Arteleku No-GUI: Using Digital Linear Editing to Teach Archival Practices at Film Schools

Luiza Gonçalves and Lucas Larriera

Introduction

In this article, we argue for the benefits of working with digital linear editing from a pedagogical standpoint. We propose an experimental "old school" linear editing workflow using the open-source tool FFmpeg, a command line tool without a graphical user interface (GUI), with the aim of creating new audiovisual pieces from archival materials without suffering "generation loss" or compression. We developed this project as master's students, and intend our process to be used in editing workshops where students can work with archival footage to make short films. At the end of this essay, we describe our own experience creating the short film *An Afternoon at Arteleku* (2023), revisiting every step of the process in order for teachers, archivists, and students to be able to replicate our experiment with other source footage.

Why do we consider this process experimental? First, because it is not intended as a professional editing workflow, but for instruction at film schools or in related environments so that students can more closely experience all the file transformations that occur when editing digital moving images. Second, it is not meant only to teach editing and montage, but also to introduce students to concerns related to digital archival practices. As we suggest, both these objectives make this method primarily suitable for orphan materials and other archival footage. As Paolo Cherchi Usai (1999) notes, the term "orphan" carries many emotional connotations, and there are several competing definitions of orphan materials within the audiovisual preservation community. The Orphan Film Symposium, for instance, defines an orphan film as "a motion picture abandoned by its owner or caretaker. More generally, the term refers to all manner of films outside of the commercial mainstream" (n.d., n.p.) It is important to disambiguate the term *film*, since in our case study we will be talking about digital copies of videotapes whose whereabouts are unknown. Dan

Streible points out that "the term *orphan film* may itself morph into a post-celluloid phraseology, but the conceptual understanding of cultural productions that get neglected will remain a binding concept" (2009, x). Therefore, we use the term "orphan materials" regardless of what carrier or format the media is found on.

Our digital linear editing workflow requires students or other users to make decisions about sequencing prior to the execution of an edit, the same way traditional linear editing workflows do. In order to place different materials in a sequence, it used to be common practice to develop some kind of "script" for the edit, meaning that both the *ins* and *outs* and the order of each shot to be chained together were decided and documented beforehand. This workflow was mandatory for editing film, which required individual strips of film to be physically spliced together, as well as videotape, which required one or more source tapes to be recorded onto a new tape sequentially (see Figure 1).

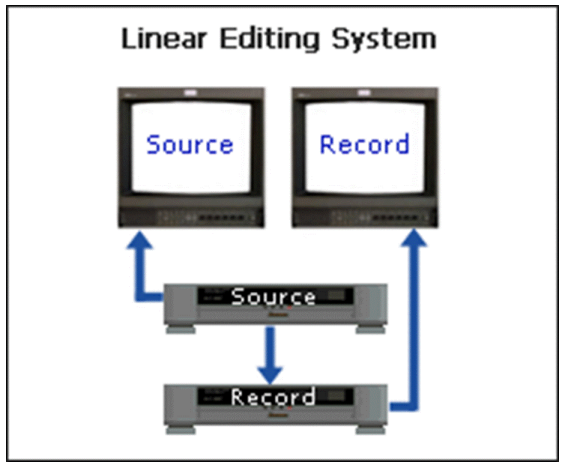

Figure 1: Simple linear (tape to tape) editing system.
https://www.mediacollege.com/video/editing/linear/setup.html

This method contrasts with the kind of work that an editor can do in a non-linear environment, in which random-access memory and the graphical user interface allows the editor to approach editing through a trial-and-error workflow without planning what they are going to do in advance. As educators and former students in the field of audiovisual studies, we recognize that the educational system cannot always keep up with rapid technological changes in professional filmmaking or preservation practices. As film students learn professional workflows, they also find personal ways to assimilate them. In this case, we can apply Donna Haraway's (1997) analysis of the three formative modes of scientific knowledge—material technology, literary technology, and social technology—proposed by Steven Shapin and Simon Schaffer (1985) to better understand the relationship between the different items that compose our project: the investigation featured on our website, the step-by-step linear editing process, and the short film we created using our proposed method.[1] From the beginning, we knew that FFmpeg as a tool was not very accessible, even for

those studying archival practices, and that, since its creation in 2000, there have been many modifications to its modes of use, its compatibilities, and its recipes. With such a niche material technology, we knew that to change the fabric of its social technology, we needed to create other technologies to complement it—not only a literary technology (the step-by-step and investigative processes) but also a new material technology that can both operate on its own and represent the intense process of editing in a digital linear workflow. In this sense, we believe that pedagogical guidance can develop new, unintuitive ways of working with software.

Because of the nature of magnetic videotape, the process of information transfer, commonly called dubbing, causes "generation loss" (see Figure 2). Similar effects are caused by digital compression in most file formats. This was the main reason we developed our digital linear editing method. Because the footage we were working with was compressed digital copies of analogue videotapes that have since been lost, we wanted to ensure that there was no further generation loss or compression when we edited the material. As Agathe Jarczyk, Reto Kromer, and David Pfluger (2019, 23) note, different file formats are typically used for shooting, post-production or processing, access, and archiving of digital video. In the case of the Arteleku video collection—the collection we worked with, which we discuss in greater detail below—we know that the original videotapes, the shooting format, were destroyed in a flood in 2011. Moreover, the original digitized files, the processing format, are also lost. The only copies of the material that remained were access copies with a strong H.264/MPEG-4 AVC compression, originally made for streaming purposes.[2]

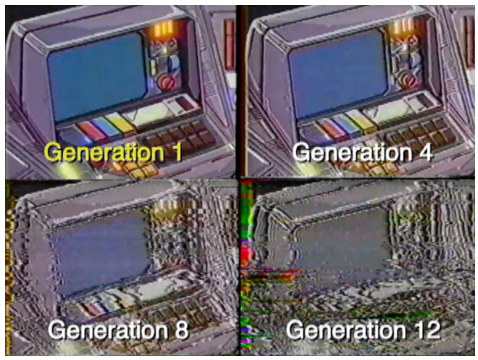

Figure 2: Screenshot of YouTube video showing an example of generational loss. BAVC MEDIA, "Generational Loss THE MOVIE," YouTube, April 5, 2019, https://www.youtube.com/watch?v=ypomMnJ31o0.

In order to make our short film using these compressed digital files, we decided to create new post-production files from the surviving access files, selecting a file format that would fit the needs of the post-production process—allowing us to edit the material without compression—while also being suitable for archival preservation. We chose the FFV1 codec with a Matroska container, given the institutional recognition of this codec and the efforts of the archival community to standardize it. As Reto Kromer, one of the developers and promoters of this format, explains:

> To have a single file format suitable for the preservation of both film and video has been the dream of many archives, especially smaller ones, since the beginning of digital moving images. Today, on the horizon, we can see something that will provide exactly this capability, in a free and open-source environment . . . Though some issues remain unresolved, Matroska, with FFV1 (and FLAC), is on the way to becoming a solid alternative—especially for small archives or archives with extremely limited resources—for preservation masters and mezzanine files. (2018, 41, 44)

Kromer notes that, as of 2018, few software applications provided support for FFV1, which was therefore not yet a suitable choice for post-production, or "mezzanine," files (44). We found this to remain true when we developed our project five years later, as FFV1 was still not supported by nonlinear editing applications. Since we wanted to work with FFV1, and because of our desire to design our workflow entirely with open-source software, we instead chose to make our short film using FFmpeg, a command line tool designed to process, transcode, and perform basic edits on video, audio, and other media files.

Nonlinear Editing and the Graphical User Interface

File transformations and conversions, including frame rate, aspect ratio, and resolution changes, are usually performed in the background of editing software, hidden behind the graphical user interface of applications such as Adobe Premiere Pro, Avid, and Final Cut. These applications render all kinds of transformations and keep them in temporary memory, with the objective of eventually executing and burning all of them into one final export, benefiting the non-stop workflow of the nonlinear editing process. In this section, we explore the implications of these GUIs on the training that film students and editors receive, as well as what valuable information they obscure. We conclude by examining how a command line tool like FFmpeg can recover and restore awareness of these processes to its users.

Stacey Irwin's research on the relationship between editors and nonlinear editing technology in the late 1990s, and these tools' standardization in the audiovisual workflow in the early 2000s, proved an important resource for our project. Her approach to identifying how the introduction of a new tool can not only change the process it is used for, but also the experience of the person who uses it—"the craft and the crafter" (Irwin 2006, 453)—became the starting point of our research. As she describes, nonlinear editing changed the experience of editors from a physical into a synthesized one:

> For the film editor, the film was literally cut and pieced together with tape or cement and then played on a machine called a flatbed that projected the image on a small screen for viewing. For video editors, the tapes were logged and stacked and then parts of each tape were electronically transferred to a separate tape using an electronic edit controller, video monitors, and tape decks to

> create a new whole from the collected parts. Today, everything from feature films to commercials, music videos to news stories are being synthesized almost exclusively through nonlinear editing computer technology. What kind of human-technology connection is forged through this creative interaction between computer user and computer tool? (2006, 454)

While Irwin centres her research around a human-technology dyad, we suggest that moving image montage is structured more around a triad—human-technology-material—adding room in the equation for footage. We can only assume that Irwin overlooks this because she is only thinking about software with graphical user interfaces, though she never mentions which specific editing programs she uses or focuses on for her analysis. While there are several differences between the variety of editing programs available and the features they offer, the graphical user interface, as Irwin's informants' testimonies relate, makes the software the protagonist of the process and takes the material for granted, relegating it to a secondary or even invisible role, privileging the GUI over the material.

The editor's interaction with the GUI structures and limits what they are able to do with the program and material, and how. As Irwin further notes,

> the computer use experience has become so "user-friendly" and template laden, that students in media programs today spend far less time creating projects "from scratch." . . . A pedagogy that accounts for learned behaviors and attitudes, like the promise of instant usability and the need for expert knowledge once the software is taken off "template mode," allows faculty and students to find common ground for understanding the practice of digital editing. (2010, 5)

This is where FFmpeg comes into play. This tool does not have a graphical user interface but relies on *recipes*, or prompts, that the user types into the command line. Because FFmpeg is not necessarily meant to be *user friendly*, the open-source community collectively creates, publishes, and gives advice on many recipes in forums and different support sites.[3]

Technology necessarily modifies the ways in which we work and the types of narratives we end up developing. Walter Murch has noted the importance of this relationship between technology and aesthetics. Writing about the ways in which sound design could be more creatively employed thanks to technological innovations, he notes that

> There is a symbiotic relationship between the techniques that we use to represent the world and the vision that we attempt to represent with those same techniques: a change in one inevitably results in a change in the other . . . Almost all of the technical advances in sound recording, manipulation and exhibition since 1980 can be summed up in one word: digitization. (2000, n.p.)

In our case, we could sum up the developments in editing since the early 2000s with the word *nonlinear*. But while Murch sketches a history of progressive development and improvement of sound technology, we are concerned that the introduction of nonlinear editing technology and GUIs have caused some skills and knowledge to be lost. GUIs inherently predetermine editors' choices and obscure the technical transformations involved in the editing process. While Irwin has diagnosed similar issues, our proposed solutions differ.

Irwin (2010) seems to be more interested in changing the vocabulary and developing new language to describe the digital editing process—including by employing metaphors to help students connect with the editing tools—than in changing the technology itself. By staying focused on the technology, we instead propose a more critical approach to providing authentic empowerment for the student: as we suggest, limiting the editing tool to its most basic functions by writing prompts in the command line restores agency to the user behind the machine. Irwin suggests that "The more the editor practices and dwells in the nonlinear editing computer, the more the learning curve is mounted, the more familiar the software becomes, and the possible displacement, when it occurs, is easily overcome as the editor becomes reoriented in the familiar environment of the software once again" (2006, 465). While Irwin encourages *dwelling* with nonlinear editing tools, developing a close bond with the computer program, we suggest that GUIs have *alienated* the editor from the material itself, as the footage is embedded within and mediated by the GUI. We believe that by using FFmpeg as an editing tool—a use not necessarily intended by its inventors—we can refamiliarize editors with the material and discover new ways of editing and working with moving images for artistic and pedagogical purposes.

As Lisa McDonald states, "Present day technicians are carriers of early formative practice and encounter modes of self-invisibility" (2002, 238). The tension between science, experimental philosophy, and technology is constant and "irresolute," as they all rely on mutually producing each other. If we, as teachers and technicians—not necessarily restricted to the art or film industries—do not propose nuances in how we use our tools, we are in turn obstructing the light that is shed on our own profession. In other words, according to McDonald, in our ever-changing and fast-paced technoscientific world, technicians have a responsibility to teach and pass on their technological expertise, because it is only through practice and interaction with technology that one can transmit technical knowledge.

As one aspiring editor tells Irwin: "You just get so wrapped up in it and so much time has flown by that you don't give your eyes a rest, or your back. Editors feel wrapped within their technological tool, lost in its presence" (Irwin 2006, 461). For this editor, the relationship with the footage is secondary to the process of interacting with the GUI—selecting, moving, cutting, pasting—which becomes a *flow*. Irwin notes that "without the software, the work does not exist. Only when the editor and the editing software meet in a place called the interface can the artful magic of the sacred space begin again" (463). We find this description of the editing process problematic in pedagogical terms. Our proposed method is not intended as a statement against nonlinear editing, but we firmly believe that letting students experience linear

editing—without the impediments of obsolete video technology—could de-alienate all the invisible micro-processing that happens in the background of a GUI. Young aspiring editors and students working with the moving image could become conscious of all the automated processes hidden behind the application interface by themselves making decisions about the standards of their media in the process of manipulating audiovisual materials. As another one of Irwin's informants puts it: "I keep telling them it's not what you work on, it's about the decisions that you make. So I think that there is a problem with computerized editing if you don't give yourself enough time to make decisions, to think about what you're doing" (462).

Irwin's research suggests that the arrival of nonlinear editing marked a significant breaking point, to the extent that many students today do not know a thing about how editing was done in the past. While film students and young aspiring editors may have some knowledge about the process of cutting and splicing celluloid on a Steenbeck, working with multiple video decks, controllers, and monitors in the analogue and early digital video era is an art completely lost to them. These discrepancies make us aware of the systematic hierarchies between different media, including film and video—hierarchies that should be questioned both in the film history and film production classroom.

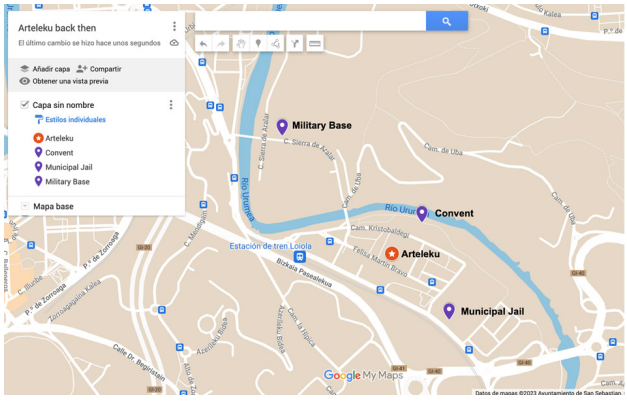

Figure 3: "Arteleku back then," a Google Map created by the authors.

Arteleku: History and Context

Arteleku was located on the outskirts of San Sebastián, a touristic city in the eastern parts of the Basque Country, in a small industrial neighbourhood beside the Urumea river called Txomin Enea. Housed in a refurbished electrical supplies factory, the arts centre first opened its doors in 1987, located between a military base, a convent, and the municipal jail (see Figure 3). Despite being off the beaten path, local artists began to flock to Arteleku, and during the 1990s, it became a highly esteemed place with international recognition. The University of the Basque Country and its School of Fine Arts had opened in the region only a few years earlier, after much debate, and started offering classes in painting, drawing, textile design, ceramics, and photography (Vaquero 1990, 39). A local Video Art Festival, with cash prize competitions in addition to programs chock-full of international video works, had also been hosted

in San Sebastián between 1982 and 1984, organized by Guadalupe Echeverria, a key member of the arts council in the neighbouring city of Tolosa (Aguiriano 1992).[4] With the political aim of supporting young artists and creative production in the Basque Country, there was a lot of money flowing into the territory.

The age of video was booming all over the world in the mid-1980s, especially in Spain, France, and the United States, and the need for artists to experiment with video as a new medium for expression, and the endless possibilities of this technology to record and play back moving images, created the conditions for various groups and collectives to emerge. Only one year after opening Arteleku and offering courses on lithography, screen printing, sculpture, and art restoration, the centre inaugurated its audiovisual lab for video production. Quickly, they began offering courses on audiovisual production techniques, including editing, performance, and more, in addition to establishing a video library open to the public. In 1989, Arteleku purchased videos from Bosgarren Kolektiboa, the most important local collective; mostly made up of U-matic tapes, the collection was expanded in 1993 with a large purchase from Electronic Arts Intermix, featuring work by Nam June-Paik, Marina Abramovic, and Vito Acconci.

Figure 4: Photo of the Arteleku team gathered at the documentation centre. The photo appeared in the book *Desartxibo*, published by the Diputación Foral de Gipuzkoa in 2002 for Arteleku's 15th anniversary.

After two remodels of the building—the Northwest side in 1992, and the first floor in 2002—Arteleku was making strides to provide optimal space for its growing community and educational programming to local artists (see Figure 4). But its closeness to the Urumea river—featured in a July 1992 video performance by Pepe Espaliu—allowed the first floor to completely flood in 2011, and significantly damaged the library and computer space as well as administrative office. Incessant rain had elevated the river into the houses of the Txomin Enea neighbourhood and people had to be rescued, but Arteleku remained closed, with zero protocols for the

protection of their patrimony or artifacts. The aftermath clean-up became a group mission for the artists, secretaries, and educators who worked there. Arteleku's library became an "archive," and what was left of it was split between different cultural institutions around the county in an effort to simply safeguard the various items. Today, very little evidence remains of the arts centre's cultural and social impact within the community—even the building itself is gone (see Figure 5)—except for the living artists that continue their practice.

In 2008, after a contest in search of a new purpose for San Sebastián's old tobacco factory, a project was started to "converge" the "cultural services" of the county of Gipuzkoa to a more centralized location (*El Diario Vasco* 2011). A triple alliance between the city council, the Basque government, and the provincial council won the contest, forcing Arteleku to forfeit its arts education programs to the state, and in 2010, a formal agreement was set in place. After many years of remodelling, the new cultural centre, Tabakalera, finally opened to the public in 2015, with a focus on visual culture. This jaw-dropping six-story building, filled with pristine offices and white-walled gallery spaces, now holds some of Arteleku's history. The books salvaged from Arteleku's library were recovered and displayed in Tabakalera's Media Lab, but the equipment used for creative productions was not kept. While Arteleku was open to the public and provided equipment and facilities for community use, there are only three spaces in the entire Tabakalera building dedicated to the actual production of visual or fine art works, none of which are open for public use: a facility used by Elías Querejeta Zine-Eskola's audiovisual postgrad programs, a computer lab with postproduction studios, and an artist residency space that lacks real equipment for production and consists of modular wooden office cubicles. All spaces can only be accessed as a paying full-time student or as a winner of a competitive open call for audiovisual projects with a specific theme and gender or age restrictions. A few of Arteleku's tapes were donated to the postgrad program by the Akmeka research group at the University of the Basque Country, and used for inspection, cleaning, digitization tests, and an investigative research project.

Figure 5: Google Street View showing the site of the Arteleku building. The demolition was part of the re-urbanization project of the Txomin Enea neighbourhood.

When we first discovered the existence of Arteleku as members of the Akmeka "Perdidas de Generación," or "Generational Losses," project, we knew that we were in contact with materials that had a deep significance to the local community. Guided by Natxo Rodríguez and Arantza Lauzirika, who had been working on recovering the memory of Arteleku since 2017, our goal was "to build a diverse, ensemble narrative from the rich and complex *artxibo.arteleku.net* website, and to enable new readings, re-readings and interpretations of the archive(s)" as well as to "publicise the accounts of those who formed part of the centre's history and make the collection available for possible future research, to ensure that the archive can be more than just a museum piece and an exercise in conservation" (Lauzirika and Rodríguez 2021, 52). Since 2021, Akmeka has received support from the Reina Sofia Museum in Madrid to maintain their website and publish their work, and in 2022, Akmeka conducted and recorded interviews with people who actively participated in workshops and events at Arteleku. These video interviews were called "Bideokaxetak," in reference to the videocassettes and tapes that made up a very big part of Arteleku's library. In 2023, as part of our contribution to the project, we also produced a short film using some of the surviving footage.

An Afternoon at Arteleku: Digital Linear Editing with FFmpeg

In making our film, it was important for us not only to do justice to the history of Arteleku, but to activate the surviving material to tell a story tethered to the huge loss experienced in the arts scene and the creative circuit after the centre shut down. We firmly believed that the way we chose to interact with the material available to us had to be justified by a very strong concept. Inspired by the various ways that Arteleku's history was being preserved through documentary films, dossiers, and "micromemorias," we chose to challenge ourselves by working with our favourite videos from the Arteleku web archive.[5] These videos appeared to be raw, unedited footage that documented the day-to-day happenings at Arteleku. Not only were we intrigued by the domestic quality of the videotape recordings, but the fuzzy, handheld mode seemed to manifest the spirit of the centre. Approaching these compressed videos as archival records, we accepted that we would not be able to access the original tapes and decided that the question of ownership was also not an important factor. In fact, our approach proposed a challenge by utilizing "institutional" material that may have originally been filmed for a promotional video but did not appear to have a clear purpose. Despite their crudeness, the gesture of editing together these orphaned videos allowed us to rescue these bits and pieces and place them in dialogue, to reactive the materials and depict an afternoon at Arteleku. Providing visual and sonic access to the mundane activities at this active arts space, which was once brimming with life, seemed to appeal to the sense of historical recovery which led our and Akmeka's efforts.

Referencing Manuel Castells (1996) in describing the cultural practice of editing, McDonald writes that "editors are [mass] media practitioners involved in this allegorical realm, constituting an active presence as both the architects of cultural expression, and concurrently, its users." (2002, 247) This "new symbolic environ-

ment" defined by Castells reminds us that media is manipulated by both the user and editor, roles that the speed of images and technology has made impossible to separate. Being aware of our dual roles made us reflect on our "active presence" and document our own process. McDonald suggests that editors hold a responsibility in their power, which is in constant tension with their role as users of both audiovisual and printed media. We also felt a responsibility toward these images, to rescuing the only testimony left—in digital form, available through Arteleku's web archive, where the generation loss suffered by the material is as palpable as the loss of the original tapes—from obscurity. These copies of copies, compressed for online streaming, became our originals. As the "architects" of their expressivity, working with these orphaned materials in a linear editing process, framed by the context of lossless workflows, provided a lot of room for experimentation.

Figure 6: Official film poster for *An Afternoon at Arteleku*.

Since the creation of our short film, *An Afternoon at Arteleku* (see Figure 6), transversed both the creative and archival domain in its editing process and form, we have considered Kromer's ethical guidelines for film restoration throughout the process. As Kromer argues, the process must be reversible and remain open to further interventions by future generations, and the work needs to result in increased access to the material. Working in the digital realm can make these goals easier to accomplish as it is possible to document every process, every move, and every action along the way in order to be able to undo it, as "restorers today do not have the right to close off the doors to the next generation" (2013, 80). As Kromer explains:

> In documenting the restoration process, the following questions must be answered:
> - What is the state of the original element before taking action?

- What kind of intervention is done? And how? And why?
- What is the state of the original element after taking action?
- Which new elements have been produced? And how? And why?

Please keep in mind that if you go through an analogue or a digital restoration process, you end up with more elements to take care of, not less. (81)

While the aim of our project—making a short film from found footage—meant that we could disregard some of these questions, the ethical considerations undergirding them remained of utmost importance, especially as we were working with footage not shot by us. However, our project's central goal, developed as we studied archival practice, was to create a case study for teaching these strategies. The "literary technology" we have developed to help activate these materials, including our website and this article, support our mission to continue pollinating these strategies for activating digital orphan materials. Working with a command line tool with no graphical user interface required strong documentation in order to go back and forth in our process to make changes and to check our work. In the following pages, we describe the steps we followed in the production of our film. The full step-by-step guide is included as an appendix to this article.

While generation loss and compression still happen in the digital realm, editing with FFmpeg allowed us to get around this problem. As our objective was to edit the footage and export a finished piece without further compression, we needed to standardize our materials. When we work with different formats in editing software with a GUI, materials are transformed and conformed without our knowledge to match the format criteria at both the timeline and export level. In order to clearly identify the materials we were working with and find the best standard, we had to read the metadata encoded within our footage to identify any discrepancies in frame rate, scan type, container, codec, dimension, aspect ratio, and more. For our project, we wanted to work exclusively with open-source software, so we used MediaInfo by MediaArea to identify these details.[6]

Knowing the unique properties of our media, we could start planning our workflow to fit our project. Being conscious about the origins of the footage gave us some useful hints as to the best way to manipulate this material. For example, many of the files run at 30 frames per second, following the North American NTSC standard, while in Europe the standard for video is PAL and SECAM, both of which run at 25 fps. This could be evidence of a moment when the technology was still in transition, and some of the cameras may have been brought to Spain from the U.S., resulting in mixed formats in the early years of video practice. We also encountered the presence of interlace scan lines in some videos, but not in others. While it would have been fair to assume that all the tapes were digitized interlaced, many of the files are progressive. That led us to believe that another step of file transformation, beyond AVC compression, took place between the original digitized copy of these tapes and the compressed H.264 versions to which we now have access. As such, knowing the technical properties of our footage not only prepared us to make more conscious decisions with it, but also to learn about and reflect on the complexity of audiovisual

media migration.

Next, we needed to standardize the material, which involved some decision making. What was the best way to conform this diverse footage to the same technical aspects? There were many reasons in favour of one decision or another. The important thing was that this decision needed to be made consciously and with justification. Usually, when combining media from different sources into one unified timeline, editing software with a GUI automatically transforms the source footage to fit the timeline's specifications. This typically leads to the loss of information, whether by expanding or compressing footage in order to fit a new aspect ratio or resolution, or dropping or duplicating frames in order to match a new frame rate.

For our film, we made a conscious decision about the dimensions we wanted our unique project to have. We decided to keep all videos in the 4:3 aspect ratio, scaling up all videos equally to 768 x 576 pixels, which is the standard PAL display resolution. In order to record this decision, we implemented a written log to trace all our actions and the reasons that justified our decisions. Since there is no automatic *undo* function to reverse an action and restore the project to a previous instance like in most applications and editing software, one must be able to trace exactly which steps one followed in order to go back to a previous state, which one does by starting over and writing a new prompt in the FFmpeg command line, modifying the specific parameter(s) that resulted in unsatisfactory outcomes. Each recipe in FFmpeg has very precise parameters, relating to different aspects of the digital files, and one must master the logic of each recipe to properly implement a workflow and chain of editing. There were times in our own execution of this project that we had to go back and modify recipes to produce more precise outputs that were easier to understand and replicate. Every "cut" one makes will also generate a new file, until one arrives at the infamous "final cut," since in order to view each version of the edit the user must export a new sequence, as there is no graphical user interface to render a preview.

	A	B	C	D	E	F	G	H	I
1	File name	Title	Duration	Shot #	TC IN	MS	TC OUT	MS	NOTES
2	5 – 1989_Serigrafia_TC.mp4	Serigrafia II	17:20	SER2_001	05:00:30:04	.160	05:00:37:20	.800	Dos personas toman notas.
3				SER2_002	05:00:57:23	.920	05:01:14:04	.160	Planos detalle de objetos.
4				SER2_003	05:01:16:13	.520	05:01:24:20	.800	Mujeres trabajando en otro taller.
5				**SER2_004**	**05:01:36:05**	**.200**	**05:01:51:16**	**.640**	Reflejo ventanal y paneo hacia la escalera.
6				SER2_005	05:02:00:00	.000	05:02:03:07	.280	Puerta a pasillo con teléfono.
7				SER2_006	05:02:12:10	.400	05:02:31:00	.000	Pintor y varios caballetes y dos planos mas de gente pintando.
8				SER2_007	05:02:34:10	.400	05:02:46:00	.000	Otro pintor de espaldas y zoom.
9				SER2_008	05:03:08:21	.840	05:03:29:19	.760	Pintora y dos personas miran otra pintura.
10				SER2_009	05:03:36:08	.320	05:03:51:10	.400	Detalle pintura y contraplano chavon hablan con chica.
11				SER2_010	05:03:52:00	.000	05:04:04:18	.720	Chica parada y paneo a izq.
12				SER2_011	05:04:10:22	.880	05:04:23:22	.880	Chavon y chica de nuevo discuten sobre la pintura.
13				SER2_012	05:04:34:03	.120	05:04:37:14	.560	Chica de espaldas trabajando en cuadro y en profundidad pareja hablando.
14				**SER2_013**	**05:04:46:21**	**.840**	**05:05:03:00**	**.000**	Chico sentado en el piso. Dibujando figuras geométricas.
15				SER2_014	05:05:21:23	.920	05:05:51:21	.840	Dos pinturas y descubre por paneo al pintor barbudo.
16				**SER2_015**	**05:05:59:22**	**.880**	**05:06:09:10**	**.400**	Persona que pinta los falsos Goenaga
17				SER2_016	05:06:29:12	.480	05:06:42:21	.840	Dibujante y señor hablan.
18				**SER2_017**	**05:06:51:18**	**.720**	**05:07:05:00**	**.000**	Mujer rulitos pinta un tarro de pintura.
19				SER2_018	05:08:01:20	.800	05:08:07:14	.560	Detalle impresiones.
20				SER2_019	05:08:22:10	.400	05:08:31:13	.520	Otro detalle más grande.
21				SER2_020	05:08:56:14	.560	05:09:12:05	.200	Pintor en lienzo translucido.
22				SER2_021	05:09:22:15	.600	05:09:32:21	.840	Pintor en lienzo translucido de perfil.

Figure 7: Our spreadsheet tracking the timecode for selected clips, made in Libre Office. Luiza's selections are marked in green, Lucas' in blue, and the ones that overlapped in bold.

Many of the steps and processes that follow are the same or very similar to those involved in working with regular linear video editing. For instance, to select what footage to include, we worked with reference copies with burned-in timecode to record the ins and outs of each selected shot on an interactive spreadsheet, created using Libre Office (see Figures 7 and 8). These timestamps were also used to trim the selected shots with the FFmpeg trim recipe. Even in this part of the process, which may seem trivial, the two of us were able to work on the same sequence simultaneously without erasing or hindering the other's work. Each could visualize freely, selecting our own ins and outs, while seeing what the other had selected, too. This collaborative editing process necessitated that we keep a very detailed record of the different shots we had chosen.

Figure 8: Video with burnt-in timecode.

Before compiling a first cut of the selected shots, we wanted to preview the sequence envisioned in our heads. We did this by using an open-source diagram app, Draw.io, where the first and last frames of each shot were placed in sequential order (see Figure 9).[7] This tool gave us a panoramic view of the entire project as if it were a timeline in a GUI. These panoramic strips mimic the age of linear film editing by providing a visual overview of the entire sequence while activating a different kind of creative input and order

Despite being a somewhat tedious and time-consuming process, digital linear editing has the capacity to restore the handicraft that is sometimes lost by working with editing software with a GUI, allowing the user to make every single file transformation a more conscious decision, as one is forcibly made aware of the specificities of each digital file. Full instructions for our digital linear editing workflow, using our film with footage from the Arteleku Video Collection as a case study, can be found in the appendix to this article. Almost all recipes were selected and slightly modified from ffmprovisr, a website created to "help users through the command generation process so that more people can reap the benefits of FFmpeg" (AMIA Open Source 2024).

Figure 9: Our mood board on the Draw.io app.

Conclusion

Drawing on Irwin's insights into how editing interfaces shape editors' processes and McDonald's call for editors to own their cultural power, our project proposes a pedagogical and creative shift: that by embracing command line digital linear editing with FFmpeg, editors can reclaim agency over their material and confront the hidden transformations performed behind GUI-based workflows. By carefully standardizing, documenting, and openly questioning each intervention in the footage, we can not only counter generation loss but also build a transparent editing methodology rooted in archival ethics. This approach disrupts the alienation caused by the GUI, restores the handicraft of montage, and foregrounds the triadic relation of human-software-material overlooked by much existing scholarship on editing. In doing so, we reject Murch's narrative of technological inevitability and insist instead on the active, ethical, and historically conscious role the editor can play as both user and architect of the editing process.

It is quite uncommon for those of us working in production to use the same tools as those in the archival field. By utilizing multiple technologies developed for media preservation (FFmpeg and the FFV1 codec) as part of the process of editing and filmmaking, we hope our proposal can speak to the necessities of all those who are interested in activating and preserving moving image materials at risk. This article is part of our effort to make our findings public, and we encourage the use and reimagination of our step-by-step process by anyone who shares our sense of urgency around the preservation of our moving image heritage. While the creative impulse may not be exercised daily, our closeness to film as professors, cinephiles, and archiving students provides ample ground for experimentation with the digital linear editing process using FFmpeg. Although the process results in a slower and more time-consuming approach to editing, working between technology and creativity reconnects us to the nature of the medium itself.

Notes

[1] See https://artelekunogui.wordpress.com/.

[2] See https://artxibo.arteleku.net.

[3] Thank you to the Association of Moving Image Archivists community for developing ffmprovisr, which inspired us to make our own website, and to our professor, Reto Kromer, who taught us how to use FFmpeg.

[4] Since the Video Art Festival depended on the official and more traditional "Film" Festival of San Sebastián, ties were cut and the project discontinued after the third edition.

[5] The "micromemorias" are investigative essays exploring the history of Arteleku. See https://www.akmeka.org/artxiboarteleku/works/home/.

[6] See https://mediaarea.net/en/MediaInfo.

[7] See https://www.drawio.com/.

References

Aguiriano, Maya. 1992. "Entrevista con Guadalupe Echeverria." *Zehar* 19: 4–7.

AMIA Open Source. n.d. "ffmprovisr." GitHub. Accessed January 2, 2024. https://amiaopensource.github.io/ffmprovisr/.

Castells, Manuel. 1996. *The Rise of the Network Society*. Blackwell.

Cherchi Usai, Paolo. 1999. "What Is an Orphan Film? Definition, Rationale, Controversy." Orphan Film Symposium. https://www.sc.edu/filmsymposium/archive/orphans2001/usai.html.

El Diario Vasco. 2011. "Arteleku asume los proyectos audiovisuales de Tabakalera hasta su apertura." February 11. https://www.diariovasco.com/20110211/mas-actualidad/cultura/arteleku-asume-proyectos-audiovisuales-201102111628_amp.html.

Haraway, Donna J. 1997. *Modest_Witness@Second_Millennium.FemaleMan_Meets_OncoMouse: Feminism and Technoscience*. Routledge.

Irwin, Stacey O'Neal. 2006. "Technological Other/Quasi Other: Reflection on Lived Experience." *Human Studies* 28 (4): 453–67.

———. 2010. "Murch and Metaphor: Reflection on Digital Editing Pedagogy." *Journal of Media Education* 1 (1): 5–10.

Jarczyk, Agathe, Reto Kromer, and David Pfluger. 2019. "Memoriav Recommendations – Digital Archiving of Film and Video: Principles and Guidance." Version 1.2. Memoriav. https://memoriav.ch/wp-content/uploads/2019/11/DAFV_1.2_EN.pdf

Kromer, Reto. 2013. "The Preservation of Home Movies: A Field Report." In *Work/s in Progress: Digital Film Restoration within Archives*, edited by Kerstin Parth, Oliver Hanley, and Thomas Ballhausen, 80–82. SYNEMA – Gesellschaft für Film und Medien.

———. 2018. "Matroska and FFV1: One File Format for Film and Video Archiving?" *Journal of Film Preservation* 96: 41–45.

McDonald, Lisa. 2002. "Digital Editing as Cultural Practice: A Merger, a Margin, a Mark." *Emergences* 12 (2): 235–53.

Murch, Walter. 2000. "Stretching Sound to Help the Mind." *The New York Times*, October 1. https://www.nytimes.com/2000/10/01/arts/film-stretching-sound-to-help-the-mind-see.html.

Orphan Film Symposium. n.d. "What's an 'Orphan Film'?" https://wp.nyu.edu/orphanfilm/what-is-an-orphan-film/.

Lauzirika, Arantza, and Natxo Rodríguez. 2021. "Open Research on Arteleku's Video Collection." *ZINE: Film Research Series* 2: 51–54. https://www.zine-eskola.eus/en/publicaciones/0004-zine02.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton University Press.

Streible, Dan. 2009. "The State of Orphan Films: Editor's Introduction." *The Moving Image* 9 (1): vi–xix.

Vaquero, Rosa. 1990. "La Mujer como Creadora: la Escuela de Artes y Oficios de Vitoria (1900–1990)." *Kobie* 7: 25–50.\]

Appendix: Step-by-step Guide to Use FFmpeg to Edit Orphaned Digital Materials

Tools: Make sure you have access to the following tools before starting:

- **MediaInfo**: a convenient unified display of technical and other metadata for audiovisual files. https://mediaarea.net/en/MediaInfo.
- **FFmpeg**: an open-source tool for handling and transcoding video, audio, and other multimedia files and streams. https://ffmpeg.org/.
- **Draw.io** (optional): a free online diagram application for making flowcharts and diagrams. https://www.drawio.com/.
- **LibreOffice** (optional): an open-source office software suite with programs for word processing, creating spreadsheets, and more. https://www.libreoffice.org/.

Video materials: You can experiment with your own selection of video materials. For reference, for the creation of our short film, we used footage from the following videos:

- *Producciones Arteleku*. 1991. 13 min, 9 sec. Format unknown. https://artxibo.arteleku.net/es/islandora/object/arteleku%3A6201.
- Zona Abierta. Taller. Artista y Máquina. 1992. 6 min, 10 sec. U-matic. https://artxibo.arteleku.net/es/islandora/object/arteleku%3A3883.
- Pepe Espaliú, *Este Río Es Este Río es Este Río*. 1992. 17 min, 43 sec. VHS. https://artxibo.arteleku.net/es/islandora/object/arteleku%3A3875.
- *Taller de Pintura de Jose Luis Goenaga*. 1993. 57 min, 42 sec. VHS. https://artxibo.arteleku.net/es/islandora/object/arteleku%3A3977.
- *Curso Serigrafía*. 1989. 17 min, 18 sec. Format unknown. https://artxibo.arteleku.net/es/islandora/object/arteleku%3A608.

In order to make it easier to understand the recipes, we have colour coded the text. If the text is marked in red, you will have to specify the file paths and/or file names of the video and other files necessary to run the command. If the text is marked in blue, you will need to specify the values (frame rate, pixels, and more) you want to use to modify your footage.

Step 0: Prepare your folder structure to keep the project organized. We recommend creating separate folders for your original files, the new preservation files, the post-production and reference files, the clip exports, the edit exports, and the access copies.

Step 1: Generate preservation copies of your footage. We used the open-source codec FFV1 and the container Matroska (.mkv).[1]

Export a video with the FFV1 codec and Matroska container for preservation[2]:

ffmpeg -i input_file -map 0 -dn -c:v ffv1 -level 3 -g 1 -slicecrc 1 -slices 16 -c:a copy output_file.mkv -f framemd5 -an framemd5_output_file

Step 2: Use MediaInfo to identify the technical specifications of your footage and make notes of any discrepancies between different files. All our material was PAL, 25 fps, and 4:3, but with distinct dimensions and scan types (progressive vs. interlaced).

Step 3: Generate post-production copies for editing, selecting the parameters for your type of scan, frame rate, and dimensions.

In order to de-interlace a video[3]:

ffmpeg -i input_file -c:v ffv1 -level 3 -g 1 -slicecrc 1 -slices 16 -vf "yadif,format=yuv420p" output_file

In order to modify the frame rate[4]:

*ffmpeg -i input_file -r output_fps -filter_complex"[0:v]setpts=input_fps/output_fps*PTS[v]; [0:a]atempo=output_fps/input_fps[a]" -map "[v]" -map "[a]" output_file*

In order to modify the dimensions[5]:

ffmpeg -i input_file -map 0 -dn -c:v ffv1 -level 3 -g 1 -slicecrc 1 -slices 16 scale=width:height output_file

We scaled the material to 768×576 pixels to maintain the 4:3 aspect ratio.

Step 4: Generate new reference files with burnt-in timecode.[6] The timecode is used to identify the cuts to be made. It is necessary to specify the font file, font size, font colour, box colour, and rate of your timecode (HH:MM:SS:FF). We set the starting timecode of each separate video with a unique hour for organizational purposes, meaning that the first file would start at 01:00:00:00, and the second file at 02:00:00:00, and so on. That way, when we took screenshots or selected ins and outs, it would be easy to identify one file from the other. This organizational strategy may not work if your videos run longer than an hour.

ffmpeg -i input_file -vf drawtext="fontfile=font_path: fontsize=font_size: timecode=starting_timecode: fontcolor=font_colour: box=1: boxcolor=box_colour: rate=timecode_rate: x=(w-text_w)/2:y=h/1.2" output_file

Our parameters were: font file = Apple Gothic, font size = 35, font colour = white, box colour = black, rate = 25/1 (see Figure 8 in our article).

Step 5: Pre-select the *ins* and *outs* of your footage by reviewing the timecoded footage using FFplay.[7]

ffplay -i input_file

Press the letter "P" or the spacebar to play or pause the footage. Press the letter "S" to advance frame by frame. Mark your ins and outs in a spreadsheet to keep track of your selections (see Figure 7 in our article).

Step 6: Convert the frame numbers in your spreadsheet to milliseconds using this reference created by Michael Allar.[8] Since the FFmpeg trim tool does not work with frames, you will need to calculate the exact timing of each in and out. For example, if the frame rate is 25 fps, the duration of each individual frame is 40 ms: 05:00:30:04 would be converted to 05:00:30.160 (see Figure 7 in our article). You can use the following list of the most common frame rates to calculate the duration of each frame.

23.976 fps is 41.70838 ms
24.000 fps is 41.66666 ms
25.000 fps is 40.00000 ms
29.970 fps is 33.36670 ms
30.000 fps is 33.33333 ms
48.000 fps is 20.83333 ms
59.940 fps is 16.68335 ms
60.000 fps is 16.66666 ms

Step 7 (optional): Generate thumbnails of the ins and outs—the first and last frames—of each selected sequence using FFmpeg.[9] Select different file names for the first and last frame. We ended the file name of the last frame with the letter "B."

ffmpeg -ss HH:MM:SS.000 -i input_file -vframes 1 thumb.png

Step 8 (optional): Utilize the open-source tool draw.io to create a diagram of your sequence.[10]

Step 9 (optional): If you want to see your footage in motion, you can create GIFs of your clips.[11]

ffmpeg -ss HH:MM:SS.000 -i input_file -vf "fps=10,scale=500:-1" -t 3 -loop 6 output_file

Step 10: Export each selected sequence from the post-production files (the FFV1 files with matching parameters, without timecode).

ffmpeg -i input_file -ss 00:02:00.000 -to 00:55:00.000
-c copy -map 0 output_file

Step 11: Create a .txt file (UTF-8) listing all clips in the desired order for the edit. It is important that the .txt file is saved in the same folder as your clip exports, and that it is formatted correctly.

file 'firstclipfilename.mkv'
file 'secondclipfilename.mkv'
file thirdclipfilename.mkv'
file 'fourthclipfilename.mkv'
and so on

Step 12: Combine the clips using the "concat" recipe.[12]

ffmpeg -f concat -i mylist.txt -c copy output_file

To make any changes to the edit, run through steps 5–12 again, selecting new ins and outs for clips or changing the order of the sequences. Have patience.

Step 13 (optional): Export a pillar-boxed HD version of your final cut.[13]

ffmpeg -i input_file -filter:v "scale=1440:1080:flags=lanczos, pad=1920:1080:240:0"
-c:a copy output_file

Step 14: Create an access copy of your film.[14]

ffmpeg -i input_file -c:v libx264 -pix_fmt yuv420p -c:a aac output_file

Notes

[1] FFV1 has been proven to be a viable archival codec, and the Library of Congress now regards it as a suitable option for preservation. Matroska is an open container format that can hold an unlimited number of video, audio, and subtitle tracks in one file. Matroska file extensions are .mkv. See https://blogs.loc.gov/thesignal/2023/12/embracing-ffv1-matroska-container-preferred/.
[2] See https://amiaopensource.github.io/ffmprovisr/index.html#create_FFV1_mkv.
[3] See https://amiaopensource.github.io/ffmprovisr/index.html#deinterlace.
[4] See https://amiaopensource.github.io/ffmprovisr/index.html#modify_speed.
[5] See https://trac.ffmpeg.org/wiki/Scaling.
[6] See https://amiaopensource.github.io/ffmprovisr/index.html#burn_in_timecode.
[7] See https://ffmpeg.org/ffplay.html.
[8] See https://fpstoms.com.
[9] See https://amiaopensource.github.io/ffmprovisr/index.html#one_thumbnail.

[10] See https://www.drawio.com/.
[11] See https://amiaopensource.github.io/ffmprovisr/index.html#create_gif.
[12] See https://amiaopensource.github.io/ffmprovisr/index.html#join_files.
[13] See https://avpres.net/FFmpeg/SD_HD.
[14] See https://amiaopensource.github.io/ffmprovisr/index.html#transcode_h264.