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Heating Things Up: A History of Baking Tapes for Video Preservation

"To put it in unscientific terms, that binder is a sponge" –Brian Ahern[1]

Tapes are inherently flawed; the physical properties which make up the tape break down over time due to a variety of factors. In *The Video Preservation Handbook*, Jim Wheeler asserts that well cared for magnetic tape can last over 50 years[2], while Dr. Peter Adelstein of the Image Permanence Institute has written that medium-term storage goals will maintain tape for 10 years.[3] In the archival community, these numbers are laughable, resulting in recommendations from the field to migrate tape as a key component of archival planning.[4] Thus, tape, as opposed to film, is not considered as valuable as an artifact. Retaining the highest quality of content, in migration, reformatting, and other techniques is the priority for preservationists. While now an understood component of the field, a main concern is in retaining the highest quality of content in tapes that have *already begun to deteriorate*[5] due to the inherent flaws of the tape's makeup. With professionals now stating that tape collections are expected to last only 15 years more, collections holders are looking for quick answers in saving their tapes.

Tape baking is the process of heating tapes to dry out the moisture they absorb as a result of natural aging and/or storage in humid and/or hot environments. This moisture can cause

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[1] Holland, Bill. "If I Knew You were Coming, I'd have Baked A Tape." *Billboard* 111, no. 23 (1999). 2 November 2010. *Proquest Central Database*. Accessed through NYU Libraries. 1.
[2] Wheeler, Jim. "Video Preservation Handbook." 2002. 10 October 2010. http://www.media-matters.net/docs/resources/Traditional%20Audiovisual%20Preservation/WheelerVideo.pdf. 2.
[3] Adelstein, Peter. "Storage". *Playback 1996*. Abstracts. 27 October 2010. http://cool.cnservation-us.org/byorg/bavc/pb96/plybabs.html. 2.
[4] Wheeler 2
[5] my emphasis

inherent properties in the tape to breakdown, become unplayable, and render its content unreachable. The first concern over tape breakdown was highlighted by NASA in 1975 with sticky shed problems on tapes instrumental to their space programs.[6] In the early 1980s, with the rise in popularity of re-editions by the record industry, companies pulled out their tape backloads and discovered that many of their master tapes were breaking down.[7] To save the content, users, and consumers of tape products pushed for answers. This moment was the start of the formation of tape baking.

This paper is an attempt to put the method of tape baking in context. It will trace the process and purpose of baking tapes, sometimes referred to as curing, incubating, or heating. It will document the history of tape baking starting in the 1980s as a restoration practice, with a survey of a variety of techniques used to bake tapes. As a highly contested practice in the preservation field, the paper will then tackle the issues surrounding the controversial nature of tape baking, especially as they pertain to the preservation and archival communities. These issues are an aspect of tape baking that cannot be discounted as a part of a larger survey of its history. Alternatives to tape baking will then briefly be explored. First, however, the paper must begin with a basic description of videotape parts and processes in order to contextualize the problems that tape baking tackles.

An Introduction to Tape Properties

Magnetic tape consists of a binder, a substrate, and often, a back coat. The content of the tape is stored in the signal of the magnetic particles. The binder holds the magnetic particles in

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[6] Richardson, Charles A. "Solving the Sticky Shed Problem in Magnetic Recording Tapes: New Laboratory Research and Analysis Provides a Safe and Effective Remedy." *Audio Engineering Society*. Convention Paper Presented at the 121st Convention. 5-8 October 2006. 4.

[7] Holland 1

place and to the base of the tape. The base, or substrate, provides the tape with its physical structure. Many tapes are also coated with a back coat, attached to the opposite side of the base from the binder.[8] As Bill Holland states, "Analogue audiotape, in essence, is a chemical compound sandwich made of an oxide coat, a plastic base, and a backing coat- plus two binders to hold the top and bottom coats to the base."[9] The back coat decreases friction of the tape as it moves through a device for recording or playback. It also allows the tape to pack well on the hub of the tape reel. The base physically supports the binder, and thus, the magnetic particles, making the tape strong enough to pass through the machine. The binder, or topcoat, holds the magnetic particles in place, but it is also responsible for allowing the tape to move smoothly through the device. To do this, the binder also contains lubricant, head cleaning agents, and static reduction agents.[10] Each part of this sandwich has its own preservation concerns, yet it is in the binder of the tape that the fastest deterioration occurs. Tape baking aims to remedy occurrences in the breakdown of the binder.

Starting in the late 1960s with the growing use of videotape, the majority of binders were made of polyester polyurethane, a material that was both inexpensive and durable.[11] Polyurethane polymers have incredibly complex molecular structures made up of large numbers of monomers, or simpler molecules that can be combined in a variety of ways to make a diverse array of binders suitable to the needs of the manufacture.[12] Polyurethane binders are still readily used today in the construction of tape.[13] A majority of the polyurethane polymers used, however,

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[8] Bogart, Dr. John W.C. Van. “Magnetic Tape Storage and Handling: A Guide for Libraries and Archives.” National Media Laboratory, June 1995. Accessed 13 November 2010. http://www.clir.org/PUBS/reports/pub54/2what_wrong.html. Section 2.0.
[9] Holland 1
[10] Bogart 2.0
[11] Wheeler 7
[12] Presto 11-12
[13] Presto 9

were later discovered to be very hygroscopic in that they readily absorbed and/or desorbed water depending on the amount of water in the air, documented as the relative humidity of storage conditions. Tapes that are hygroscopic absorb water from the air and are susceptible to hydrolysis, a chemical reaction where the polyurethane molecules react with water and break down, creating a weakness in the binder.[14]

In the late 70s, Edward Cuddihy, working for NASA, hypothesized that with the increase of humidity, the abrasive wear of recording heads by tape increases dramatically. In looking at the affect of humidity in the microenvironment of tape (the container) with the affect on head ware by tape, Cuddihy looked at the tipping point where headware dramatically increases at; Cuddihy looks for a cause in environmental conditions that could correspond to this catalytic point (40-45%Rh). Cuddihy had hypothesized that at this catalytic point, a major change would occur in the hydroscopic properties of the tape. No major change occurred; water content in the tape gradually increased in proportion to the increase of humidity. Although unsuccessful with his initial hypothesis, in his conclusion, Cuddihy asserts that the relationship between binder properties and recording headwear may be directly connected:

> Tapes formulated to have magnetic coatings which are either hard or high in surface friction probably tend to wear recording heads, and the dependency with relative humidity would be that of Fig 13 (hypothesis assumptions, with increase of humidity, abrasive wear dramatically increases at a tipping point around 40Rh). On the other hand, magnetic coatings formulated to be softer, or with reduced surface friction, are probably less abrasive, and there-fore head wear and the humidity effect would tend to be minimized or nonoccurring. In turn, it is possible that heads would now wear the surfaces of these latter class of tapes, and the wear products from tape could either be

[14] Wheeler 17

> powdery or gummy, depending on relative humidity and the hygroscopic property of the magnetic coating. Increasing the water's content *would* increase the tendency for tape wear products to be gummy. Thus the hygroscopic properties of magnetic coatings formulated to be either softer, or reduced in surface friction, may be an important parameter dictating whether tape wear products will be powdery and nonadhering, or gummy and promote tape sticktion to recording heads.[15]

Writing in 1976, Cuddihy posits that increasing the water content of 'softer' magnetic coatings may be a factor in the increase of tape residue that results in head wear. In essence, his work is foundational in directly relating the increase of humidity of storage environments with the increase in binder breakdown.

Interestingly, it is commonly known that the breakdown of the binder is caused by the scission of the polyurethane molecules. Upon their reaction to water, the molecules chemically break down, and the shorter urethane molecules rise to the surface of the tape, creating a more viscous surface and a sticky residue on the surface.[16] The breakdown of polyurethane molecules creates smaller molecules that the tape essentially sheds from the binder. This is known as Sticky Shed Syndrome (SSS). This shedding can create head clogs in the playback machines, resulting in increased dropouts, head clogs, and sometimes causing the tape to stop in the machine; loud squeaking noises are common when this occurs.[17]

Urethane linkages vary in size. Medium sized urethane strings used in the polyurethane molecule are key to retaining binder stability. Short strings break down easier when water is

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[15] Cuddihy, Edward F. "Hygroscopic Properties of Magnetic Recording Tape." IEEE Transaction on Magnetics, (March 1976): 134.

[16] DeLancie, Philip. "Sticky Shed Syndrome: Tips on Saving Your Damaged Master Tapes" Mix, May 1990, 149.

[17] Bogart 2.1

introduced, while long strings create an increase in viscosity of the binder.[18] Unfortunately, before the high pressure gas chromatagraph was invented in 1984, which could confirm the length of the urethane strings used in the binder, tape manufacturers tested the polyurethane provided to them by vendors by checking the viscosity. Since the viscosity of the sample only provided an average idea of urethane string length in the polyurethane molecule, many of the binders manufactured, especially in the period from 1975 to 1984, contained a combination of short and long string urethane strings, making them highly susceptible to hydrolysis and sticky shed syndrome.[19] This is the cause of why some tapes have a problem with sticky shed and are often baked.

Sticky tapes suffering from sticky shed syndrome will first emit a powder or a gummy residue from the binder. The binder will be softer than usual. Additionally, tapes can appear to have oily areas on their surface.[20] Each manufacturer has their own chemical makeup for binder construction, and thus, not all tapes are affected.[21] Various scholars and professionals in the field warn against specific brands of tapes. Steve Smith of Ampex Recording Media publicly stated problems with their Ampex 406/407 and 456 tapes;[22] Eddie Cliente adds 3M 250 and AGFA 468 to the list;[23] William Lund, formerly of 3M, offers up 3M brand stock 226,227, 806 and 807 made from 1978 to the mid 1980s.[24] A detailed list of tape brands found to suffer from sticky shed syndrome can be found on Richard Hess' website.[25] Because of Ampex's history as a lead

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[18] DeLancie 149
[19] DeLancie 149-150
[20] Wheeler 19
[21] Rary, Rich. "Baking Old Tapes is a Recipe for Success". The Association of Independents in Radio. Radio World Magazine. 10 October 2010. http://www.airmedia.org/PageInfo.php?PageID=197.
[22] Delancie 149
[23] Ciletti, Eddie. "If I Knew You Were Coming I Would Have Baked A Tape (A Recipe for Tape Restoration)." 11 October 2010. http://www.tangible-technology.com/tape/baking1.html
[24] Rarey
[25] Hess, Richard. "Degrading Tapes." Updated 28 May 2010. Accessed 12 November 2010.

tape manufacturer, Ampex's 406 and 407 stock are the most common tapes found to have sticky shed syndrome, mainly because of the quantity it distributed.

Baking a Tape

On April 14, 1956, Ampex Recording Studios, now Quantegy, made a presentation at the CBS Affiliates meeting in Chicago, demonstrating their new product made to record television programs for networks. At the time, television networks were using kinetoscopes to record programs broadcast in the Eastern Time zone so they could replay these programs hours later for the West Coast. Ampex's new product, the first practical videotape recorder, allowed the networks to record on tape manufactured by 3M, immediately replacing the kinetoscope. The product was so successful that the following week, Ampex demonstrated it every 15 minutes to patrons of the National Association of Radio and Television Broadcasters convention in Chicago. The videotape recorder was born. This machine recorded and played back a signal on 2-inch wide tape, or 2-inch quad.[26]

This technological breakthrough was so successful that it propelled Ampex into the position as leaders in the field. It is not surprising, that they were the first to publicly encounter the fallout from sticky shed syndrome in the early 80s. Initially conceived as a problem inherent to Ampex products, it was eventually discovered that sticky shed syndrome affected all tapes suffering from polyurethane molecule breakdown and hydrolysis, exacerbated by high humidity and temperature storage conditions. Engineers from Ampex are credited with inventing the tape baking process, although there is some speculation that it was created in the field by studio

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http://richardhess.com/notes/formats/magnetic-media/magnetic-tapes/analog-audio/degrading-tapes

[26] Martin 51-53

engineers.[27] In 1989, Ampex Systems Corporation filed for a patent for the invention of the tape baking process; it was awarded in 1993.[28]

Tape Baking is a restoration procedure. Tape restoration "involves actions to stabilize and return a deteriorated or damaged tape as nearly as possible to its original condition. This means treating a failing tape in a manner that enables the recording to be played at the same level of quality it held when first laid down."[29] Cuddihy's experiments determined that the chemical reaction of hydrolysis in tape was reversible, up to a catalytic moment.[30] Baking is an attempt to reverse hydrolysis; heat causes the binder polymers to reattach, temporarily increasing their strength and viscosity, and allowing them to be played in the machine.[31] This process is essentially an attempt to dry out the tape, firming up the binder and reducing sticky shed. Many professionals advocate for immediate migration, because sticky shed syndrome will return to the tape. Placing the tape at a low, steady temperature for a long period of time will often dehydrate the tape so that the content can be accessed.[32] The Ampex patent reads, "In this invention it has been unexpectedly found that deteriorated magnetic recording media exhibiting an undesirable degree of shed, stickiness and/or squeal, can be restored to playable and excellent quality media by heat treatment at a sufficiently elevated temperature for a sufficiently long time to restore the media to play- able condition exhibiting none of these undesirable properties."

Ampex recommends baking the tape at 130°F. It is very important that the temperature is steady throughout the entire process. The literature cited throughout this paper recommends temperatures from 122° to 140°F. The time required to bake a tape varies dramatically across the

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[27] Holland
[28] "Restored Magnetic Recording Media and Method of Producing Same." 3
[29] Wheeler 2
[30] Bertram, H. Neal and Edward F. Cuddihy. "Kinetics of the Humid Aging of Magnetic Recording Tape," *IEEE Transaction on Magnetics*, Vol. MAG-18, No. 5, (September 1982): 999.
[31] Restored Magnetic Recording Media and Method of Producing Same." 3
[32] Wheeler 20

field. Ampex initially recommended at least 8 hours, with best results recorded at 12-16 hours and the maximum at 36 hours; recommended humidity is 15% Rh.[33]

Most recommendations for time in the baking process vary depending on the width of the tape. Holland recommends 10 hours for 2-inch tapes, eight hours for 1 inch and ½ inch tapes, and six hours for ¼ inch tapes.[34] Cicelli recommends 1 to 4 hours for ¼ inch tape, 2 to 5 hours for ½ inch, 3 to 6 hours for 1-inch tape, and 4 to 8 hours for 2 inch.[35] Bill Lund of 3M recommended eight to ten hours.[36] Bogart recommends three days.[37] These numbers vary dramatically, but it is widely understood that the time of baking is not a key control; baking for as long as is needed is the most common recommendation.[38]

Tape baking is a temporary fix to sticky shed syndrome. It can last up to a month depending on the storage of the materials and the length of baking duration. Professionals recommend baking once and immediately transferring the material to another tape[39], however, some experts in the field advocate that baking can be performed over and over again to the same desired results.[40] Tape baking can also be carried out on tapes that are on cassettes, on reels, or on other tape housings; the packed tape layers will not stick together.[41] Tape baking can be performed on any polyester based binder whether the content is audio, video, or data based. Acetate based tapes should not be baked; they will melt.[42]

The tape to be baked must have a good pack on the hub. Before baking, the tape should be

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[33]"Restored Magnetic Recording Media and Method of Producing Same." 2
[34] Holland
[35] Cilelli
[36] Rarey
[37] Wheeler 2.1
[38] Rarey
[39] Bogart 2.1
[40] Steve Smith, Quantegy, quoted in Holland
[41] "Restored Magnetic Recording Media and Method of Producing Same." 3
[42] Holland

fast forwarded to the end and then rewound to the start and played to the end. This will provide the tape with a flat pack. Baking may also help flatten out tapes that have not been packed well and are deformed due to stretching or edge damage. A good pack is essential to baking a tape.[43] If a tape that is not packed well is baked, edge damage can occur. In the case that a tape is unevenly wound, yet it cannot not be rewound due to shedding concerns, machines can be remedied to make them safer by removing the head stack and stationary guides so that the tape is not rubbing against these parts.[44] The Library of Congress warns that rewinding a tape before baking will increase print through, pointing to contradictions in the field.[45]

Assuming that tapes have been stored tails out, the archival recommendation, it is also recommended that tapes are packed heads out for baking. The urethane strings that are shedding off the oxide layer can easily be transferred to any plastic leader adjacent to it with the addition of heat. By turning the pack from tails out to heads out, this process is avoided.[46] Additionally, tapes should be placed in an oven that has not been preheated, allowing it to gradually acclimate, and tapes should rest after baking to allow them to cool down on their own. Tapes should not be played while hot. Tapes should stay on their reels and there should be enough space in the oven for good air circulation, since one of the most important aspects of successful tape baking is in maintaining a very consistent temperature throughout the process.[47]

A History of Tape Baking

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[43] AMIA. Video Preservation Fact Sheets. http://www.amianet.org/resources/guides/fact_sheets.pdf. 6
[44] DeLancie 152
[45] Gibson, Gerald. "Magnetic tape deterioration: recognition, recovery and prevention." Presented at the IASA Conference in Perugia, August 26, 1996. 17 November 2010. http://www.unesco.org/webworld/ramp/html/r9704e/r9704e11.htm
[46] DeLancie 152
[47] Rarey

In 1976 Cuddihy documented his experiments in heating tapes as part of a larger experiment to determine the hydroscopic properties of magnetic recording tapes by documenting the changes in humidity they go through in the micro environment of their sealed cases. The report explores not only the changes that occur in heating tapes, but also cooling, and through humidity conditioning techniques. The tape was gradually heated to 55°C (131°F) at a rate of 15°C (29°F) per hour. They found that as the temperature increased, the case %Rh also dropped as expected. The tape pack desorbed water, causing the case %Rh to increase. Cuddihy's results point to the fact that the tape worked to maintain a relative humidity within its case, but it interesting that with heating, the tape desorbed water.[48] This is the first documented case of tape baking. It also relates the desorbtion of water to a corresponding increase in the humidity of the environment, a factor that will later be considered as part of dewpoint.[49]

In the 1980s, with the rise of sticky tape problems within recording industries who wanted to use their master tapes from the last few decades to reformat and re-release, the industry mobilized to find a solution. After all the experiments conducted on sticky shed syndrome, professionals turned to heating tapes to counteract the hydrolysis process. Ampex is credited with inventing the solution of tape baking to specifically target this issue. They applied for a patent for the process in 1987 and were awarded it in 1993.[50] As the major target of sticky shed products at this time, Ampex also started to offer free baking services for their clients, which continued through 1999 until there was consensus in the field that Ampex was not alone in providing tapes that suffered from SSS.[51] Ampex still provides free services to some clients.

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[48] Cuddihy 132
[49] "Understanding Dewpoint". Image Permanence Institute. 16 November 2010. http://imagepermanenceinstitute.org/shtml_sub/article_understanding_dp.asp
[50] Restored Magnetic Recording Media and Method of Producing Same." 1
[51] Holland

In April of 1989, Agfa hosted a talk to discuss tape restoration and sticky shed. They presented Agfa-XT, a fee-based, send-in service to clients, where tapes undergo a rigorous process of inspection, chemical and mechanical cleanings, heating, and direct format transfer. This process cost $280-$350 for a 2,500 foot roll of any width in 1990.[52] Commercial ovens can run $5 to $6 thousand dollars a piece.[53] Although these commercial grade treatments were offered in the market, many professionals and amateurs simply baked tapes using everyday or homemade devices. The Ampex patent[54] and Ampex staff[55] publicly suggest the use of a convection oven, like Faberware's, which can hold one tape and can be operated at a low, consistent temperature. These cost around $150 in 1990. Holland describes a story where Eric Levenson, a Senior Vice President at Universal Music Group/Polygram, ran out to Macys during the work day, purchased the same mode Faberware convection oven that they had in their staff kitchen for $350, and baked Eric Clapton tapes to reissue on CDs.[56]

A conventional kitchen oven is not recommended. For one, it is difficult to maintain a very consistent low temperature; many oven thermostats are not perfectly accurate. Also, there is the danger of exposure to electrical fields, which can affect the magnetic signal of the tape.[57] Mike Rivers discusses one successful means of using his oven by replacing the 25 watt appliance lamp with a standard 100 watt light bulb, and inserting a fan for air circulation. Rivers uses a muffin fan salvaged from a dead PC power supply. A little experimenting and Rivers was able to maintain a stable 130 degrees.[58]

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[52] DeLancie, sidebar *Send Us Your Masters*, interview with John Matarazzo of Agfa.
[53] Holland
[54] Restored Magnetic Recording Media and Method of Producing Same." 4
[55] DeLancie 152
[56] Holland
[57] DeLancie 152
[58] Rivers

Want to make one at your own home? George Horn of Fantasy Records invented a temporary tape oven which has been successful. Tapes are placed on a metal rack resting on cinder blocks on a table. A 14" cardboard box is placed open side on the rack with the flaps cut off. Tapes must be spaced to allow for airflow. Horn cut a hole exactly the size of a 1500W blow dryer and inserted it into the box. Place the blow dryer on low heat and speed, add a cooking thermometer, a small meat one will do, into the other side of the box to gain a temperature of 130°F with not more than a 10 degree variation, and four to eight hours of heating later, and a few more hours to cool to room temperature, tapes are baked and ready to play.[59]

In 1998, Eddie Ciletti of Manhattan Sound Technicians offered another solution. He uses a commercial dehydrator made for drying meat and vegetables, specifically the Snackmaster Pro model FD-50 made by NESCO®/American Harvest®.[60] Now discontinued, it was replaced by the $65 FD-60 Snackmaster, but there are also a variety of other dehydrators offered by the company[61] that have the required features listed below. The machine has an adjustable thermostat and built in fan which is purported to maintain a consistent temperature with only, at most, a 5 degree variation. No dangerous magnetic fields were found in the use of this device. Trays can be modified and made larger by creating one tray by cutting dummy trays, adding height to the tray below.[62] The added benefit is that the device can also be used to make jerky or dried fruit; the FD 60 comes with a fruit tray and jerky spices.[63] Ciletti warns against processing food and tapes together.[64]

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[59] DeLancie 150
[60] Ciletti
[61] Nesco Food Dehydrators. http://www.nesco.com/category_449f7f01f1ea
[62] Ciletti
[63] I am not endorsing this product. It is just interesting. Product site: http://www.nesco.com/category_449f7f01f1ea/subcategory_39febe0b9343/product_db21f85c8f63/session_5c93534b6712/
[64] Ciletti

Baking Concerns

As is evident, tape baking varies across the field, and there is a distinct divide between professional processes with equipment made specifically for treating tapes and homemade devices assumed to work as well.[65] This can have drastic consequences for archivists and preservationists whose goal is to be responsible for the stewardship of a collection and maintain it at its highest possible quality. While tape baking may seem like a viable option for the problem of binder breakdown, many voices in the field warn against the use of tape baking as a catch all remedy for sticky shed. One of the major concerns is that baking a tape, a restoration process, can harm a tape as well as hurt it. Tape baking is an inherently invasive process. By heating up the tape, all levels of the binder-base-backcoat sandwich are affected by this heat in their own way. They expand and contract in different ways, placing wear on the tape as a whole.[66] Cuddihy discusses that heat can speed up the hydrolysis process, damaging the tape in the long run.[67] Bogart acknowledges that baking was developed for a very specific polymer breakdown, and, "for other kinds of degradation on other tape types, tape baking may actually cause more damage."[68]

With the popularity of baking in the past decade, concerned professionals in the archival field worry that content is being lost by baking tapes. As Jim Lindner warns, "The fact that there is no field test to determine the level of hydrolysis damage, or to determine whether the tape even has this damage at all does little to dissuade those from using a process that at best is a

[65] George Blood. Personal Interview. 15 November 2010.
[66] Richardson 7
[67] Betram and Cuddihy 999
[68] Bogart 2.1

highly questionable remedy for all the ills that can befall tapes".[69] Additionally, there is not yet any significant research into the affect of the magnetic signal by baking. Holland discusses several professionals who attest that there is evidence that some high-frequency material is lost in the process, jeopardizing the content of the tape. The Library of Congress is currently conducting a study on the sound fidelity of tapes before and after baking.[70] While Ampex asserts that a tape can be baked as many times as needed, it is understood that a tape can only be baked a few times before the tape will no longer play.[71] These concerns are heightened when the accepted practice across the field is to bake the tape before playing when in doubt of its condition.[72]

Additionally, baking tapes can harm the tape and content if not done correctly with patience and vigilance. Rarey warns against baking with any mold growth, as it will stain the surface of the tape.[73] Holland warns against baking acetate as it will melt or burst into flames. Baking master tapes with splices can result in adhesive staining the oxide of the tape and the loss of valuable content. [74] If the temperature is too hot, print through can become amplified. Baking uneven tape will damage the edges.[75] Lastly, bakers must understand the difference between lubricant and binder breakdown. Lubricant breakdown, although more rare, leaves a whitish shed, instead of the dark, gummy shed of binder breakdown. Tapes affected by lubricant breakdown should not be baked, while tapes that are affected by binder breakdown should not be

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[69] Lindner 7
[70] Library of Congress. "Documenting Sound Fidelity before and after Tape Baking." 23 September 2010. http://www.loc.gov/preserv/rt/projects/fidelity.html
[71] Holland
[72] for example see Ciletti's article where he states, "If uncertain of the tape's condition but the pack is good, bake it anyway."
[73] Rarey
[74] Holland
[75] Cilleti

treated with lubricant.[76] All of these concerns are series problems for professionals in the field who see the tape baking clientele split between knowledgeable preservationists and careless bakers.

Alternatives

As Cuddihy informs us, and tape baking takes its inspiration from, hydrolysis affecting the polyurethane molecular structure of the binder is reversible. Many tapes are not yet at the catalytic point and they can simply be placed into a proper storage environment. George Blood of George Blood Audio Lp simply puts tapes in his controlled vault for 6-8 weeks and as a result has seen a dramatic increase in the tapes they must bake.[77] Mick Newnman from the National Film and Sound Archive has also had good results in reversing hydrolysis with low humidity storage (35%Rh) conditions.[78] As Cuddihy says, "The best solution, of course, is to understand the various chemical processes in the tape system which lead to degradation, including hydrolysis, so that a reasonable long term storage environment can be predicted."[79]

Studies and experiments have been conducted on solvent cleaning processes using isopropyl alcohol to clean the surface of the tape and also the removal of the backcoat to stop stickyshed from occurring, yet not enough research has entered the field as to their viability.[80] Another method sanctioned by AMIA is in drying the tapes out using a desiccant, like a silica gel, which will absorb the moisture in the tapes, temporarily allowing them to be played. Tapes are removed from their containers, placed in sealed plastic bags, and then placed in a refrigerator

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[76] DeLancie 149
[77] George Blood. Personal Interview.
[78] Mick Newman. National Film and Sound Archive. Australia. Email correspondence. 12 November 2010.
[79] Betram and Cuddihy 999
[80] Library of Congress. "Sticky Shed Syndrome in Magnetic Tapes: Characterization, Diagnosis, and Treatment. 23 September 2010. http://www.loc.gov/preserv/rt/projects/sticky_shed.html

for at least a week. Timing is subjective to the condition of the tape, and has yet to be accurately determined. Once completed, tapes should be reacclimated to room temperature before playing.[81] Currently, clay based desiccants experiments are being conducted to determine success rates.[82]

The Library of Congress is currently in the process of researching the tape baking process. The Conservation and Preservation Research and Testing Divisions embarked upon a preliminary study in 2008 to tackle the causes, detection, and treatment of Sticky Shed Syndrome of magnetic tapes. Their findings point to remedial treatments of baking and dry cleaning, yet they have only stated that both treatments have their advantages and disadvantages.[83] The Library of Congress continues to research tape baking specifically and the research will be valuable to the field.[84]

Tape baking is a controversial method due to its invasive qualities and lack of definitive research as to effectiveness. Proponents on both sides of the debate still argue over the value of the process and the field has yet to fully determine the best course of action in moving forward in this interesting restorative process.

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[81] AMIA fact sheets 24
[82] Mick Newman
[83] Library of Congress. "Sticky Shed Syndrome in Magnetic Tapes: Characterization, Diagnosis, and Treatment. 23 September 2010. http://www.loc.gov/preserv/rt/projects/sticky_shed.html
[84] Library of Congress. Webcast. http://www.loc.gov/preserv/tops/tops50/hobaica/hobaica.ram