CHAPTER 14

A Philological Approach to Sound Preservation

Federica Bressan

Sound recording technology has been around for roughly 150 years. Since Thomas Edison's phonograph in 1877, the techniques and technologies to improve the quality, the bandwidth, the duration of sound recordings, and the portability of recording/playback devices have been evolving and keep being improved today. The result is a diverse coexistence of practices and standards, some of them so obsolete that it is not inappropriate to speak about "media archeology." This chapter will focus on the challenges posed by audio heritage in the Digital Humanities. It will include a guide to support a rational systematization in the field of preservation, because every technical choice or solution has an impact on our perception of preserved objects and, through them, on our understanding of the world. Remembering that sound recording technology has not always been around is a good place to start, because it reminds us that hearing "voices from the past" is a true marvel of our times and a world without them would be a very different place.

F. Bressan (✉)
Ghent University, Ghent, Belgium
e-mail: federica.bressan@ugent.be

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Keep the Music Playing

In order to understand why the preservation of audio documents should be challenging at all, we need to define "**audio document**" and "**preservation**." Let us begin with the concept of **carrier**. An audio carrier is a physical object designed to store an audio signal. This definition does not say anything about diverse types of carriers or about the complexity of how the signal is stored on them. Tape cassettes, compact discs (CDs), and vinyl records are examples of audio carriers we are likely familiar with. As for "preservation", it is defined as "the sum total of the steps necessary to ensure the permanent accessibility—forever—of documentary heritage."[1] Here, forever means "decades or centuries, or long enough to be concerned about the obsolescence of technology."[2] Imagine you have a sound recording on tape and you want to preserve it, ideally, forever. What can you do? For example, we can lock it up in a safe and come back every other year to check that everything is ok. This works for most objects we have considered worth preserving and makes up much of our shared cultural heritage. There are obvious differences between objects made of paper, wood and stone, but none degrade at the rate of audiovisual carriers, the life expectancy of which can be measured in years or decades. The paradigm of "traditional" cultural heritage, which privileges "preserving the original," has persisted relatively unquestioned.[3] But what is the equivalent for audio carriers? Should we extend the life of a specific tape, because it stores a specific recording? This was in fact the main approach in the early days of preservation, but it did not work because audiovisual carriers are subject to a process of physical degradation that eventually causes the irreversible loss of their content—in a generation's time. The paradigm of "preserving the original" applied to audiovisual carriers is doomed to fail. So, can we find another way?

[1] Ray Edmonson, *Memory of the World: General Guidelines to Safeguard Documentary Heritage* (Paris: UNESCO, 2002), 12. Accessed May 5, 2018. http://unesdoc.unesco.org/images/0012/001256/125637e.pdf.

[2] Margaret Hedstrom, *It's About Time: Research Challenges in Digital Archiving and Long-Term Preservation. Final Report: Workshop on Research Challenges in Digital Archiving* (Washington, DC: National Science Foundation and Library of Congress, 2002).

[3] Dietrich Schüller, *The Ethics of Preserving Audio and Video Documents* (Paris: UNESCO, 2006).

To answer this question, it may be useful to stop and reflect on what the object of our interest is: the tape or the recording? The carrier or the message? The content or the container? Normally it is the recording or, more specifically, what the recording *means* (not the audio signal in itself, but rather a song or a speech represented by the signal). If the recording is not valuable then the carrier may still be the object of desire for some collectors. But, the problem of preservation primarily emerged not because carriers, as such, were at risk, but recordings. We can then agree that the objects of preservation are sound recordings, and that audio carriers are important insofar as they are the physical objects on which sound recordings are stored.

Fortunately, there is something that distinguishes audiovisual carriers from other "traditional" cultural heritage materials, except for written texts: the possibility to separate the content from the container. Leonardo da Vinci's Mona Lisa is intrinsically one with the canvas. There is nothing we can extract from it and move to another canvas. Or, at least, not in the same way in which we can copy or re-mediate a sound recording. An audio carrier is an industrial product and it belongs to, what Walter Benjamin terms, the era of "mechanical reproduction".[4] This means that sound recordings can have a life expectancy independent from the carriers. The carriers fatally degrade, but the content can be copied onto new carriers as the old ones give out. This represents a paradigm shift, from "preserving the original" to "preserving the content", and it raises a whole new set of problems because, according to Ray Edmonson:

> copying is not a value-neutral act; a series of technical judgments and physical acts (such as manual repair) determine the quality and nature of the resulting copy. It is possible, in effect, to distort, lose or manipulate history through the judgments made and the choice and quality of the work performed. Documenting the processes involved and choices made in copying from generation to generation is essential to preserving the integrity of the work.[5]

Therefore, the crucial question of audio preservation is not about the carriers, but about the *process of re-mediating* their content.

[4] Walter Benjamin, *The Work of Art in the Age of Mechanical Reproduction* (Frankfurt am Main: Schram Verlag, 1955).

[5] Ray Edmonson, *Audiovisual Archiving: Philosophy and Principles* (Paris: UNESCO, 2004), 14.

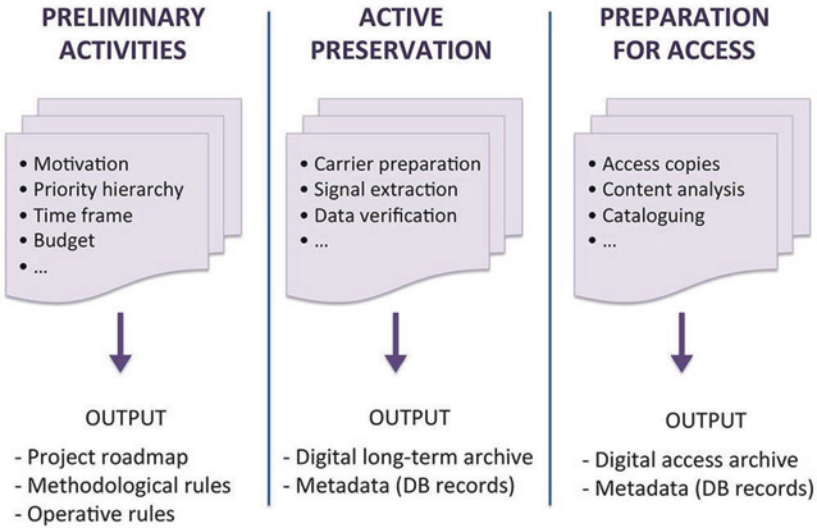

Fig. 14.1 The scheme summarizes the main steps of the preservation process for audio documents

A Methodology in the Making

A detailed description of the methodology (theory and practice) for the transfer of audio documents to an all-digital document set would require an extended dissertation. Here, we present the theoretic foundations of the methodology and give a general overview of the fundamental steps, before we focus on some practical examples to show the connection between audio documents and digital **philology**.[6]

Figure 14.1 shows the three fundamental steps of preservation: preliminary activities, active preservation, and preparation for access. Active preservation (as opposed to passive preservation) is the step that is normally identified with the entire process, as it consists of the extraction of the information contained in the original carriers and its encoding onto

[6]For an extended account of existing methodologies see the International Association of Sound and Audiovisual Archives—Technical Committee 05 (IASA-TC 05) (2014), the International Federation of Library Associations and Institutions (IFLA)—Audiovisual and Multimedia Section (2004), Media Preservation Initiative Task Force (2011), and Bressan (2013).

a new medium. We speak of **digitization** when the recording technique of the source carrier is analog and the destination carrier is digital. When the recording technique of the source carrier is digital [for example, when we transfer information from CDs or Digital Audio Tapes (DATs) to Hard Disk Drives (HDD)], we should use the term *re-mediation*, as there is no analog to digital (A/D) conversion of the audio signal.

The goal of the methodology is to make sure that preservation is performed according to rigorous scientific protocols and that a qualitative output is achieved. In this context, we will consider a "qualitative output" that which derives from a working approach that implements philological principles (these principles are elaborated below). Output that is not backed up by documentation of the objective of the action, its limit, or the procedures that have been applied is considered *low profile*.[7] The trans-coding that occurs when the information from the source carrier is extracted and moved to a new carrier has **hermeneutic** implications, because it cannot be performed without creating (or assuming) a *model* of the source.[8] A model requires, by definition, the identification of relevant features. George Brock-Nannestad suggests, "it should be emphasized that selecting features for restoration or preservation in the worst instance means deselection of the rest."[9] Deselection means exclusion from the information workflow and can result in features being discarded from history.

Wrong data (for example, a badly compensated equalization curve) means wrong or misleading output data. The expected final output is a digital collection of data (Fig. 14.1) that represents the audio signal and all the accompanying material of the source carriers; each element in the digital collection is associated to a description (metadata). At a higher level of abstraction, we can define the output as a collection of "objects" associated with descriptions that help retrieve and identify these objects. The objects that are normally included in an audio *preservation copy* are:

[7] Giuseppe Gigliozzi, *Introduzione all'uso del Computer Negli Studi Letterari* (Milan: Bruno Mondadori, 2003).

[8] F. Bressan, S. Canazza, T. Vets, and M. Leman, "Hermeneutic Implications of Cultural Encoding: A Reflection on Audio Recordings and Interactive Installation Art," in *Digital Libraries and Multimedia Archives.* Proceedings of the 12th Italian Research Conference on Digital Libraries (IRCDL 2016) (Elsevier, Procedia – Computer Sciences, 2017), 47–58.

[9] George Brock-Nannestad, "The Rationale Behind Operational Conservation Theory," in *Conservation Without Limits: IIC Nordic Group XV Congress*, ed. Riitta Koskivirta (Helsinki, FI: IIC Nordic Group, 2000).

the audio signal, pictures of the carrier, the box and its attachments, a video of the carrier during signal extraction, and a descriptive sheet including codes for data integrity verification (**checksums**). What cannot be directly represented in a digital form (e.g., smell) is thoroughly documented in a description as objectively as possible, hence the need for common vocabularies and reference grids (until maybe in the future we will develop a technology to digitize smell or to recreate it from our description).

Computer Science: More Than Software Tools

Reconstructing Audio from a Picture

Photos of Ghosts (also known as Photos of Grooves and Holes or Supporting Tracks Separation) is an innovative method to reconstruct the audio signal from a picture of the grooves on a disc's surface. Overlapping pictures of the disc surface are divided in sectors, the grooves on each sector are identified and rectified thanks to image processing techniques, then the waveform is reconstructed from a unification of the grooves' segments. The touch-free technology allows for the treatment of fragile and even broken disks. The automation of image processing tasks decreases the time and cost of digitization with respect to reading the disc on a turntable. Using this process, a new approach to sound restoration can be envisioned: for example, foreign bodies can be graphically removed from the picture before the audio is reconstructed. Thus, we can obtain clean audio directly from the carrier, instead of applying noise removal filters later. Photos of Ghosts is also inspiring innovative ways to produce preservation copies of phonographic discs: instead of storing the audio signal, we may store a high definition 3D model of the carrier itself and reconstruct the audio as necessary with future and more sophisticated algorithms. It is intriguing to imagine the same approach for magnetic tapes: instead of audio, we would store a "magnetic map" of the tape and the benefits for endangered tapes would be revolutionary.

Remind and Rewind

The preservation of audio recordings with digital technology is predicated upon the disembodiment of the document. All relevant

information should be transferred minimizing information loss, nonetheless audio, video, texts, and images collapse in a flow of **unimedia**[10] and will only be accessed through software applications—the sense of touch is lost. Typically, iTunes-like audio players rarely include a functional integration of the accompanying material (images, video, etc.). Remind[11] and Rewind[12] are two applications dedicated to digitized historical audio documents. Besides providing the user with a graphic interface reproducing the original controls of the equipment, they connect audio and metadata in a meaningful way. Reel-to-reel recorders move along the tape linearly, not allowing for random access. Remind preserves this feature in the replica of the control panel, including fast forward and rewind at fast or library wind speed. Conversely, Rewind is the virtualization of a turntable and, like the real-life original, it supports random access. Both applications allow the user to adjust the equalization curves, which are modeled according to the analog original. The video of the carrier during digitization, if available, is aligned with the audio, therefore, eventual defects on the source carrier are easily detectable and associated to the audio stream. Remind and Rewind also support specific features of the historical equipment, such as quadraphonic audio (Remind) and stylus type and weight (Rewind). The uniqueness of these applications resides in the fact that their design is dedicated to digitized audio documents and in that they constitute a step towards future applications that may integrate a philological approach to gestures (loading a disc on the turntable) in VR environments.

Digital Philology: An Emerging Discipline

What is philology? It should not surprise that the meaning of the term philology is obscure to most people who are not directly involved with it for their profession. It normally conjures images of yellowed pages, filled with text that people called philologists spend their life analyzing.

[10]Nicholas Negroponte, *Being Digital* (New York: Vintage Books, 1995).

[11]Federica Bressan, Sergio Canazza, Carlo Fantozzi, and Niccolò Pretto, "Tape Music Archives: From Preservation to Interaction," *International Journal on Digital Libraries* 18, no. 3 (2017), 233–249.

[12]Sergio Canazza, Carlo Fantozzi, and Niccolò Pretto, "Accessing Tape Music Documents on Mobile Devices," *ACM Transaction on Multimedia Computing Communications* 12, no. 1s (2015), 1–20.

But, whatever it is, most people know that "it has to do with texts." This association is correct and touches the core of philology. The discipline of philology is applied to different fields, and the definitions found in each field tend to consider specific aspects of the discipline—sometimes leaning towards analytic activities, sometime towards the interpretative ones. The term refers to the critical study of texts, the languages they use, and of methodologies for their historical interpretation. Philology is a foundational form of study; its goals are to resolve issues concerning the nature of textual evidence, so that literary, philosophical, and historical theories based on texts are less likely to be undermined by misdating or misreading of the textual data. Philological studies include such subfields as etymology (principally focused on the development of characters and their semantic basis), paleography (the study of old [Greek: paleo-] writing) and epigraphy (the study of inscriptions [Gr. Epigraphe]), and historical phonology and linguistics. More broadly, philology engages issues of textual history (the lineage of editions behind extant texts) and the mastery of various historical, institutional, and cultural fields that relate to the essential formative environments within which texts were generated.[13]

It should be kept in mind that this definition applies to "traditional" philology, and by all means not to "digital" philology. But, as we will see, digital philology is a new discipline born out of the encounter of two pre-existing areas of study, i.e. philology and computer science (or, textual criticism and information science). It is important to clearly define the contributing areas separately before observing how they merge together. For the purposes of our discourse, we do not need to proceed into the implications of the nature of texts nor the single movements within the history of philology. In its essence, the piece of information that we need to take home is: philology is a discipline that deals with texts, intended as such (written sources) and as entities with a cultural meaning (their interpretation). Particular attention is given to the authenticity and the accuracy of texts.

There are many reasons why the impact of the "digital revolution" on our society is hard to assess (for one, lack of historical distance). Digital technology has become pervasive in all aspects of our life, directly or indirectly. But, not everything that has to do with digital technology has turned into something qualitatively new. Narrowing

[13]Class Materials presented by Professor Robert Eno, Indiana University, 2011.

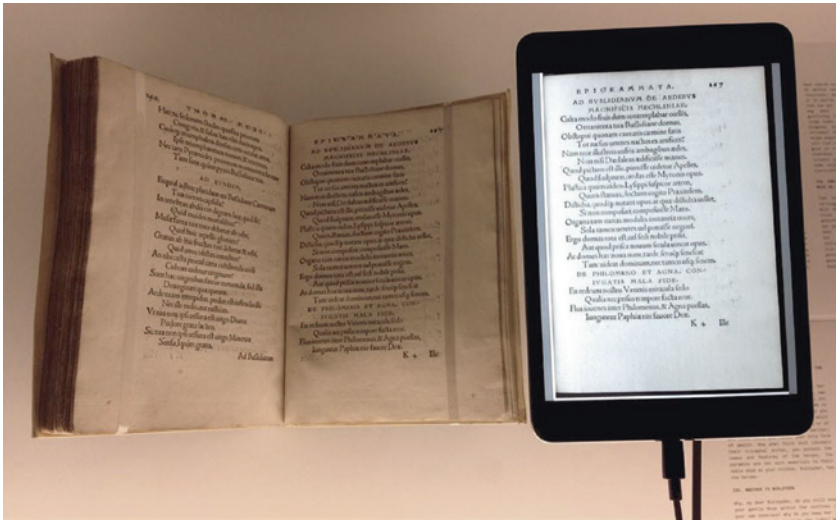

Fig. 14.2 Manually counting words in a text on a digital device does not make you a digital philologist

our scope to our field of interest, "digital philology" cannot be claimed as a new discipline due to the simple existence of digital texts (roughly speaking, a text that can be displayed on a computer screen). Intuitively, we can agree that changing the medium has an impact on the text and on our perception of it. But, pinning down what this impact is, let alone measuring it, is no easy task. Acknowledging that a traditional philologist does not become a digital one just because he reads some texts on his computer screen is a very important starting point (Fig. 14.2). Digital philology is not the discipline that deals with texts displayed on a computer screen. Let's think of art for an obvious example: an electronic reproduction of da Vinci's Mona Lisa does not make it "digital art". Intuitively we may feel that there is something different in the work of a scholar who analyses a text, or a painting, in direct contact with the real object or from a computer screen, but the point is that the questions they ask and the methods they apply are not necessarily different. Scholars involved with textual criticism and other disciplines that rely on literary sources are currently engaged in re-thinking their activity in light of the impact of digital technology on research and education.

"Digital philology" is an expression constituted by two words: so far, we have considered the second. What about digital? Digital refers to the other contributing area of knowledge: computer science. Computer science brings to the table its approach and some of its concepts and methodologies—not only technology. The conceptual principles used to model the world, or the tendency to look at things with different levels of abstraction, are tools of thought that can easily be exported to other domains, and fruitfully so. To summarize, the contribution of computer science comprises: technological tools for quantitative analyses and for sharing *corpora* through a network; and, methods and concepts that inform the theoretical speculation for fostering the development of new tools, in a virtuous loop.

There are three degrees of impact in which computer science can influence or transform the job of a philologist. From the smallest impact (level 1) to the greatest impact (level 3):

- Level 1: the computer performs tasks that could be done by hand.
  - Example: counting words in a text.
  - Benefits: the time needed to perform the task is reduced to fractions of a second; accuracy is virtually optimal (clean data, no bugs in the count algorithm, filter set properly, etc.).
- Level 2: the computer performs tasks that could be done by hand *qualitatively* but not *quantitatively.*
  - Example: counting words in a million texts.
  - Benefit: the task is possible whereas, before it was not (plus, sustainable computational time, and accuracy).
- Level 3: the computer manipulates the data in a way that allows us to ask new research questions. Inspiring examples are found in new research fields such as the neurosciences.

Indeed, Marcos Marín (2001) suggests "what is different is not the quantity, it is the new insights, the new questions that we can ask."[14] From the point of view of how deeply computer science modifies philology by contributing to it, two distinct steps can also be distinguished:

[14]F. A. Marcos Marín, "Where is Electronic Philology Going? The Present and Future of a Discipline," in *Proceedings of the First Seminar on Computers, Literature and Philology*, ed. Domenico Fiormonte and Jonathan Usher (Edinburgh: University of Oxford, 2001), 11–22.

1. preparation of the working materials;
2. support to textual criticism (assisted or [semi]automated analyses).

This chapter focuses more on the first point, which is included in the definition of preservation: the way in which inscriptions are photographed and text corpora are transcribed and encoded, as well as the way in which a sound recording is re-mediated, "is crucial for the way in which these research objects will be studied in the future. […] The creation of digital objects […] is a crucial part of the humanities research. It is more than just preparation for research."[15]

What has been said so far constitutes a fairly large body of principles, ideas, and observations. But, a good theory is one in which the prescriptions can be implemented in the real world. So, let us examine three examples where some fundamental principles of philology are applied to scenarios frequently encountered in the practice of audio digitization. The true value of these examples does not lie in the practical solution adopted each time, but in the principle that led to the solution.

Examples of Practical Implications of the Theoretical Principles of Digital Philology Applied to Sound Recordings

Handling audio carriers correctly (applying a set of technical skills) is crucial for their protection, but the compilation of an encyclopedic manual for the treatment of historical sound recordings would be a sterile exercise. The solution to most operational problems encountered in the daily practice of digitization find a natural solution in the frame of an overarching intellectual perspective, based on the notion that audio documents are complex cultural objects of historical value, of which technology represents only one aspect. A parallel with other domains may prove useful again: we are not describing the technique to restore the leg of a Louis XIV cabinet. We are in front of a cabinet and we are asking ourselves the fundamental question: is this just a piece of furniture

[15]Wido van Peursen, "Text Comparison and Digital Creativity: An Introduction," in *Text Comparison and Digital Creativity: The Production of Presence and Meaning in Digital Text Scholarship*, ed. Wido van Peursen, Ernst Thoutenhoofd, and Adriaan van der Weel (Leiden: Brill, 2010), 1–27.

or something with an artistic and historical value? The answer will dramatically determine the approach to restoration: if it is just a piece of furniture, we will proceed with the best reparation possible, to optimize stability and robustness. The materials and techniques we choose will only have to fulfill the requirements for stability and robustness. No other external factor will influence the intervention. But, if the cabinet is recognized to have an artistic and historical value, then a lot of external factors will come into play: solidity and robustness will have to be balanced out with stylistic requirements, the choice of materials and techniques will depend on other choices at a higher level—not only the technical level! In this latter case the provocative question "should we replace the leg at all" would represent a valid theoretical position and could result in an answer that nullifies any subsequent questions about the techniques and methods of restoration.

These opposite approaches are theorized in a milestone textbook ([1963] 2005) called "*The Theory of Restoration*" written by Cesare Brandi.[16] Even if this is a book that everybody in the field of preservation and restoration of cultural heritage ought to be familiar with, it certainly did not address audio and video carriers that, in 1963, were far from being recognized as part of the world's cultural heritage. The good news is that the fundamentals of Brandi's theory are still valid, and they can be applied to audio and video documents. So, there is no need to invent a new theory for audio and video documents from scratch: including them in the family of cultural heritage materials allows us to extend the traditional theory and only adapt or integrate the aspects that do not translate to the new context. The bad news is that the exclusion of audio and video documents from the definition of cultural heritage materials has shown an incredible inertia and Brandi's theory is, to this days, hardly applied to audio and video documents, and, hence, necessitates the following examples.

Silence/Blank Tape

Often, it may happen that a tape has not been fully recorded (i.e. There are portions of tape where no useful signal is present). In everyday language, we would say that there is "nothing" there, or maybe that "there is silence." Digital storage space is expensive and it is reasonable for most

[16] Cesare Brandi, *Theory of Restoration* (Florence: Arte e restauro, 2005).

institutions/individuals to decide that keeping "silence" is not a good idea. However, the nature of "silence" as "nothing" (no information) is questionable for a number or reasons. Some reasons concern the informational content of the tape. What we perceive as "silence" may contain useful information on the recording system used to make the recording, on previous recordings (subsequently erased), and most importantly on disturbances possibly present throughout the tape. This information is essential to enhance the performance of the algorithms for noise removal and it can be extracted with existing signal processing tools. As for the future, we cannot foresee the limits of technological evolution but, from past experience, it is reasonable to say that new signal processing tools will become available. The "silence" on the tapes might contain useful information that we are not able to extract today, but maybe we will in the future: if we get rid of the "silence," we will never know.

In addition to considerations related to the informational content of the tape, there is a formal reason, more closely related to the principles of digital philology. The blank portions on a tape can be compared to the blank pages in a book or manuscript. The object of our preservation are the tape and the book as a whole. The "whole" is the cultural entity: the audio and the text are only part of the whole, and we need to preserve every part to maintain the "documentary unity". Removing any part of the whole corrupts the documentary unity and represents a deliberate act of interpretation of the content (meaning), because it requires a decision about what is relevant and what is not. We aim to "save history, not rewrite it," therefore, this kind of interpretation should not be allowed during digitization.[17] At a later stage, an expert may decide that the silent parts are not relevant to the target audience and omit it from the access material, but it will always be kept in the document's preservation copy. This holds true for blank parts of the tape at the beginning, at the end, or in between recordings. Eliminating blank portions from a sound recording is equivalent to ripping pages out of a book. What philologist would approve of this?

Similarly, changing the speed of a recording or eliminating multiple speeds during digitization impose interpretations and lead to the loss of

[17] George Boston, Memory of the World: Safeguarding the Documentary Heritage, a Guide to Standards, Recommended Practices and Reference Literature Related to the Preservation of Documents of All Kinds (Paris, France: UNESCO, 1998). Accessed May 5, 2018. http://unesdoc.unesco.org/ulis/cgi-bin/ulis.pl?catno=112676.

information in preservation copies. Most tape recorders support multiple tape transfer speed rates (some of them are standard values, while some may be custom). This allows a great flexibility in the use of tapes, the duration of which is not pre-determined by its length but depends on the tape transfer speed rate at which the recording is being made. There is nothing to prohibit multiple speeds on the same tape. But, why would someone select different speeds? The most common reason is: the tape was running out before the recording was over. The recording of a live event, unlike that of an interview for example, does not offer the possibility to stop the recording at the end of the tape, turn the tape or take a new one, and resume the recording. Therefore, it is very typical in live recordings (concerts, theatrical representations) to encounter a speed decrease at some point, normally at about two thirds of the tape length. The most likely reason was to make the tape, or rather the recording capacity of the tape, last longer. But, this is not the only probable reason. The quality of the recording is a function of the tape transfer speed rate (as a rule of thumb, "the higher the speed, the better the recording"). Sometimes, field recordings containing spoken parts (interview, introductions) and musical/sung parts (typically folk repertoire, such as ethno-musicological recordings) include alternating speed rates depending on the content: lower speed for the spoken parts, faster speed for the musical/sung parts. The number of speed changes along the same tape can vary from two to twenty, there is no way of knowing this in advance, for example by looking at the tape. And, this is a crucial point: the characteristics of a tape (the recording parameters: speed, track configuration, etc.) are only revealed at playback time (along with some syndromes due to ageing). Therefore, tapes should always be monitored from top to bottom during digitization.

So, what do we do when we encounter a speed change? We have a natural tendency to approach sound recordings as the "final listener," after all, a sound recording is made to be listened to. But we are preserving a historical cultural object, a "whole," that is *not necessarily ready for fruition*. In other words, the material might not be ready to be delivered to our final audience. Our work should be inspired by the UNESCO precept to "save history, not rewrite it," and not by what we think our final user might like.[18] I will elaborate on this below. Our job occurs prior to the preparation of the materials for the public: our goal is to produce a preservation copy that is reliable and complete, so that

[18] Ibid.

a variety of future uses are possible starting from this material. Then we may ask: "How do we save this tape, and not rewrite it?" It is not an easy question, because there is a technical challenge standing between us and the content of the tape: for the content to be intelligible, it must be read at the correct speed. Intuitively, we strive to have a single digital file where every section is properly intelligible. This solution satisfies, again, our desire to be the listener of that file. But, if we eliminate the speed differences, which are a characteristic of the tape, we *lose information* in the transfer process. A digital file with no speed changes will either be the result of a real-time speed change at playback (fundamentally impossible to perform accurately for technical and cognitive reasons) or of an editing work after digitization. In either case, the result will not match the source tape, with its "segments" characterized by different tape transfer speed rates.

We must ask ourselves how we can preserve the speed differences and at the same time let the audio be intelligible. A valid answer is: the tape will be read in its entirety as many times as there are speeds encountered on each tape side. Note that it is not as many times as the speed changes, but the speeds themselves. This solution is satisfactory because every digital file will reflect all the speed changes on the source tape, at the cost of having to read the tape multiple times and, of course, storing an equal number of digital files. This can be work and cost-intensive if one of the speeds only appears for a few seconds or minutes, which can be the case. However, from a philological perspective, this approach is sound and defendable. In a way none of the digital files exactly corresponds to the source tape, but in a way *all of them* contain the necessary information to reconstruct it.

This example demonstrates that the ratio between tapes and digitized files is not necessarily 1:1. For tapes with two sides, there will be at least be two digital files. In the case of multiple speed (and non-standard track configuration, a problem we do not tackle in this chapter) we can have N digital files resulting from one tape. The presence of a blank portion of tape may raise additional questions about speed: at what speed was it recorded (if it was recorded)? We said in the previous example that silence can be a precious source of "hidden" information about the recording system and the tape content. So, even reading blank parts at the correct speed is a philological issue.

The final example involves editing. There are many ways in which one may feel tempted to edit a digital file resulting from an A/D conversion.

The whole spectrum of available digital tools offers chances for "temptation." These include enhancement tools (noise removal, frequency boost, etc.) and the possibility to cut and paste audio segments to reconstruct content unity. In either case, the intervention on the digitized file needs to be considered, from a philological viewpoint, an arbitrary act of interpretation. When audio material is prepared for the final users all sorts of interventions are allowed (and the user should be made aware of them), but our attention at this stage goes to the archival material that serves as a reference for preservation purposes. It is *supposed* to be "raw" material, not ready for fruition. Therefore, from a philological perspective, any intervention should be avoided at this stage, rather, the benefits of edits can be realized *at a later stage*.

A softer position on this matter (a viable "middle way") is represented by the possibility to perform reversible modifications *only*, and to document them very well. All compensations and processing, if applied, are based on the capacity for precise counteraction,[19] which means reversibility of each operation and, consequently, on the capacity to trace the original characteristics/values that were modified.[20] When digitizing a sound recording that belonged to our family we may decide to act according to our personal taste: we can go from the digitization to the preparation of a playlist with tracks that were optimized for our ears (matching our needs and aesthetic taste, applying a de-noise or a sound boost for example). But, when digitizing a historical sound recording that belongs to a public archive or a collection that has a clear value for a larger community, we must put ourselves back in the shoes of the philologist who deals with a historical document (a "whole" with a specific meaning in a cultural and social context). Then, all the possible ways to intervene on a digitized audio file should become questionable.

There are parallels between audio preservation and other forms of textual preservation. Removing noise can correspond to correcting a spelling mistake: what historian would allow for that? It is the work of the historian to study the pristine documentary source and build theories

[19] Dietrich Schüller, "Preserving the Facts for the Future: Principles and Practices for the Transfer of Analog Audio Documents into the Digital Domain," *Journal of Audio Engineering Society* 49, no. 7–8 (2001): 618–621.

[20] Federica Bressan, "The Preservation of Sound Archives: A Computer-based Approach to Quality Control" (PhD thesis, Sciences Engineering Medicine, Verona, 2013), 34–35. Accessed May 5, 2018. http://samp.dei.unipd.it/proceedings/12_WSa1_01.pdf.

based on all the information it contains. What we consider a spelling error today might have also been an archaic spelling of the same word. What about texts in languages we do not understand? Removing blank pages, re-uniting paragraphs, adding punctuation are all operations that are legitimate in a process of text editing, but they are inappropriate in a context of preservation. The text must be preserved as faithfully as possible, and that includes errors and mistakes. No philologist would want to work on a reworked version of an old manuscript (especially if the re-working has not been thoroughly documented), and the same strict policy should be applied to historical sound recordings. Adopting this policy will result in more reliable audio resources and establish the value of sound recordings as documentary sources.

These are just some examples of possible violation of philological principles in common audio preservation practices. Everything in the field of preservation is the result of a choice. There is no right or wrong as in a mathematical proof, therefore, decisions should be informed and documented. When choosing a treatment for historical sound recordings many approaches are legitimate if they are well documented and they justify every choice in light of philological principles. Ignoring these principles, is also a choice, but one that devalues historical sound recordings as documentary sources. Also, final users (scholars or the public) should develop the awareness and the critical tools necessary to evaluate the material they access and pressure archival institutions to deliver complete and reliable materials.

Conclusions

The preservation of audio documents is a recent field of study and practice that requires theoretical and technical expertise. The nature of sound recordings poses some unique challenges for digital preservation. Namely, it involves the disembodiment of the physical object in a process that results in an all-digital collection of data. The transfer process requires the identification of the relevant features of the audio documents and their correct trans-coding so that we "preserve history, not rewrite it." As a result historical audio recordings can be made permanently accessibility. Several disciplines are called to contribute to this task, from archival science to computer science to chemistry; their contribution is not limited to the provision of working tools but also concepts and methods that forge a new cross-disciplinary domain.

Digital philology is a new discipline, which emerged from the combination of textual criticism and computer science. Its application to audio documents is particularly important, because these sources are not always perceived and treated with the same philological rigor reserved for printed texts and traditional documentary forms. This chapter provides an introduction to digital philology for audio documents, and some examples where philological principles are reflected in the preservation practice. Preservation is a field where intellectual work is still needed; it is normal that a great wave of technological expansion is followed by a time in which practices are formalized and ordered. It is important that the ongoing technological evolution is accompanied by intellectual work, because the consequences of technical choices reverberate all the way up to the cultural interpretation of documents and influence the way we understand the world. Without rigorous philological principles applied to the preservation of audio documents, we risk leaving poor documentary material.

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