent issue for the preservation of the U-matic tapes is the obsolescence of the media and the playback machines. Squeaky Wheel does not have any playback machine and finding a working one has become harder and harder. As less and less U-matic machines remain working condition, this format is now considered at high preservation risk.

Most U-matic tapes have not aged well under normal indoor temperature and humidity condition in Buffalo New York. Many of the tapes have sticky-shed syndrome, a condition originated from binder deterioration due to hydrolysis (chemical changes due to absorption of moisture). Tapes with sticky-shed problem have gummy surface and the oxide that holds the visual content could flake off the polyester tape base. When a videotape has sticky-shed, not only will it not play correctly, the sticky residue can also clog up the tape heads in the U-matic playback deck, then transfer to and contaminate other tapes played afterwards in the same deck.

Physically, the tapes are susceptible to signal loss, damage from mold, physical tape structure deterioration and other mechanical issues related to many replays and unwinding/rewinding.

Before Digitization: Assessment, Documentation, and Cataloging

The collection was assessed to create a detailed inventory before digitalization. Each tape was photographed for future visual reference and examined to record essential information, including barcode number; date; runtime; episode content (including, but not limited to artist/collective names; individual work titles, descriptions, runtimes; producers, etc); tape condition (mechanical, contamination and deterioration issues). This information helped Squeaky Wheel to access the scope of the collection, its overall condition, and to apply the funding for digitization.

Digitization Process:

1. Each tape was:
    1) examined for mechanical, contamination and deterioration issues.
        a. If tapes exhibited sticky shed syndrome, they were baked first in low heat for many hours to correct the gummy texture and ensure the tapes and/or the deck does not get damaged in the process. Figure 4 & 5
        b. If tape leaders broken, they are respliced, if required
    2) cleaned in a specialized tape-cleaning machine.
    3) repacked to ensure proper playback and reduce dropout.

Figure 4: Preparing tape to be baked.

Figure 5: tapes ready to be "baked" in a dehydrator.

2. The video head inside the U-matic deck was thoroughly cleaned before each playback.

3. Internal/external analog Time Base Correction and other video signal processing used as needed during the analog to digital conversion process, in conjunction with calibration tools to insure the signal is properly adjusted to National Television System Committee (NTSC) standards prior to digitization. The adjustment covers Luminance, pedestal, chroma, hue, timing, and audio volume levels.

4. As each tape was digitized, two file types were produced, along with related metadata:
    1) Archival master video file:
    This type of master file has lossless encoding format to keep as detailed information transferred as possible.

Specification: NTSC Uncompressed 10-bit Quicktime video file, with 720x486 resolution, frame rate of 29.97, and captured at a bit rate of 200Mb/s, with two track 48,000K (sampling rate) at 16 bit PCM (Pulse-code modulation) uncompressed audio resolution.

2) Web ready reference video file:
This type of reference file has lossy encoding fromat to reduce the file size for web viewing.
Specification: H.264 Quicktime video file, 720x480 resolution, frame rate of 30P, and captured at a bit rate 5Mb/s, with two tracks AAC (advanced audio coding) audio.

5. Metadata Creation:
   1) Each tape was re-barcoded, and a new, unique item number added.
   2) Additional metadata was added to the original assessment spreadsheet during digitization, including:
      a. supervising digitization technician
      b. problems/audio-visual abnormalities such as footage drop-outs, video sync issues, general errors witnessed during a calibrated playback.
      c. any additional notes (duplicates, etc)
      d. treatment done on tapes in order for optimal playback, including backing, repairs to the tape and/or housing
      e. equipment used
      f. time based corrections and calibration tools (if any)
      g. time and date of this digital migration

6. Ingest and Digital File Storage
   1) Ingest software tracked any dropped frames during digitization. When dropped frames were encountered, the tape was re-queued from the beginning and re-digitized. Up to three passes were made for each tape to insure the most complete capture possible.
   2) After the original files were ingested, they were moved to a non-linear editing timeline and examined for proper setup, playout and audio levels.
   3) A checksum* was generated for the files on the original capture drive. All files (the master and the reference video files and the related metadata) were stored on two sets of hard drives and one set of LTO** tapes. After files were moved to external hard drives and the LTO tapes, checksum verification of the duplicate files was performed to ensure accuracy of the files before delivery of the drives to Squeaky Wheel.

      ** A checksum is a data set used to verify accuracy of a digital transfer in order to ensure file integrity and alert to any potential data corruption in a transferred or copied file.*

      *** LTO or Linear Tape-Open tape is an open standards magnetic tape data storage technology designed for archival storage between 15-30 years.*

After Digitalization: Storage of the Original U-matic Tapes and Digital Preservation Activities

1. Physical storage:

1) The original U-matic tapes were carefully packed in boxes at Media Transfer Services and transferred to Visual Studies Workshop (VSW) in Rochester for long term storage. These tapes would be stored in VSW's Archive of temperature and humidity controlled collection storage facility, and away from problematic magnetic fields. They are also available for search and education through VSW collection management team.

2) The two sets of hard drives and one set of LTO tapes are stored at different location for stewardship and safe storage. One set of hard drive is kept at Squeaky Wheel Film and Media Art Center; the other set at the Garman Art Conservation Department at SUNY Buffalo State. Lumiflux Media would care for the set with LTO tapes.

2. Web Storage:
   Digital Reference Files are uploaded to Squeaky Wheel's Vimeo account as private, password protected links.

3. Access & Project-Specific Ethical Considerations:
   1) All of our metadata is available online (http://www.squeaky.org/exhibitions-events/squeaky-wheel-axle-grease-archive/) and is not governed by any copy right following the Creative Commons CC0 1.0 Universal Public Domain Dedication license.
   2) The access to the Digital Reference Files at Squeaky's Wheel's Vimeo account is limited to mediamakers and/or rightsholders, and project organizers at this time.
   3) Access is governed by Squeaky Wheel's Rights and Re-use Statement.

This PDF and the larger project of which it is a part, is made possible through the generous support provided by The Council for Library Information Resources (CLIR) Recordings at Risk program.

About the project participants:

Squeaky Wheel Film & Media Art Center (est. 1985) has a mission to continue a legacy of innovation in media arts through access, education, and exhibition. It is the only organization in Western NY to offer education, equipment access, and exhibition programming dedicated to exploring film & digital media arts.

Media Transfer Service specializes in preservation, digitization, and recovery of audiovisual media collections. They cover a diverse range of media and clients and take an individualized approach to each audiovisual media digitizing and preservation project in their dedicated facility.

Additional partners and project support:

Patricia H. and Richard E. Garman Art Conservation Department, SUNY Buffalo State Lumiflux Media – Albright-Knox Art Gallery – Burchfield Penney Art Center — Visual Studies Workshop