Physical Problems, Sonic Implications. A discussion of the ethics of preservation treatments and audio recordings

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This paper arose out of thinking about a dilemma sound archivists face in the treatment of polyester tapes. The recommended treatment of the tape is detrimental to the physical condition of the tape yet beneficial to the audio content. How do we make a decision regarding the treatment approach?

To explain the dilemma: magnetic tapes produced since the 1970s by a range of primarily US manufacturers have with time begun to exhibit the effects of binder degradation. The tapes shed a sticky residue that causes the tape to bind to the heads of the tape machine during replay and often exhibit a characteristic squeal, which is apparent both physically and in the modulation of the resultant signal. In extreme cases the tape may bind to adjacent layers resulting in a short loss of signal, or drop out, in addition to the degradation of the speed stability of the replaying tape. Various papers and studies identified the process as hydrolysis (Cuddihy, 1980, Brown et al., 1982-1986), and recommended that the tapes be treated at elevated temperature and low humidity for a specified period of time. Discussion arose as to whether the tapes should be exposed to temperatures approaching 50°C for around 8-12 hours, which appeared successful, or to room temperature, but at humidity conditions approaching zero, often for months. Research revealed that a specific break point could be measured, wherein at temperatures above 50°C the effects of hydrolysis were clearly reversed, but that a small, possibly insignificant, loss of high frequency information occurred (less than ½ dB at 10 kHz). However, for treatments at the lower temperatures for extended periods of time, the residual effect of hydrolysis, measured as scrape flutter, never quite reached optimum levels, though no measurable change in frequency response was noted (Bradley, 1997). Still further work tended to infer that the observed temperature/restoration breakpoint of around 50°C related to the glass temperature of the binder (Hinterhoffer et al., 2000). Polyesters undergo two state changes during heating: plastic temperature is the temperature at which the plastic looses its mechanical stability and becomes 'plastic'; for polyester tapes this is around 105°C and clearly these temperatures are extremely

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damaging to the tape and detrimental to the replay of the signal: glass transition temperature is the temperature at which the plastic takes on some of the characteristics of a liquid but retains its mechanical stability, like glass at room temperature. Providing no mechanical stress is applied to the tape while it is at the glass temperature, the only changes that occur to the makeup of the tape itself are at the molecular level, and this produces the positive benefit associated with the restoration. It is unknown if this has any long-term detrimental effect of the tape itself, but it does facilitate a better transfer than other methods (Bradley, 1997). The question for a sound archivist is then, ethically, at what temperature should the tape be treated?

The inquisitive sound archivist would look for a code of ethics to guide them in this issue. Ethics and guidelines for practice in the preservation, restoration and transfer of audio recordings have been discussed and considered for more than 20 years. The most notable of these is the International Association of Sound and Audio-Visual Archives (IASA) Technical Committee document *The Safeguarding of the Audio Heritage: Ethics, Principles and Preservation Strategy* known fondly as TC03 and published in 2001[1]. It was recognised even during the process of negotiating the language and content of TC03 that it had significant limitations and explanatory power, and so the *Guidelines on the Production and Preservation of Digital Audio Objects*[2] was begun and is now near ready for publication. However areas still remain where neither the guidelines, which is a code of practice, nor TC03, which is a code of ethics, provide unequivocal guidance. I was a member of the committee that prepared the TC03, *The Safeguarding of the Audio Heritage*, and am currently the editor of the *Guidelines on the Production and Preservation of Digital Audio Objects*. I support both, but in this paper I'd like to survey the codes of ethics and practice and consider the models from which they were developed. In doing this I hope to show how they are best utilised and why they are not rules, but guides for interpretation by informed audio archivist-technicians.

It is best to be clear about what we mean when we talk about ethics in the area of heritage collections. "Curator: The Museum Journal" included an article in its July 2002 edition, entitled *Professional Ethics Revisited* (Nicholson and Williams, 2002), in it the authors draw a distinction between codes of ethics and standards of practice. The former are typified as reflecting a set of personal values to which a group have agreed, which are not susceptible to change and are codified by its authors. Standards of practice are similar, in that a group must agree to them, and the philosophy that underpins them, and a record of the precise form of what was agreed to must be made. In other aspects however, according to the authors, they manifest explicit differences. Standards of practice may be rigorously measured and enforced, may change as technology provides new options and generally include detailed recommendations. A code of practice finds its specificity in the technology of the day,

[1] Third edition, 2005. Per la traduzione italiana cfr. bibliografia. N.d.C.

[2] IASA-TC04, *Guidelines on the Production and Preservation of Digital Audio Objects*, 2004. Trad. it. a cura del MART*Lab*, *Linee guida per la produzione e la preservazione di oggetti audio digitali*, Roma, Associazione Italiana Biblioteche, 2007. N.d.C.

while a code of ethics should express enduring principles. So the declaration that all sonic content must be captured in the transfer of a particular sound recording from analogue to digital could fall within the gamut of a code of ethics, but the stipulation that an analogue recordings should be encoded at a minimum standard of 24 bit, 96 kHz can only be included in a standard of practice, even though the latter may encompass, or be informed by, the former.

The practice of sound archiving has been with us nearly as long as the sound recording itself, the earliest archive being established in 1899[3]. Most Sound Archives grew out of libraries and museums, and their documentary practices seem to be drawn predominately from the former, while their storage and preservation practices mostly came from the latter. The sound recording is both document and object, and aspects of both permeate the codes of behaviour that have informed sound archivists. However the profession of sound archiving, which concerns itself with all aspects of acquisition, documentation, access and particularly, preservation only grew out of the perception of the distinctive issues and problems associated with archiving sound.

In the preservation of audio the sound archivist has, in the past, been primarily concerned with the stability of the original carrier, assuming that if the carrier was preserved then the audio content inscribed or encoded on its surface or into its coating, would be preserved with it. This was an appropriate assumption at the time that the need for a sound preservation strategy was only just becoming apparent. The newly formed field of sound archiving was coming to terms with the realisation that the sound carriers were physically and chemically unstable. Moulds grew on the surfaces of their earliest cylinder recordings and they deformed in hot temperatures and cracked in dry conditions, the instantaneous or acetate discs on which many unique and original recordings were made up until the 1950s revealed themselves to be made from a nitro-cellulose compound which would crack or craze without warning. The work done in the film archiving community revealed to the sound archivist how audio acetate tapes, on the same type of carrier as the so called "safety film", were exuding acetic acid and becoming brittle in the process. The forthcoming recommendations were to store at specified conditions, a sliding scale combination of low temperature and humidity, and these became the primary tools of the sound archivist. Still further, worrying indications regarding the stability of the polyester or Mylar tapes, the newest and supposedly, most reliable recording format available, were presenting themselves in some common brands of tapes, and these too required study and treatment. The computer storage industry, with its heavy investment in magnetic media initiated investigations, which claimed that the process was a hydrolytic reaction, and so reversible. No one is sure whether the hydrolytic breakdown of the effected tapes was an aberration or whether all tapes would soon follow. Whether or not it was an aberration, the fact remains that a large proportion of the modern data carriers had been affected and all the investigation and reports of the time were concerned with carrier stability, from the influential and all encompassing US based Rome Air Report to the IEEE transactions of carrier stability.

[3] The earliest Sound Archive is generally thought to be the Phonogrammarchiv of Austrian Academy.

The recommendations for tape restoration made by the computer industry were not mediated by any consideration of the ethics of treating the object; they were, rather, driven by the pragmatic imperative that the data had to be retained intact. As the process of sound preservation concerned itself with treatment of objects, which were of, or contained, some cultural significance, the ethical issue of treatment were important. The conventions which informed behaviour, codified or not, were drawn from the museum world. The sound archivist, in line with best thinking, invoked the conservation principles of reversibility, authenticity and objectivity in the treatment of the physical carrier.

The concern with the physical carrier was justified, the loss of the carrier does result in the loss of the inscribed audio content. However, what was not apparent to the majority of sound archivists was that the converse of this statement did not hold, the preservation of the carrier does not necessarily represent an ability to preserve the audio content. The notion of format obsolescence became a primary concern as the archival community came to a realisation brought about by a market shift from analogue to digital, that the superseded replay technology may not be available in the future to replay the large legacy collections, and that without appropriate technology to replay the sound recordings, the audio content was just as inaccessible as if it had chemically degraded.

Sound archiving underwent a fundamental shift in thinking, no longer was the quest for the ultimate carrier that would survive the ravages of time, but rather a search for a methodology that would allow the technology dependant audio archives to manage their collections through the inevitable and unavoidable market driven changes. It is a revolution still underway, with pockets of resistance continuing to fight against the changes. Digital audio encompasses both the possibility of permanent encoding with the fear of perpetual change. The long-lived carrier has given way to the long-lived file, and with this realisation the concern for the audio content began to take primacy over the issue of carrier stability.

Still, in spite of the inherent changes in thought that sound preservation had undergone, recent attempts on codifying ethics have derived at least their basic principles from traditional conservation documents. The UNESCO publication *Philosophy of Audio-Visual Archiving*, for example, cites as one of the sources for its code of ethics the Australian Institute for the Conservation of Cultural Materials code (Edmondson, 1998). Yet the object conservators have begun to question and re-evaluate their own codes of ethics and the principles they espouse. The debate on theories of conservation and the new principles they formulate sheds light on the thinking regarding sound preservation.

Earlier conservation codes have been directed only towards the tangible aspects of the physical object. As conservator Alison Wain notes, the notions expressed in most codes of ethical behaviour place "the original physical material of the object above all else". For Wain the primary issue that is neglected by the traditional conservation codes is that of the intangible values of the object, those values expressed through their use and function, those values that may be lost or compromised if access to an object is restricted even for the very good reason of extending its life. If an object is designed to be used, if it has some functional or social purpose from which it derives its value, denying that purpose or use denies the meaning of that item. The act of preservation

is therefore only meaningful in relation to the user of the collection. This critique of conservation clearly states that, as the only useful way an object's cultural value can be measured is through its meaning, the intangible aspects of the item must have precedence over its physical characteristics.

Other commentators, in seeking to elucidate a doctrine for preservation action have critically examined the commonly accepted principles that have underpinned what has been termed modern scientific conservation theory. The principle of reversibility has been at the heart of all conservation codes of behaviour, however, for some years, the conservation profession has recognised the practical impossibility of it as a doctrine. "Reversibility", states one article, "is now considered a chimera" (Munoz Vinas, 2002: 25). The publication *Reversibility – Does it exist?* (Oddy and Carroll, 1999) recommends to the conservation profession a far more relaxed definition of reversibility, as technically and philosophically, the concept is not attainable (Munoz Vinas, 2002: 25). Instead, concepts such as "re-treatability" are suggested, or the recommendation that conservators "select treatments whose benefits far outweigh the losses they cause" (AIC, 1994).

Similarly, the ideas of objectivity and authenticity have been critically examined from both the philosophical and the practical point of view. The particular state of any given object, which is selected to be described as its authentic state, is problematic. To choose an "authentic" state to which an object may be returned is to exercise subjective judgement regarding the value of a particular time. In the museum world, the object has most often acquired value because of its history, its past is what gives it meaning. To return the object to state that predates its history is to negate that value. The damage suffered by an object through time should not necessarily be removed.

Even the notion of damage is not clearly specified. Damage, it is suggested may or may not be intentional or positive. "If not deliberate (but still) positive, we call it 'patina', if deliberate and positive, we call it 'restoration', if negative, then it is 'damage'" (Ashley-Smith cited Munoz Vinas, 2002: 26). An example from the audio world might be the CD release of all the recordings of American Blues musician, Robert Johnston who though enormously influential after his death, only made a small number of recordings in the years 1936 to 1938. Rory Block, a present day performer whose style heavily and deliberately derives from that of Robert Johnston and who learnt from repeated listenings to the old recordings approached the new release with trepidation. In the cover notes she wrote "I still haven't heard the remastered Robert Johnson CDs, I'm terrified. Terrified that I've gotten it all wrong, terrified that I won't recognise it without the crackles" (Block, 1991). For Rory Block, the status of the surface noise as either patina or damage was dependant on whether it confirmed her own understanding of the musical performance, it was, and could only be, a subjective judgement, and one that is not necessarily fixed for all time "As socially and culturally salient entities, objects change in defiance of their material stability" (Thomas ,1991: 125)

Theorists and philosophers make the point that the past is unknowable in any accurate, objective way. Keith Jenkins in *Re-Thinking History* states that "we can never really know the past; the gap between the past and history is an ontological one, that

is, in the very nature of things such that no amount of epistemological effort can bridge it". (Jenkins, 1991:19). This philosophical evaluation of the past is part of a general understanding expressed in historiography of which Loewenthal's *The Past is a Foreign Country*[4] is probably the most famous. However, at a much less rarefied level, it is not possible to know the technical past because so little is documented and so often the standards were not adhered to accurately. The fact that anything much is known of the recent technology of the sound recording past is entirely due to the sleuth type work of a few dedicated individuals who would themselves be the first to admit that their hard earned knowledge is partial, and that it contains numerous assumptions. As was asked so cogently by George Brock-Nannestad of the significance and content of the audio collections, "Do we know what we have?" The answer came in the conclusion to the article; no, we may know what we are intending to keep, but we are discarding a lot of unknown information in the process of audio transfer (Brock-Nannestad, 2003: 25).

The ethics codes of the conservation profession do not have a perfect fit with the issues surrounding sound preservation for a number of reasons. Principally, the major distinction is that the primary object which sound archivists are required to preserve is not the carrier of the sound recording, but the ability to listen to a recording of a sound event. Also, the ephemeral nature of the physical sound recording itself is such that, either through chemical degradation or format obsolescence, many, if not most of the original recordings in archive collections will become relatively inaccessible except through surrogates. The developing sound recording market will soon make a mockery of the physical/virtual distinction, as carrier independent recordings become the accepted approach. In the nascent field of digital preservation the issue of a reliable and 'authentic' preservation path of the digital content in the absence of an original with which it can be compared, is a central theme. Wain, from the standpoint of a traditional conservator, makes the statement that "the preservation of (the) digital files raises all the same ethical questions as are raised by tangible objects". Sound preservation falls between the field of traditional preservation and digital preservation and can find some value in both.

A sound recording is clearly more than a physical object. Even those archivists most committed to maintaining the physical carrier recognise that a sound recording consists of two parts, the encoded sound information and the physical object that carries that information and on which it is inscribed or encoded. Implicit in almost all the writings on sound preservation is the recognition that the primary reason for preserving sound recordings is the sound. The first notable attempt to codify audio practice, Bill Storm's 1980 paper *The Establishment of International Re-Recording standards*, stated as a first condition "that the inherent sound quality of the records is their primary value" (Storm, 1980). The initial ethical assumption has nonetheless been a tenet of all future thinking. It might have been assumed that the conundrum presented by the restoration of a hydrolysed tape can be resolved in this statement, however, further analysis

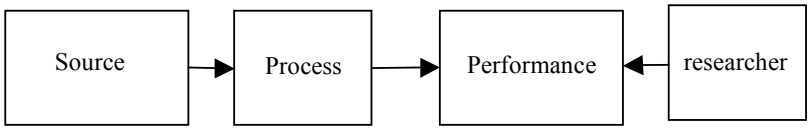
[4] David Lowenthal, *The Past is a Foreign Country*, Cambridge, Cambridge University Press, 1985. N.d.C.

has identified the partial knowledge intrinsic to any transfer process (Brock-Nannestad, 2003) and TC03, the IASA technical committees Ethics, Principles and Preservation Strategy more carefully states that "Carriers are bearers of information: desired or primary information, consisting of the intended sonic content, and ancillary or secondary information that may take manifold forms. Both primary and secondary information form part of the Audio Heritage" (IASA-TC03, 2001).

The relative importance of the two is balanced in a call to consider "the content, the type of carrier and the needs of (future) users". In order to determine which tape treatment is appropriate, it is necessary to speculate on what information future users may derive from an original tape before undertaking that treatment, and to balance it against the audio quality and content. If the past is unknowable, the future is even less so, and so the sound archivist is still faced with the dilemma in selecting treatment without future knowledge of all that a researcher may ask of the recording, or what its future condition will be. This is particularly so if, as is expected to be the case, the original carrier becomes inaccessible through format obsolescence and the last transfer to a more permanent carrier is made now. From the point of view of the object, the sound archivist must preserve an item such that the audio content is maintained, and that no secondary information, be it technical or notational, is lost by the process, providing of course that these steps to maintain the object do not degrade to audio content.

From an audio content point of view, though most archivists agree that a sound recording has two component parts, there is a third aspect to the recording that is so obvious that it is overlooked, implied in any understanding of audio. However, it may be advantageous to separate out the process, and so determine to what degree we may preserve each part. If we consider preservation responsibility to include the preservation of access to the audio item we can better plan and analyse how our preservation path is working.

Drawing on the thinking of the digital preservation world we can examine the National Archives of Australia's conceptualisation of digital record delivery which breaks the concept of a record down into some fundamental concepts.

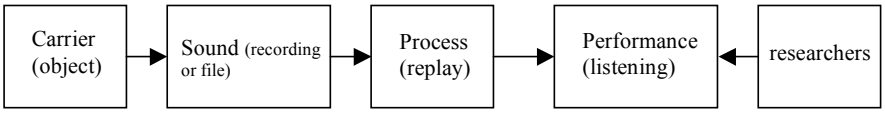


"The *source* of a record is a fixed message that interacts with technology. This message provides the record's unique meaning, but by itself is meaningless to researchers since it needs to be combined with technology in order to be rendered as its creator intended. The *process* is the technology required to render meaning from the source. When a source is combined with a process, a *performance* is created and it is this performance that provides meaning to a researcher" (Heslop, Davis and Wilson, 2002: 8-9).

In the archival evidential model espoused by the NAA, the carrier is of little consequence. Using a nitrate film as an example they state:

> In the case of audiovisual material, the film is not generally valued as the archival record, since it is the moving image on the screen that interests researchers. Before nitrate film decays and turns to a brownish dust, conservators copy the film to a newer, more stable medium, such as polyester film. Conservators ensure that all the characteristics considered essential to the performance of the moving image are retained.

However, as has already been identified, even though it is not the essence of the sound recording, the carrier is a significant store of information, and while some may become unstable and unplayable, most will not become brownish dust. Assuming adequate storage, the major difficulty will be in obtaining appropriate replay technology. Indeed, the coarse groove shellac discs produced in their millions are very likely to robustly outlast any current replay technology, and even if unplayable at some future time, will provide valuable information nonetheless. The carrier should be retained even after a transfer to a new carrier. So it is proposed to rework the NAA model specifically for audio. The main components would need to include the carrier, which is the physical object that carries the sound, the sound recording, abstracted from the carrier, the process and the performance.

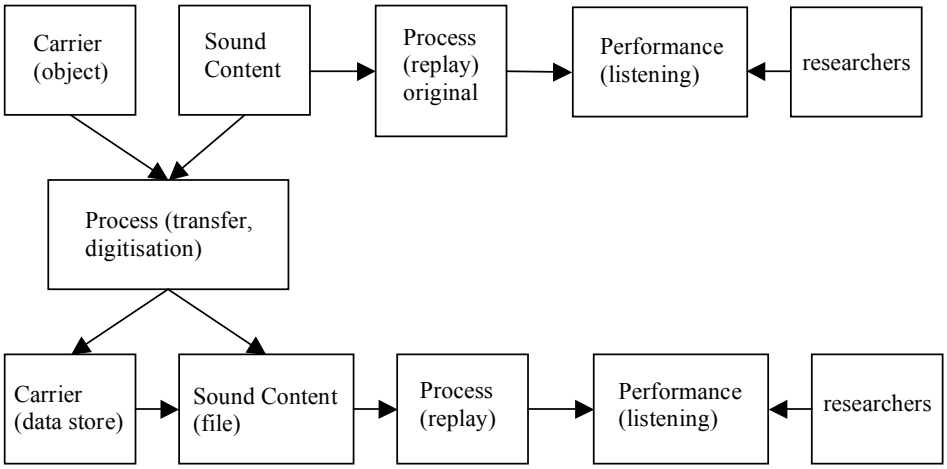


The model is particularly useful because it can be applied regardless of whether we are considering a LP record, a ¼ inch analogue tape recording or a digital file. In the physical domain, the source may be the analogue sound on tape, the process the tape player and the performance is the combination of the two being listened to by a researcher. It is clearly the responsibility of the sound archivist to consider their ethical responsibility in the carrier, the sound content and the replay process.

However, the only practical identified preservation pathway is that of digitisation and data storage. In the virtual domain of mass storage the source is the file, and there is a necessity to include the concept of a transfer process when converting from analogue to digital.

The issue changes when considering the introduction of a digitisation process with the expectation that this will provide a preservation path. The carrier and its sound content are processed or replayed to produce an audio signal that is digitised with the intention of preservation. It is now possible, using the above diagram, to examine each stage of the process to understand if it is feasible to undertake each stage in an ethical or objective way.

The transfer and digitisation process is the stage that is clearly critical as it provides the link between the carrier and its audio content and the digital storage and replay



system. It is the step between the original item and its preservation surrogate. It is necessary to ask the following interrelated questions of the procedure.

1. In the transfer process, was the replay process accurate?
2. What is it that is intended to be captured?
3. Is the resultant sound file an accurate representation of the original?
4. Will the new replay process equate to the original replay process?

In the transfer process, was the replay process accurate? From the point of view of knowing the precise characteristics of the original item, this is rarely possible. As has been discussed, many historical recordings were made prior to standards being agreed upon, and so their specific characteristics may not equate with standard technologies, and may not be known or even documented. Further, the degree to which any of these recordings actually adhere to the pre-standard standards is also a matter for conjecture. However, research and the body of archival knowledge allows for the trained sound archivist to make informed assessments of the likely characteristics, and assess the aural characteristics of the recording to further refine those initial informed assessment. The archivist must investigate, analyse and interpret all aspects of the recording, its carrier and any associated material, and within the informed bounds of those constraints, make any necessary subjective decisions. Many characteristics of sound recordings are better analysed and corrected before being digitised, many are better left until after. It is up to the individual sound archivist-technician to determine what is appropriate and to document carefully and clearly what steps they took so future users can understand the processes.

What is it that is intended to be captured? The question of whether the replay process is accurate is bound up in the intentions of the user or archivist. Bill Storm's original article on reproduction standards posited two possible intentions; to either preserve the notion of the original performance, that is, the sound as it would have appeared to those present at the recording, or to preserve the sound of the recording such as it

would have been heard at the time of its release. Though sound archivists continue to pay lip service to these two approaches, the practice of sound archiving developed along a third path, the strategy of optimal signal retrieval.

The notion of preserving the original performance is an aspiration rather than a real possibility. Heritage audio technology would not have allowed an accurate reproduction of the sound of the period even if the type of technology used was known. As well as an accurate description of every part of the technology and its condition, it would be necessary to have a spatial map of all sound sources in relation to the microphone. Instead, this category should be understood as representing to the sound archivist the notion of a restored recording that has been altered to produce an aesthetically pleasing recording. It is an approach based almost entirely in subjective taste. This is clearly not appropriate for an archival approach to sound archiving.

The notion of preserving the sound as it would have sounded to its contemporary users is also unattainable. To undertake this approach it would be necessary to replay the recordings only on vintage technology appropriate to the era of the recording: cylinders could only be played on cylinder machines, acoustic discs on acoustic gramophones and so on. This would require decisions about standard technology for each era and decisions about the standard and quality of the technology for replay. Would it be necessary to use 1950's tape recorders with 1950 tapes, a 1923 gramophone with a 1923 disc? There would also then be a need to document the calibration of the technology, which is most often not possible with heritage technology, and finally to record the sound a microphone would be required, especially for non-electric replay technology. Even if all these requirements were possible, and the older technology could be maintained properly, in many cases the process of replay could easily damage the original recording trhough heavy replay styli or worn or damaged moving parts. The sound archivist must then think of the physical well being of the object, especially if it is uncertain whether the full signal is being retrieved from the original recording.

Sound technicians have recognised that these approaches are impractical, and instead have implemented a very pragmatic ethic which now finds its wording in the IASA ethics document TC03.

"6. Optimal signal retrieval from analogue carriers. Optimal retrieval of the signal on historic recordings can only be achieved by modern, well maintained replay equipment, ideally of the latest generation, in order to keep replay distortions to the absolute minimum".

The logic of optimal signal retrieval is not to produce an approximation of either the technology of the time or the sound of the event, but rather to extract as much of any signal and associated recording artefacts from the recording, to do that in a standard, repeatable manner in accordance with an agreed notion of best practice, and to store that signal unaltered in a form that can be maintained for future use. This sort of ethic does not have an equivalent in the lexicon of the object conservator. It is an ethic that belongs to the AV archivist.

Is the resultant sound file an accurate representation of the original? Clearly, if the above approach is a fair representation of a valid sound archiving approach, this question is not

relevant. Instead, it is more appropriate to ask if this sound file is an item from which a justifiable sound recording can be made. Does it contain all the information it is possible to extract from the original sound recording? Will future users be able to answer all the questions they have? The pursuit of an accurate representation has been abrogated for the goal of all the possible sound information. However, the detailed knowledge necessary to extract the required information is not always available, and may not always be known. As discussed above, the sound archivist cannot know the questions that will be asked of a future sound recording, but it is very likely, in the long term, the only object of which they will be able to ask those questions is the digital object. Yet again this recommendation is an aspiration, it cannot be achieved, but it must be aspired to. The sound archivist-technician has a responsibility, to present and future users, to have a complete understanding of the past and present technologies in order to ensure that they are extracting all possible information, and must adhere to well documented, standardised procedures so that future users can reconstruct the processes that led to the current version when it is clear that the aspiration was not attained.

Will the new replay process equate to the original replay process? The answer to this question depends on the type of original material. An original digital recording cloned to a digital storage system and replayed for a future user will equate well with the present replay system, but for a digitised copy of an analogue recording, the new replay process cannot equate to the original replay process. The entire tactile and interactive process of handling and loading the recording onto the replay technology is gone, the adjustments made to optimise the recording are no longer possible, they have been irrevocably integrated into the sound file by the sound archivist-technician who made the transfer. The future user will not hear a sound that equates with the sound a past user might have heard, they will be presented with more than could have been heard at the time the disc was made, they will have the added patina of age, the noise and distortion, both inherent and added through damage. They can seek to gain a greater understanding of the past the recording represents through analysing the dense record that an optimal signal transfer provides, but they cannot visit the past through a recreation of the listening experience. In producing a file from the strategy of optimal signal retrieval, and storing that file unchanged, the possibility remains of undertaking restorative processes which may approximate other listening environments or aspirations without altering the archival file.

This paper has ranged across a number of issues, I will now attempt to draw the many disparate threads together, and see if we can answer the initial preservation dilemma that faces the sound archivist-technician. In the light of our discussion of preservation guidelines and ethics, under what conditions should a hydrolysed tape be treated?

A treatment of some sort must be made or the tape will be unplayable. All sound archiving guidelines agree that the sound is the reason for preserving the item, so it takes precedence in making the decisions. Taking into account the principle of optimal signal extraction, the sound archivist-technician needs to consider the content of the material to determine whether the proposed treatment will have a positive or detrimental effect.

The minute loss of high frequency information is unlikely to be significant, and is well within the tolerances of the calibration of the tape recording equipment. It is also possible to adjust the response, though it will invite an equal increase in noise floor in the same frequency range. The improvement of scrape flutter and speed variation is valid because fluctuating speed caused by the replay of the tape cannot effectively be treated in the digital domain. So on balance, and considering only the present transfer, the decision would be to treat the tape at 50°C and 0% RH.

However, the decision also requires other consideration. Is this the only transfer to be made? Will the replay technology be available in the future equal or better than the latest technology? Will technological developments provide the opportunity for a more accurate transfer and digitisation process in the future? Will the treatment preclude an even greater level of signal extraction in the future if the technological developments occur? Will the unaltered original artefact be a necessity for future researchers to provide secondary information or will the treatment compromise that possibility? We cannot be as unequivocal as with the first set of questions, it is quite possible that the answers will cause the sound archivist-technician to be less certain about the choices made.

Finally, the sound archivist-technicians must ask themselves; do we have an appropriately comprehensive knowledge of the effect of any treatment? To know the complete consequences of any action is not possible, philosophically and practically the partial knowledge of the outcome of any action has been demonstrated time and again. Yet to eschew decision because of this is to paralyse action and possibly render material inaccessible.

So the answer to the dilemma is only found in the individual case. The sound archivist-technician must understand the technology that produced the items in their care, the chemical make-up and mechanical characteristics of the carriers, the characteristics of modern technology in rendering the sound from older technology, an awareness of the developing technologies, a comprehension of the research needs of their users and an appreciation of the aesthetic of the content in their care. Guidelines and ethics will only guide the informed; technical decision cannot be made in isolation of the content. The conservator of traditional objects was originally envisaged as a mixture of the curator and the scientist, the sound archivist must be equipped as a blend of sound technician, chemist and audio curator in order to ethically undertake the tasks given them. Only then will a full appreciation of the sonic and aesthetic implications of the physical restoration of the audio object be understood.

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