Reconsidering Technical Labor in Information Institutions: The Case of Analog Video Digitization

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Abstract

Technical labor is still typically made invisible in the functioning of academic libraries and other information institutions even as they begin to disseminate technical and craft knowledge through makerspaces and other sites of library innovation. This paper seeks to recover one type of technical labor, digitization, as information work that embodies mental and manual activities and is both materially and intellectually productive. This paper draws on findings from an empirical study conducted by the author from 2015–2017 that used qualitative-interpretive methods to study the discursive and material practices of professional media preservationists as they worked to digitize analog video recordings in small-scale, high-quality ("artisanal") digitization projects. One key finding of this research is that in order to produce "legitimate" digital copies within their institutional contexts, media preservationists must coordinate their physical and mental activities to develop understanding of the invisible electrical signals that carry the encoded video information, blending objective and subjective modalities of knowledge. These findings have implications for understanding how the invisible labor of digitization has significant mental as well as manual dimensions, contributing to ongoing debates in information studies and the digital humanities on the relationship between "doing" and "signifying" in terms of knowledge work.

Introduction[1]

Technical labor is still generally made invisible in the functioning of academic libraries and other information institutions even as they have started disseminating technical and craft knowledge through makerspaces and

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other sites of library innovation.[2] Promoting positive discourses around "making" and nurturing embodied engagement with tools and materials has not translated into a broader consideration of library work. Technical labor, such as that involved in preservation and digitization activities, is rarely considered as an intellectual activity.[3] As such, it is easy to undervalue the intellectual contribution of librarians, archivists, and other information professionals in the production of the digital copies that researchers will be using long into the future. Workers who engage in labor that is hidden or made symbolically invisible are at much greater risk of being marginalized materially. Discourses of labor impact how that labor is rewarded and its workers protected. The DLF Working Group on Labor in Digital Libraries (2018) suggests, "In order to determine the value of labor within digital libraries, employers categorize workers in various ways. However, neither these categories nor their impacts on library workers are well understood, even as some categories of workers are more visible than others and are therefore more valued in terms of credit, compensation, and opportunity" (5). Valuing depends on the relative visibility or invisibility of particular types of labor, which depends on the nature of the work and the social relations that define the exchange value of its products. This implies that digital library workers whose intellectual contribution to their labor remains invisible, as in the case of digitization work, will be compensated at a lower rate and given fewer opportunities for advancement than managers or other administrative staff. Rethinking the invisibility of this type of work will pave the way for material and economic improvements to the working conditions of digital laborers. The qualities of the work—i.e., what the work is perceived to entail, the tasks involved, skills required, and outputs produced—are used to differentiate between intellectual/managerial labor and the technical work that maintains digital systems and produces digital copies. Even as the discourse of contemporary knowledge work is founded on the dematerialization of labor and the obfuscation of production, digital systems embody these repressed relations of industrial production. The maintenance of digital systems, including servers, software, etc., is clearly necessary for digital library components to function, yet it is often overlooked and undervalued. Similarly, the digitization of library materials for the purposes of constructing digital library collections is typically perceived as nonproductive technical work, when in fact it is a form of productive labor that produces digital products that circulate as commodities.[4] Digitization work is far from a purely technical practice, as its products are shaped by the decision-making and other judgments made by digitizers.

In order to better understand the nature of technical labor in libraries, this paper draws on findings from an empirical study conducted by the author from 2015–2017 that uses qualitative-interpretive methods to study the discursive and material practices of professional media preservationists

as they work to digitize analog video recordings in small-scale, high-quality ("artisanal") digitization projects.[5] Digitizing analog video for preservation has become a pressing concern for the moving image preservation field, since content stored on analog video tape is at severe risk of loss due to decay and the rapid obsolescence of playback equipment. For this study, thirteen media preservationists (eight digitizers, four administrators, one quality-control specialist) were recruited. By looking at the practices of media preservationists digitizing analog video tape, "signal work" emerged as a key part of their practice. "Signal work" describes a cluster of micropractices and epistemic techniques in which media preservationists engage to translate between analog and digital systems of representation. A central part of this work involves engaging with the invisible and inscrutable video signal, a continuously varying voltage encoded within the magnetic oxides of reels of video tape. Framing this labor as "signal work" helps to recover the otherwise invisible intellectual aspects of this type of technical labor. Furthermore, understanding technical work in libraries can contribute to ongoing debates in information studies and the digital humanities on the relationship between "doing" and "signifying" in terms of scholarly production (Cecire 2011). These debates hinge on definitions of what counts as scholarly knowledge production, how the creation of digital projects should be judged in relation to the production of texts and primarily linguistic modes of scholarly communication. With the rise of digital scholarship labs in academic libraries, which engender closer collaborations between librarians and research faculty, better understanding the intellectual contribution of technical labor can help to recover the intellectual contribution of library staff to the digital projects that they facilitate.

Valuing Library Labor

The visibility or invisibility of labor depends not only on the particular tasks and skills associated with the work itself but on the cultural structures within which that work is carried out. Distinctions between manual and mental labor depend on the classification of labor practices and related skills in job descriptions, which shape how a given job fits into the hierarchies of the wage economy. How particular types of labor are valued in the library impacts how workers are treated and compensated (DLF Working Group on Labor in Digital Libraries 2018). For instance, if digitization is perceived as "merely" manual labor, then it is easier for administrators to rationalize the use of contingent laborers in short-term grant-funded projects or the use of student workers paid at minimum wage (Williams 2016).

The supposed immateriality of digital labor depends on changes in the structure of economic relations associated with the rise of neoliberal economics and the transition from a Fordist to post-Fordist global economy, in which libraries are now embroiled. Siobhan Stevenson (2011) suggests

> the clear distinction within Fordism between the manual (material) labour performed by the automated assembly line worker, and the intellectual (immaterial) labour of the manager, product designer, or engineer no longer exist. In today's information-based service economies, the demands on workers are increasingly intellectual and immaterial. (776–77)

At the same time, as we shall see later in this paper, digitization offers a counterexample of labor that is both intellectual and material, further destabilizing these assumed categories.[6]

In attempting to understand how librarians fit into this emerging economic climate, Douglas Raber (2003) has conceptualized librarians as "organic intellectuals," following Marxist philosopher Antonio Gramsci, claiming that "they play an ideological and organizational role in maintaining a historic bloc's hegemony over the relations of economic production and civil society" (35). The intellectual status of librarians and their wider social impact is important to note, especially in terms of how this contributes to maintaining structures of power. However, this does little to offer insight into how different types of library workers are assigned power and prestige within their institution. If we consider the creation of digital copies of library materials as productive labor (i.e., producing commodities), then the modern capitalist relations between intellectual, managerial, and productive forms of labor are at play. Digital library workers are thus classified based on their relation to the production of digital copies, with the technicians who are engaged directly in the physical labor of digitization valued differently than other employees, such as administrators who plan and manage projects.

Considering the dematerialization of labor and the unstable, intellectual classification of library professionals, it is not surprising then that technical work is often outsourced or assigned to temporary workers. This is particularly true of digitization projects, which often rely on grant funding, employing student or short-term employees. This is not to say that some digitization labs are not fully staffed, but that the perceived nature of the work makes it easily fashioned into contract or temporary labor.

Better understanding the current status of technical labor can benefit from drawing on library and information science (LIS) research that uses social practice theory to study workplace practices in context and considers workers' embodied, multisensory, and socially shared ways of knowing. Sundin and Francke (2009) define practice as the "various manifestations of repeated activities, including historical, social, cultural and material ones" (para. 6), and social practice theory privileges the body and forms of embodied knowing, including know-how, skills, and tacit understanding (Schatzki 2001). These dimensions of information practice are typically overlooked in traditional cognitivist approaches that focus on individuals within a narrowly defined conception of information behavior. At the

same time, social practice theory extends the focus of analysis beyond individuals to include "the accountability of a shared way of doing" (Corradi, Gherardi, and Verzelloni 2010, 277), that is, the socially shared aspects of a "practice" that make human activities meaningful within institutional and professional contexts. Practice theory has been applied in information literacy research, particularly in the work of Annemaree Lloyd (2007, 2009, 2010, 2011, 2012) and others (e.g., Sundin and Francke 2009; Tuominen, Savolainen, and Talja 2005). Practice theory has also seen fruitful application to studying the information practices of blue-collar technicians (Veinot 2007), and it allows us to consider a range of information-related tasks that are often invisible, including "the physical manipulation of tools and documents in virtual and physical spaces, as well as emphasizing the specificity of interfaces" (Lischer-Katz 2014b, 1102).

This research also draws on approaches from workplace studies research (e.g., Barley and Orr 1997; Luff, Hindmarsh, and Heath 2000), which often adopt an ethnographic perspective to studying laborers in various types of workplace contexts, including technical workers, such as photocopy machine repair technicians (Orr 1996). Drawing on approaches from social practice theory and workplace studies, this paper seeks to recover one type of technical labor, analog video digitization, as a form of library work that embodies mental and manual activities and is both intellectually and materially productive.[7]

Work, Technical Knowledge, and Practice

Mainstream discussions on the knowledge economy and knowledge work tend to obscure the actual workings of any specific workplace activity. This is particularly true of technical work, which is an uneasy blending of expert knowledge and manual dexterity. Rennstam and Ashcroft (2013) suggest,

> Traditionally, knowledge has been linked to certain kinds of work and workers, evident in the common labeling of scientific, technical, managerial, and consulting occupations as "knowledge-intensive" labor performed by "knowledge workers." . . . Blackler (1995: 1023) advised that the study of knowledge work should entail reflection on the category itself, "a broader debate about the nature of expertise and of the changing systems through which activities are enacted." (4)

Understanding the nature of work depends on rethinking existing categories and looking closely at what is actually happening in the carrying out of work in context. The lack of knowledge in the field of librarianship about the technical work that is being enacted in libraries makes it difficult for library professionals to argue for a rethinking of how it is valued. Karen Gracy (2004) has argued for an ethnographic approach to studying the work conducted in archives, which makes it possible to study "processes and practices *in situ*—within communities of practice—rather than as idealized conceptions of archival theory" (336). She has successfully used this

approach in her research on the technical labor of film archivists (Gracy 2007), which provides a useful guide for generating rich empirical data on the technical work being conducted in other types of cultural heritage institutions.

The field of workplace studies also offers some approaches for looking at work in technical contexts, also employing an ethnographic lens to gain rich insight into the workplace activities and the meanings shared by groups of workers of various fields. For instance, Julian Orr's (1996) ethnography of photocopier repair technicians shows how the technical work of repair involves a social network of knowledge sharing among the community of technicians, their embodied engagement with troublesome electromechanical systems, and their ongoing development of tacit knowledge (i.e., knowledge that is difficult to verbalize, formalize, or record, and is often only gained through the experience of carrying out a particular activity). In the sciences, too, this distinction between the work of the technicians who calibrate complex instrumentation and the scientists who do the "real science" is widespread (Barley and Orr 1997). Science and technology studies researchers have led the way in investigating the tacit, embodied, and *situated* (Suchman 1987) knowledges that are often overlooked in traditional definitions of knowledge in work mediated by digital technologies. Wanda Orlikoswki (2008) continued this work and brought a practice approach to technical workplace contexts.

LIS research that utilizes social practice theory contributes to this rethinking of technical activities by studying information practices in contexts of work.[8] Notable examples of workplace research in LIS that utilizes a practice theory approach include research on power company workers (Veinot 2007); firefighters (Lloyd 2007); ambulance workers (Lloyd 2009); renal nurses (Bonner and Lloyd 2011); and library staff engaged in digitization work (Lischer-Katz 2014b). Embodied knowledge and the role of the body is likely involved in all types of work, and information studies is seeing increasing interest in considering this type of knowledge in a variety of contexts (e.g., see Cox, Griffin, and Hartel 2018 and their special double issue of *Library Trends* that considers rethinking the role of the body in LIS research).

Research Context: Analog Video Preservation

Analog video recordings throughout their history have contained content ranging from news footage and other broadcast television material, to avant-garde video art, documentaries, community access content, home movies, and many other types of audiovisual (AV) material. Since its first public demonstration by the Ampex Corporation in 1956, analog video signals have been primarily stored on magnetic tape, an inherently unstable medium, which has necessitated the large-scale migration of video content onto new media carriers over the years (Martin 2005). The preservation

of motion picture film also relied on the duplication of films onto more stable formats (from nitrate to acetate to polyester-based celluloid), and this history has informed how video preservation has been approached by preservationists. In 2003, Paula De Stefano (2003) argued that

> the problems encountered in video reproduction and preservation are just as troublesome and require the same, if not more immediate, attention as those encountered in motion picture film. Video formats and playback equipment are equally diverse and, even more so than motion picture film, present a formidable preservation problem because they are less stable over time and because duplication choices for video are less reliable as preservation formats. Whereas moving images recorded on chemically unstable nitrate and acetate film bases can be transferred to a chemically stable polyester film base, the current hunt to identify transfer media to preserve early video materials remains frustrating and problematic. In addition, obsolescence of the playback equipment is a greater problem for video formats and digitally produced moving images than motion picture film. (130)

For years, the preservation of analog video tape involved copying to other tape formats. While a preservation format was never officially codified as a standard, libraries typically preserved their analog video tapes (recorded on VHS, Umatic, etc.) to more robust professional formats, such as Betacam SP, and later Digital Betacam (encoded digitally, but still recorded onto magnetic tape). In the mid-2000s, conversion of analog video tape to digital formats became seriously considered as a solution, since conversion to digital code reduced the problems of analog noise, distortion, and signal loss that tended to accumulate every time video is transferred from one analog format to another. In 2007, McDonough and Jimenez (2007) suggested, "Digitization holds the promise of preserving the electronic signal intact, rather than subjecting it to decay at each future migration" (168). During this time, most video conversion work was still being conducted as tape-to-tape transfers; however, with the rise of file-based production workflows in the television and film industries, increasing familiarity and comfort with file-based preservation encouraged preservationists to shift to copying analog video tapes directly to digital files.

The work of moving from analog signals to digital code requires significant technical expertise to competently engage with the complex configuration of analog and digital tools of the digitization system. In the case of analog video digitization, this can include video playback equipment (tape decks and various system components), analog and digital scopes and meters, audio mixers, signal processors, time base correctors, video monitors, digital capture cards, and capture software. Each component can involve important decisions made by the preservationist that shape the resulting copies. Film archivist and theorist Ray Edmondson (1995) has pointed out that

> the very nature of AV media gives rise to peculiar ethical issues. For example, when a film is copied for preservation from a deteriorating base to a new one, the process—however scientific or exact—always involves subjective artistic and technical choices in which the manipulation or loss of some of the image and sonic content are available options. The loss of screen or sound quality is in effect the loss of information—the equivalent of removing vital pages from a book. (251)

This raises a variety of questions about how to respect "the original" in the process of copying. The original itself may be a copy (e.g., from a negative, in the case of film), which complicates matters further, as this requires the preservationist to consider whether they should preserve the information on the medium in its current, possibly degraded condition, or attempt to restore it to an earlier, more ideal state. Should a scratched film frame be restored? Should a video be color-corrected? These types of questions can be answered in different ways depending on the context of preservation, the views of the preservationists, and the expected users of the digital copies. The production of copies, then, is not an automatic or neutral practice, but one that relies on a set of professional and institutional practices and policies to ensure the creation of "legitimate" copies.

In this sense, digitization for preservation purposes could be seen as a form of "knowledge work." Dahlström, Hannson, and Kjellman (2012) argue for understanding "library digitization as a knowledge organization practice—comparable to, e.g., descriptive cataloguing—and therefore a signifying practice rather than a neutral, unconditional and mechanical one" (457). Practices of digitization also leave traces of themselves on the digital copies that are produced. Bonnie Mak (2014) has emphasized that digital copies can be used as evidence of the particular historical moments in which they were produced, just as medieval manuscripts or microfilmed newspapers can be studied as documents of particular cultural and historical moments of translation into new material forms. Paul Conway (2015) has pointed out how the products of digitization projects and the collections developed around them become cultural objects in their own right, evidence of the methods of copying that were used as well as assumptions made by digitization staff about how they expect users to engage with the copies in the future. The way in which the digitization work is conducted also has implications for how scholars will be able to access the content in the future, as projects using mass digitization techniques to scan books have been shown to embed significant quantities of errors (e.g., illegible or missed pages) in the digital copies produced (Conway 2013).

Digitization practices are not neutral, and how they are carried out involves judgments on the part of digitizers that will impact how those digital copies will appear for future users. The work of digitizers can be viewed as a form of knowledge production that blends intellectual and material labor. This suggests the importance of looking closely at the practices that

digitizers engage in. According to Karl Marx (1967), the economic value of any commodity depends on the social relations and the productive labor that produced it. In this sense, digitization can be viewed as a productive activity that creates new information objects through processes of copying that replicate the particular social conditions of production. Libraries and archives use these copies to expand access to their collections through digital library projects or to ensure long-term preservation of decaying materials. In most library and archival contexts, the digital copies are considered as surrogates for existing collections rather than as new commodities; however, as digital files, like any digital file, they are able to circulate globally and become licensed, monetized, and commodified. In the age of Google, users' engagement with digitized cultural heritage objects also become occasions for collecting and monetizing data on user behaviors (Thylstrup 2014). Understanding the labor that produces them gives insight into emerging relations of production in the so-called postindustrial economy. As the following case study will demonstrate, through the concept of "signal work," we can develop new understanding about the role of technical labor in digitization projects, which shows how labor in cultural heritage institutions can be both intellectually and materially productive.

The Case of Artisanal Analog Video Digitization

The work of digitizing complex visual documents, in this case analog video recordings in small-scale, high-quality artisanal production, provides an appropriate context for examining how the technical work of digitization is carried out and the ways in which epistemological assumptions about the nature of information become embedded in the resulting digital copies. The main research objective of this research is to understand the processes of knowledge construction of media preservationists engaged in the work of the artisanal digitization of analog video tape recordings.

Theoretical Framework

This research adopts a social constructionist perspective and draws on concepts from social practice theory (Schatzki 2001), taking the body as central to knowing and the unit of analysis at the level of socially shared practices composed of acting and understanding within a community of practice (Wenger 1998). It also employs concepts from Reiner Keller's (2013) sociology of knowledge approach to discourse (SKAD). Keller elaborates on Foucault's (1970, 1972) concept of *dispositif*, defining it as the material configuration of human agents, tools, and discourses "that are the basis for the production of a specific discourse and/or for the production of a discourse's power effects, its interventions into the world" (52–53). Dispositifs are objects through which discourses gain material reality, in the form of such things as architecture, technological artifacts, classification systems, standards, regulations, etc. Dispositifs are also

activated through particular material practices that contribute to the materialization of discourses. This conceptualization supports the integrated analysis of discursive and material practices in studying the work of media preservationists digitally reformatting analog videos and their practices of knowledge construction.

Methods

Data were generated for this project as part of the author's dissertation research between October 2015 and December 2016 from thirteen media preservationists (eight digitizers, four administrators, one quality-control specialist) recruited from six preservation labs. Data were generated in the form of discourses and observations of their material practices by conducting semistructured interviews, video-recorded observations and think-aloud sessions, and review sessions in which participants reflected on the video recordings of their workplace practices.[9]

Sites and Participants. The selection of sites and recruitment of participants was guided by the theoretical concerns of this research and by the author's own familiarity with the field of preservation. Having been involved in the preservation field from 2005–2012, the author has first-hand knowledge about ongoing projects, familiarity with the types of locations in which digitization is typically carried out, and professional contacts at a range of potential research organizations carrying out digitization projects.

Sites of artisanal digitization were selected based on the following criteria:

- The digitization of analog video recordings is currently being carried out.
- The mode of digitization is highly skilled and of low output (termed here "artisanal").
- Institutions are committed to preserving the informational and aesthetic values of visual documents (based on their public mission statements posted on their websites).

Identification of sites of artisanal analog video digitization based on these criteria followed a three-step process:

- Organizations that preserve film and video collections were identified by consulting the organizational member directory of the Association of Moving Image Archivists (AMIA), which is the largest North American professional organization for preservationists working with film, video, and digital media collections in libraries, archives, and museums.
- From this initial set, organizations were identified that are presently conducting digitization projects involving analog video recordings. This involved searching the websites of potential organizations to find any information indicating that they were conducting these types of projects.
- Organizations were contacted to confirm that they were currently engag-

ing in artisanal digitization projects and that they would be willing to allow access to their preservation labs.

The following final set of six organizations (all are nonprofit organizations) was formed, with each matching the criteria noted above (U.S. region is noted in parentheses): Site L1: a large art museum (Northeast); Site L2: a small community video production and preservation center (West Coast); Site L3: a small video and media art distributer and archive (Midwest); Site L4: an audiovisual media preservation project (West Coast); Site L5: an audiovisual preservation lab at an academic library (Northeast); and Site L6: a small community media and video art archive (Midwest) (see table 1, "Profiles of research sites," below).[10]

The six sites selected for this research all share some common characteristics and are also distinctive in several significant ways. In terms of similarities, they all express a commitment to preserving analog video recordings in terms of their aesthetic and/or documentary values, as evidenced by their institutional missions statements; they each operate at a small scale of digital reformatting, as demonstrated by their relatively low output and highly skilled production practices; and each employs highly skilled labor, as evidenced by the fact that all of the participants recruited for this study have advanced academic degrees.

While they share many common characteristics, the six sites selected differ in terms of their geographic location, institutional characteristics, and their histories of carrying out digitization initiatives. In terms of geographic location, Sites L1 and L6 are both in the Northeast region of the United States. L1 is located in a large city, New York, while L6 is in rural New York State. Sites L2 and L5 are both located on the West Coast of the U.S., in the San Francisco Bay area, with Site L2 in the Mission District in San Francisco, and L5 on the campus of the University of California, Berkeley. Sites L2 and L7 are located in the Midwestern region of the United States, both in the city of Chicago. This diversity in locations provides insight into how the practice of artisanal digital reformatting is geographically dispersed.

Each site has its own institutional identity that is shaped in part by its particular focus on the preservation of certain types of visual materials (as articulated in mission statements found on official webpages) and how it conceptualizes the types of materials it preserves. Site L1 collects materials considered modern or contemporary art; Site L2 preserves media art, primarily analog videotape; Site L3 preserves media art and distributes copies to educational institutions; Site L5 preserves all audiovisual formats that are sent to it by partner organizations; Site L6 preserves all audiovisual formats that are owned by the library that it is housed in or that are brought in by faculty members from across the university; and Site L7 preserves media art and community-produced documentary footage. Site L1

Table 1. Profiles of research sites

	Location	Commitments to preservation from Mission Statements	Year Institution Founded	Digitization Initiatives Started	Collections Being Digitized	Formats Observed Being Digitized
Site L1	New York City	"establishing, preserving, and documenting a permanent collection…" "Recognizes all forms of visual expression, including painting and sculpture, drawings, prints and illustrated books, photography, architecture and design, and film and video…"	1929	~2011	~1,600 video tapes were digitized	Digibeta Tape Copied from 1/2" Open Reel, to Digital File
Site L2	San Francisco	"works to preserve and digitize precious works of media art and other cultural artifacts"	1976	1994 for video tape; File-based digitization workflow: ~2008.	Preserves documents from collections of other organizations	Analog Video formats: ½" open reel, Umatic ¾", Hi-8
Site L3	Chicago	"dedicated to fostering awareness and scholarship of the history and contemporary practice of video and media art through its distribution, education, and preservation programs."	1976	2009	6,000 tapes, "video art"	½" Open Reel Analog Videotape
Site L5	Berkeley, CA	"undertaking an urgently needed project to digitize, provide online access, and preserve historic California audiovisual recordings."	2010	2011	Tapes and films sent to them through partnerships with 127 archives and libraries	Quality Control: VHS video, 16mm film
Site L6	Ithaca, NY	"the American Institute for Conservation (AIC) Code of Ethics and Guidelines for Practice."	1986	2012	Have digitized ~1700 items; expect to digitize ~2000 per year when operating at full capacity. Collections include ¼" audio tape; cassette; DAT; LP; VHS/ SVHS; Umatic ¾"; Betamax DV/MiniDV	VHS Video, Umatic ¾"
Site L7	Chicago	"to preserve audiovisual records of history and culture and to engage audiences with their creative reuse"	2003	2006	7,000 analog video tapes of video art and local documentaries	VHS Video

is a large, internationally renown modern and contemporary art museum; Site L2 is a small hybrid media education and preservation organization that digitizes media art produced by the local, national, and global arts communities; Site L3 is a small distributor of media art to educational institutions, and it preserves analog video tapes and makes digital copies to support those efforts; Site L5 is a small grant-funded preservation project that works with over a hundred different archives across the state of California and helps them digitize their collections with the assistance of outside vendors; Site L6 is a small audiovisual digitization lab in the preservation department at a large research university; and Site L7 is a small media archive that preserves its own collection of media art and community documentary footage, while also offering its services for hire to other organizations. Site L1 is a significantly larger organization than all of the others, has a longer history, and is better equipped with the resources necessary to deal with a complex array of media art works. At the same time, Sites L2, L3 and L7 have been conducting digital reformatting projects longer than Sites L1, L5 and L6, which suggests that they have had more time to develop codified knowledge around artisanal digital reformatting techniques.

In summary, each of these sites can be seen as a unique setting in which preservationists must negotiate tensions between the techniques of copying with the institutional complexities of maintaining the aesthetic or documentary values of the work. This provides the opportunity to examine the same emergent social phenomenon within organizations that have different institutional characteristics, approaches to preservation, and collecting policies. While each institution is unique, it is clear that they are similar in that each employs small teams of highly skilled preservation professionals to digitally reformat complex visual documents.

Participants. Research data was generated with participants (interviews, video recordings, observations, etc.) in the spaces of the digitization labs where the work of artisanal digital reformatting is enacted. Gaining access to the site was accomplished through contacting the administrator in charge of each site, and the participants were recruited by having administrators distribute the IRB-approved recruitment letter. Information was collected on participants' educational backgrounds, position titles, and their institutions (see table 2, "Participant information," below).

In each site, research was conducted within the lab spaces in which preservationists conduct the work of digitization. Semistructured interviews were conducted following the project's interview protocol with the preservationists engaged in the work of digitization (these participants will be henceforth referred to as "digitizers," as they are the employees at each site directly engaged in the process of digitization).[11] They were observed as they carried out their work, and a video camera was used to record their

Table 2. Participant information

ID	Location	Institution Type	Job Title	Self-Identity
P1_L1	Northeast	Conservation dept. of a large art museum	Assistant Media Conservator	Media Conservator
P1_L2	West Coast	Small community video production and preservation center	Preservationist	Video Preservationist
P2_L2	West Coast	Small community video production and preservation center	Preservation Project Manager	Preservationist
P3_L2	West Coast	Small community video production and preservation center	Preservation Technician	Moving Image Archivist
P1_L3	Midwest	Small video and media art distributer and archive	Digitization Specialist	"Doesn't think about it."
P1_L6	Northeast	Audiovisual preservation lab at the academic library of a large research university	Collections Analysis Assistant	Archivist
P3_L6	Northeast	Audiovisual preservation lab at the academic library of a large research university	Lab Manager	Audio Engineer
P1_L7	Midwest	Small community media and video art archive	Video Technician	Video Archivist / AV Archivist

physical activities throughout the workflow of digitization. Their built environment and the infrastructural elements of the digitization labs, including the types of equipment, tools, and visual displays that participants used in their work of digitization, were photographed and analyzed.

Data Analysis. Data were analyzed using qualitative-interpretive methods, including discourse analysis. Interviews, observations, and review sessions were transcribed and then coded using qualitative data analysis software, MaxQDA. Data coding began by establishing *a priori* codes based on the theoretical framework, and by employing grounded theory procedures to draw out emergent codes from the data. Keller (2013) recommends the use of grounded theory tools to give structure to discourse analytic projects, such as using open-coding procedures and axial coding (Charmaz 2006). The coding of data generated from interviews and observations was also informed by insights drawn from earlier research that was conducted on preservation practice (Lischer-Katz 2014a) and discourses of preservationists (Lischer-Katz 2014b), as well as a pilot study. The pilot study was conducted on October 22, 2015, at the preservation department of an academic library. Three participants were interviewed and were observed as they conducted the work of digital reformatting. The pilot study helped to develop an initial coding scheme for the project and enabled the refinement of the interview and observation protocols.

Because of the emergent nature of a qualitative research design, data analysis went hand-in-hand with data collection (Creswell 2014). Review sessions with digitizers were scheduled after interviews had been transcribed

and coding had begun, so that the coding process could be shaped by new data generated by participants' reflections on their actions captured in the observation videos. Audio from the interviews and video recordings were transcribed. Video recordings were reviewed, and key moments of decision-making (e.g., when participants were looking at video monitors and making adjustments to the video signal), were identified for in-depth analysis and coding. At these key moments, the participant's actions and gestures were noted and linked to the transcript of their verbalizations. MaxQDA allows video files to be imported, transcribed, and coded in one timeline. These data were integrated with the researcher's observational notes and diagrams of participants' workflows that were created in the field. Data analysis followed these steps:

- Step 1: Organize and prepare data: Audio from interviews and videos was transcribed, checked for mistakes, and organized. Researcher notes from visits to each site were organized.
- Step 2: Look over the data: All of the interview transcripts and observation videos were quickly looked over, with emergent codes being developed. Emergent codes were integrated into the initial coding schema. Looking through all of the data at this stage was also useful for evaluating the data for "overall depth, credibility and use of information" (Creswell 2014, 197).
- Step 3: Line-by-line coding of data: Interview transcripts and observation videos were coded based on the *a priori* codes established through initial coding and the initial coding schema, while still being sensitive to emergent codes.
- Step 4: Organizing codes: Codes were examined for relationships to common high-level themes and were grouped into higher-level themes, relating them to concepts from the project's theoretical framework. Drawing on concepts from my theoretical framework helped to shape the organization of codes. The sociology of knowledge approach to discourse (SKAD) was useful for grouping themes related to the circulation and legitimization of knowledge required to properly carry out the work of artisanal digitization. Concepts from social practice theory were helpful for examining the embodied and aesthetic dimensions of participants' practices and how they emerge as legitimate and socially meaningful. Through this process, codes applied to later transcripts were compared with codes on transcripts coded earlier to ensure that the meaning of codes was not shifting significantly by "constantly comparing data with the codes" (Creswell 2014, 203).
- Step 5: Representation of themes. The higher-level themes formed by organizing codes were used to begin to outline the findings section. This outline was used to develop a commentary based on the structure of the themes and subthemes, with illustrative quotes used to support analysis with presentations of data.

Findings

This section presents a selection of key findings from this project relevant to debates on the nature of technical labor.[12] It characterizes the digital labor of artisanal digital reformatting of analog video recordings as "signal work"; describes the epistemological problems that arise in this work; and analyzes how participants integrate different strategies of knowledge construction into their practice in order to overcome these epistemological problems. One major challenge they face is dealing with "errors" in the video signal and determining whether they are inherent to the video or a result of their actions. Errors can range from "drop outs," which appear as horizontal white streaks in the frame of the video image (brief losses of video signal due to scratches, creases, flaking oxide, dust, or other problems that affect the video signal that the playback head picks up), to "flagging," which is often a tape tension problem that causes the top edge of the video frame to shift periodically from side to side (like a "flag" waving in the wind). Additionally, any piece of video equipment is at risk to a host of other problems such as electrical hum due to problems with the electrical supply in the building where they work or issues around the synchronization of sound and image due to improper wiring between system components. Throughout their daily work, they try to establish some degree of certitude in their knowledge around the diagnosis and correction of errors in the video signal. Racks of equipment are common elements of their built environments that structure how they use the space and interact with the various elements of the digitization system (see fig. 1).

Signal Work

As discussed briefly in the introduction, "signal work" refers to a cluster of micropractices and epistemic techniques for carrying out the work of translating visual information from the representational system of analog videotape to the representational system of digital files. The signal in question is the video signal, which is a continually varying electrical voltage generated by playing back a videotape with a video tape recorder (VTR). Within the signal is encoded the video image, synchronizing information, and sound information necessary for displaying audiovisual content on a video monitor.

Through observation of their workplace practices, it became apparent that digitizers can never experience the signal directly (unlike motion picture film, within which each frame can be viewed over a light source). Instead, they must rely on a set of tools for measuring and visualizing aspects of the video signal, which typically includes the following components: (1) calibrated cathode ray tube (CRT) video monitor; (2) waveform monitor; (3) vectorscope; (4) audio meters; (5) video capture software; and (6) software-based visualization tools (see fig. 2). Participants accomplish their work through activating and manipulating the video components

Figure 1. Example of video rack

within their video transfer lab, in which a series of analog and digital components are wired together, with the measurement and adjustment tools placed at critical points in the "signal chain." This allows for the analysis and adjustment of signal characteristics at each stage and for feedback to be obtained on the effects of those adjustments. This ensemble of tools represents a prototypical assemblage of components that was identified by observing participants' workplace settings and how they carry out their work, with minor variations to this prototypical system observed across the different sites studied in this research. This presents a common sociotechnical assemblage that shapes the problem space of archival video digitization work.[13]

The process of translation from analog to digital requires participants to trace the signal flows through this signal chain of components in order to locate the sources of breakdown and errors, monitoring and adjusting

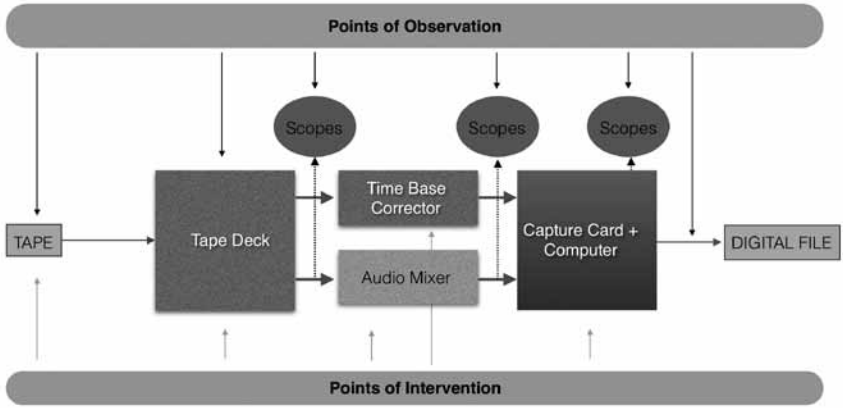

Figure 2. The signal chain

signals at different points during the process of system calibration and during video capture. Digitizers are seen shaping the video signal by adjusting the sequence of video components connected together, often by physically disconnecting and reconnecting wires, integrating knowledge acquired through "points of observation" along the signal's flow with their manual adjustments at "points of intervention" in the signal path. At the same time, within their descriptions of carrying out their work, digitizers define an "epistemology of the signal" in which they work to make signals intelligible under conditions of uncertainty, working to overcome limits to their knowledge about the signal, and balancing subjectivity and objectivity in their decision-making by utilizing measurement and visualization tools and their own expertise.[14]

Points of Observation of the Signal

Digitizers observe the video signal at multiple points along its journey through different components in the digitization system. For example, P1_L1 pointed out that comparing the signal at different points helps to ensure that the signal is consistent from the tape to the digital file:

> P1_L1 (Review Session): We monitor the postdigital signal. Digital and analog. It goes back out analog. We have the signal coming off the deck to compare the two. Uhm . . . So you're measuring on different things just to make sure they are all the same.

Because participants would like to have full knowledge of what is happening at each component in the signal chain, they use CRT[15] monitors and video scopes[16] connected at different points to evaluate the signal at each stage, including at the point where the signal is coming directly off of the VTR (which is in direct physical and magnetic contact with the source videotape), the point where the signal leaves the time base corrector (TBC),[17]

and the point after the signal has passed through the capture card and is encoded into a digital file. Being able to evaluate the signal at each point allows for the identification and remedy of errors (see fig. 2, "The signal chain," above). Being able to monitor and measure signals at each point enables the digitizer to identify any alterations the signal chain may be making to the original signal coming from the tape being played back.

Digitizers point out that signals compared at different points along the signal chain should appear the same, but they admit that since the analog signal is being translated into a different system of encoding (i.e., digital encoding) and display (i.e., a flat screen, high definition monitor), a comparison between the analog original and the digital copy will always look significantly different, and that this inherent difference in the materiality of analog and digital images must be taken into account when evaluating the quality of the resulting digital copy. For instance, while digitizing a tape and watching the monitoring equipment at Site L2, participant P3_L2 reflects on the negative affective experiences of seeing significant differences in the quality of the analog image on the CRT monitor, when compared with the digital image on the computer monitor:

> P3_L2 (Think Aloud Session): It's very frustrating. . . . Sometimes the digitized image looks very different on like a computer monitor, versus a CRT monitor. Like for me, this [*gestures to CRT monitor*] looks great, it looks good. But here [*gestures to same image in capture window of the computer monitor*], it looks kind of grainy.

These perceived differences in how the analog and digital images look is unresolvable and related to the specific materiality of the image-forming systems of the analog and digital worlds, but it still frustrates P3_L2's efforts to produce what they perceive to be the highest quality copy. When comparing the analog and digital images, then, digitizers must learn to distinguish between differences that are attributable to the materiality of the particular viewing technology and differences that may be attributable to a problem somewhere within the signal chain. This is developed through direct experience, "developing an eye" for the different types of visual media, as well as constantly checking signals at different points in the signal chain.

Looking at scopes (waveform monitors and vectorscopes) supports the diagnosis of problems at the signal level. Waveform monitors visualize the voltage of the analog video signal over time, which allows for adjustment of brightness (balancing the whitest white and the blackest black of the image within the constraints of the signal standards for video broadcast); and vectorscopes, which visualize color elements of the video signals (measuring saturation and hue).[18]

P3_L2 spends a lot of time comparing video signals at each point along the signal path. In this quote from P3_L2's review session, we can see how

comparing signals, once learned and integrated into practice becomes a routine that is difficult for P3_L2 to fully quantify, but is shaped by the behavior of a particular tape:

> P3_L2 (Review Session): I'll definitely do it [i.e., compare video signals] a decent number of times during the capture. Sometimes if there's a . . . uhm . . . maybe an aspect of the image that looks problematic to me, I will check more, because maybe I'll be concerned that, maybe I'll be concerned that I over adjusted levels. . . . Especially if there is errors on the tape, that is something I will check for a lot, to be sure that it's consistent with the original, basically.

P3_L2 moves their eyes back and forth, across the monitors and scopes throughout the capture process to ensure that no errors appear in the digital copy. At times, this activity appears routine, but it is also *situated* in that it is shaped by the evolving interactions between the materiality of the tape and the system components, and the emergence of errors in the video signal.

Points of Intervention in the Signal

Digitizers intervene in the signal chain when they calibrate the system; set up the tape for capture ("set up"); and, less frequently, during the process of digitization. Initial calibration may involve running test tapes or signals through the signal chain. Test tapes can either be professionally produced tapes that contain precisely generated video test signals, or they can be tapes that digitizers are familiar with and thus trust that if their equipment is adjusted based on that tape, the configuration will be accurate. These adjustments are intended to get the system back to a neutral baseline, as discussed in P1_L1's reflections during their review of the video recording of their work:

> P1_L1 (Review Session): And here, I'm putting the tape in, looking at bars, and then basically looking at all the systems that are going on to make sure that they are good. You know what I mean? That everything is set, that everything is how I expect, it's going smoothly, as accurately as possible, is kind of what I'm, is what I'm doing at this point.

The use of a standardized test signal produces "color bars"—which P1_L1 refers to here as simply "bars"—on the CRT monitor, allowing digitizers to adjust system components to a signal that follows technical standards and is familiar to digitizers. It allows them to setup their equipment in a familiar way that they understand, so that the system is, in the words of P1_L1, "how I expect." Like other standards that have been widely adopted, using color bars (developed for broadcast television) ensures uniformity and sameness of video signal characteristics across space and time so that a video system can be calibrated, tapes produced, and video signals broadcast to television sets in a standardized and controllable way.

Using test signals or tapes in this way helps digitizers reduce uncertainty about how the complex configuration of components in their signal chain may be impacting the final digital copy.

Having more points of observation allows for more points of intervention in which the digitizer can calibrate each system component to standard color bars and other test signals. The ideal signal chain would have monitors and scopes set up at each point in the signal chain, in order to construct knowledge of the signal, in what some participants refer to as its "native state," i.e., coming directly from the videotape playback. P2_L2 lists all the components in "the ideal" signal chain and how they should all match if they are properly calibrated:

> P2_L2 (Review Session): You know if you're doing an off-deck comparison to a postdigital comparison, and the deck doesn't have a TBC and you're going through a TBC, uhm, you might be better off with a post-TBC digital comparison. Or you might want to have all three if possible, so you can see what the signal looks like in its native state, what the signal looks like after you've made your adjustments, and then what the signal looks like after you've captured it. . . . I think depending on the format, and the deck, and the machine you're using, and the TBCs we have, those things will kind of vary but, I like more, because I like to look at it all.

P2_L2 wants total knowledge of the signal ("I like to look at it all"), including how it looks coming off of the tape (the "native" signal), the signal being adjusted, and the final signal at the point of digital translation.

Once the digitization system has been calibrated and the signal chain can be trusted to produce predictable results, digitizers load a tape into the VTR, play back portions of the tape, and adjust the system to compensate for any errors that may appear. This is an iterative process of running the tape, monitoring the signal on the CRTs and the scopes, and making adjustments that they determine to be necessary:

> P3_L2 (Interview): When I'm studying the TBC, I'm normally watching the analog scope, but then I'll compare it to digital and be like, "Oh, this can come down a notch." And then I'll go back and be like, "Oh, go up a notch." It becomes a very fine line between being perfect, and then I'll check the deck and I'm like, "Oh, the deck is a little bit darker," and, "Oh, then that's too low."

Errors in the signal can occur at any point along the signal path, including at the VTR or later on in the signal path at the TBC. Once errors are observed, digitizers can intervene in the signal. This can be accomplished by swapping out equipment, as mentioned earlier, or by adjusting settings on one or more components in the signal chain. At the VTR, there are tracking controls, skew controls, and tape guides that can be adjusted in order to optimize the contact between the video head and the recorded video tracks on the tape. At the TBC stage, digitizers can make

adjustments to the timing of the signal (which affects the position and stability of the resulting image on the screen), the chroma (color), and luminance (brightness) levels to ensure that they are within the guidelines established for "broadcast legal signals." In this case, digitizers have to interpret the abstract visualizations on the waveform monitor and vectorscope, which charts the video signal's timing, voltage, and phase. Any adjustments made at the TBC can be evaluated by looking at these scopes, as the visualization of the video signal can be shown to change at the same time as the adjustment is being made. For instance, P1_L1 explains the process of adjustment as one characterized by calibrating, monitoring the signal on the scopes, and then making adjustments to bring the video levels into accordance with the standard guidelines:

> P1_L1 (Think Aloud): I would set up to bars, if there were bars [i.e., recorded on the tape], I would set up to them. And then go into content. So you can see here, we're going above 100 there, with the titles, and the blacks are a hair above too. So we're hot. . . bring the whites down. [*adjusting controls while looking at scopes*] Because it's a pretty white background. [*looks back at the video monitor to examine the image*] So that looks pretty good. I'm just going to go back to the titles again. So I brought the whites down "negative 7."

In this description of digitization work, P1_L1 talks about adjusting the equipment to the video test signal that is sometimes recorded at the beginning of a videotape. In this case, P1_L1 looks at the waveform monitor and notices that the luminance part of the signal is too high ("too hot") and reduces it. The "whites" (the peaks of the video signal) and the "blacks" (the lowest visible parts of the signal) are both observed on the waveform monitor as being outside of the measurement points where they should be, so P1_L1 adjusts the signal accordingly.

As seen in this typical example, digitizers must coordinate their hands (adjusting the controls of the TBC) with the movement of their eyes, which they use to evaluate the effects of the adjustments on the scopes, as they scan back to the CRT monitor to see how the video image is affected.

In the following example, participant P1_L3 describes the process of monitoring and adjusting the video image as the tape deck is playing during the setup phase of digitization work:

> P1_L3 (Think Aloud): [*Adjusts skew control on tape deck, and thin line of horizontal static moves through the center of the video image on the CRT monitor*] So, I'm getting a lot of this flickering, skewing at the top. And that usually has to do with the skew adjustment, so I can kind of stabilize it. And then this bar of static [*points to horizontal bar of static across the bottom of the CRT monitor*], I can bring that down with the tracking knob. And when I adjust that, it also starts to steady . . . we're actually getting a lot of flicker here [*Points to top of the video image*]. I noticed that the TBC I'm going through tends to enhance that effect. So, if I send it through a different TBC, it will look different. [*Stops tape play-*

> *back and swaps out cables on one TBC and patches them into another TBC in the rack*]. So that's the plus side to having two different TBCs. Then again, these are the only ones we have that seem to be able to handle the signal. [*Starts tape playback again*] So, now it's a lot darker, but it's a lot more steady, I think.

This example illustrates the ways in which signal work combines comparing and matching of video images, swapping elements in the signal chain, and making decisions about how to produce the highest quality image that best represents the original recording, oftentimes requiring a subjective decision on the part of the preservationist to decide what *looks* like the best quality given the physical condition of a particular tape. In this case, the participant must rely on personal aesthetic judgment to decide whether a darker image is preferable to one that is unstable and flickering. At the same time, digitizers try to remove their own personal aesthetic taste from their work as much as possible in order to create a digital copy that is an "authentic" translation of the original using the video scopes, even if the resulting copy does not look exactly how they would personally prefer it to look. P3_L2 describes making an effort to be aware of their personal taste interfering with the ability to be objective in the production of digital copies that accurately reflect the original video recordings:

> P3_L2 (Interview): I always aim towards more saturated color, and other people don't. But just because I like really vibrant colors doesn't mean that I get to have them. But, that's where, like, scopes obviously come in really useful as well, because it can be hard. Sometimes I won't even realize that I'm leaning in a certain direction, but then I will.

P3_L2 expresses the need to always be self-monitoring during the process of carrying out the work in order to ensure that adjustments to the video quality are not being carried out based on personal taste. P3_L2 goes on to explain the rationale behind focusing on objective measurements provided by the scopes, rather than relying solely on one's eyes and taste to evaluate the image presented on the video monitor:

> P3_L2 (Interview): Because we're not here to improve an image, either, as much as we might want to. But I very much believe that if something's recorded to look bad . . . I mean, that's, it's not our . . . If somebody at a later point wants to make, you know, improve on this footage, well, then go ahead. But that's not our place. Our place isn't to improve anything. It's to preserve an image the way it was recorded.

P3_L2 is suggesting that employing objective measures (i.e., using the scopes) helps to ensure that the video is adjusted in a way that maintains the visual quality of the original, which may involve restraining one's self from "improving" a video signal that was "recorded to look bad" (i.e. not up to broadcast video standards), which happens often in avant-garde video art and community broadcasting material.

Epistemology of the Video Signal

As can be seen from digitizers' descriptions of their signal work, competently carrying out the work of digitizing analog videotapes relies on a complex configuration of equipment for playback that can produce puzzling outcomes, such as visual errors or other problems that the digitizer may need to investigate. Unexpected and unexplainable errors are more likely when dealing with decaying tapes, since tapes with damage can produce unstable video signals that behave in unpredictable ways. With more experience working with decaying tapes or a range of tape formats, digitizers develop an understanding of what to expect when a certain videotape format from a particular time period is played back (i.e., older tapes are typically more susceptible to decay). Even as digitizers become increasingly knowledgeable about how different types of tapes will behave, there are always limitations on the degree of certainty that digitizers can have about what is happening in the signal chain when they are attempting to make an appropriate intervention. Because video images are invisible at the level of the magnetic inscriptions on the tape and at the electrical signals prior to display on the CRT, the images cannot be observed directly and digitizers are only able to "know" the signal through their tools of visualization, i.e., their scopes and monitors. The signal chain and the configuration of components that structure it produce results that are indeterminate and often resist full understanding by digitizers.

For video preservationists, this means that "the signal" is often perceived as resisting complete knowability, requiring evaluation and interpretation of what the original recording might have looked like at the time of creation and what may be the best copy possible at the present moment, given the current condition of the tape. The original recording is difficult to reconstruct because of the indeterminacy of the signal and the gaps in their knowledge about what is shaping the signal. Digitizers' efforts to carefully produce digital copies correspond to what Bonnie Mak and Heather MacNeil (2007) identify as a key archival value of "authenticity," which in the age of digital documents, must be maintained through "an ongoing process in which librarians and archivists construct and reconstruct authenticity in accordance with their understanding of the nature of those resources and current conventions for managing them" (47). In the work of digitizers, we can understand their efforts to be "neutral" and "to preserve an image the way it was recorded" in terms of reconstructing the "authenticity" of the original in the resulting digital manifestation. This is accomplished through the use of a range of epistemic techniques.

Epistemic Techniques

Earlier analysis of the work of the digitizers discussed in the present study had identified a set of *epistemic techniques*, "arrays of sensory-cognitive micropractices that participants enact in order to construct knowledge

about [the video signal], act upon the video signal, and produce 'legitimate' digital copies of analog originals" (Lischer-Katz 2017b, 744). These *epistemic techniques* consist of "applying calibrated vision; patterned looking; matching and comparing visual representations of signals; historicizing the tape; investigating the nature of errors; and constructing copies" (Lischer-Katz 2017b, 745). Most relevant to the present discussion on understanding technical labor are the last three epistemic techniques, which are discussed in more detail below.

Historicizing the tape describes how digitizers integrate knowledge about the history of a particular videotape format and its historical context so that they can adjust their expectations about the visual quality of the videotape and their sensitivity to errors. P3_L2 offers a telling example of historicizing the tape: "If you know your video formats, and your video history, and the way people were dubbing [i.e., copying], dubbing tapes in the '70s or the '80s. That's all kind of useful knowledge for, uh, ascertaining if errors that you're encountering are native to the recording." By drawing on their historical knowledge of video techniques and technologies and combining this with what they know about a particular tape, digitizers can adjust their expectations about what types of errors they will encounter.

Investigating the nature of errors describes how participants perceived the video signal as a phenomenon that resisted complete knowledge, because it could never be directly observed. Participants contrasted this to motion picture film, which can be viewed frame by frame on a light box with a magnifying loupe: "I can't describe it, but you can definitely get this kind of feeling when something is 'native,' so to speak. When something [i.e., an error] is resolvable, and something isn't resolvable" (P1_L2). Investigating the nature of errors involves drawing on their own experiences and trusting their "feelings" about the source of an error. They have to trust the technical tools they are using and their own judgments, since they cannot view the video image directly, without mediation by the playback equipment.

Constructing copies refers to a cluster of micropractices—detecting, identifying, diagnosing, correcting, and documenting errors—that digitizers engage in to produce knowledge claims about the nature of errors and to document the choices they make in constructing digital copies. This involves integrating "historical knowledge developed about the tape formats and the particular ways in which each can produce different types of errors; distinctions between analog and digital errors; and whether errors are inherent or introduced by the signal chain or human error" (Lischer-Katz 2017b, 746). Digitizers explain that reconstructing an ideal original was not possible because the nature of video recording technology is fundamentally based on practices of copying and recopying, which makes the idea of "an original" illogical. P1_L1 puts this point succinctly: "Well, I mean it's . . . the nature of this work, there is no original. There's

the myth of the original. There's no original." While the nature of video technology complicates traditional ideals about art objects as originals, acknowledging that copying is intrinsic to the medium means that participants understand that their work involves constructing the copies as "legitimate" copies, in their roles as preservation professionals working in preservation institutions.

Role of Institutional Knowledge

While much of the knowledge necessary for carrying out the work of digital reformatting is developed through digitizers' own efforts to "develop an eye" for interpreting video signals and actively reading and learning about emerging knowledge in the field, this work is also structured in many ways by institutional knowledge. Institutional knowledge in this context refers to the stocks of knowledge of institutional actors, accepted methods of digitization, and the configuration of technical artifacts within each institutional context. In each digitization lab in which digitizers work, their development of personal knowledge is shaped by the pre-existing institutional knowledge in place, which is replicated and put into practice through a process of "learning the ropes" and becoming familiar with the processes and expectations associated with how work should be carried out in that institution. This process involves managers or existing staff members showing new workers how to carry out certain tasks and monitoring and correcting their actions as new workers learn institutional workflows and policies. This replicates institutional knowledge over time through the guidelines and standards adopted by the institution and interpreted by institutional actors who train new workers, encouraging them to mimic the actions of experienced digitizers in order to learn the official, institutionally sanctioned techniques of digitization.

Digitizers are introduced to institutional knowledge at the time when they join the organization and learn to do the work in their particular work site. More experienced workers begin by showing new workers how to do the work, encouraging imitation:

> P1_L6 (Interview): Well, I guess I had someone when I first started, someone showed me what to do. And I guess just trusting that. Uhm . . . of course, I have heard differing opinions, and, but I really don't have any fear as to like voltage, based on watching other people do it, and not get shocked or electrocuted. Uhm . . . and, now, I do sort of wonder whether we need to be cleaning the heads after every use, which, there's arguments that it would actually be better to clean it less to prevent the heads from deteriorating faster.

After more experienced workers begin to trust that the new workers are doing the work properly, they will stop monitoring them and will leave them to do their work unsupervised. At this point new workers internalize the watchful eye of the experienced worker and begin self-monitoring. If

they feel like they have done something inconsistent with the established way of doing things, they will stop their work and go find an experienced worker to check any decisions that they are unsure of.

The original source of the institutional knowledge can sometimes be identified, particularly if the individual or group is still working for the institution. When asked about who in the their institution makes decisions about which standards to adopt, P1_L3 explained that they were put in place by the previous person who carried out the digitization work, and that they had become the administrator for the project (P2_L3): "So, you should ask [P2_L3] why he's selected these standards. I have tried to stick with continuity." In this example, we can see how institutional knowledge is replicated by new workers trying to maintain continuity and replicate established methods of doing things in their own work.

In other institutions, the origin of local guidelines is unknown, having been handed down through multiple generations of workers, as P3_L5 suggests: "I was not around when our standards were origin[ally set up] . . . like the technical specs we created, were originally set up." P2_L2, as well, suggests that key elements of institutional knowledge are passed down: "I mean, some of it was passed down from previous people, kind of, QC procedures." QC (quality-control) procedures are typically encoded in checklists or workflow software that are used by participants to structure the QC procedures and make sure that all aspects of a digital copy are evaluated (including whether the audio is synchronized properly, that any visual errors that cannot be corrected are documented, the proper aspect ratio, etc.). These checklists and workflow programs become structuring elements of activity in the preservation lab, institutionalizing knowledge through their incorporation into the built environment of the digitization lab and regulating the work of digitizers. These examples suggest that the personal knowledge of digitizers necessary to enact their practice is partially founded on knowledge that is handed down from one generation of workers to the next, which becomes a shared way of acting and knowing in the digitization lab.

Materializing Institutional Knowledge

The structuring of the built environment encodes institutional knowledge for the present and future generations of digitizers, through defaults and presets on equipment. Once these are established, they may be difficult to change or will become accepted as part of the digitization lab's infrastructure, unquestioned by new workers.[19] Encoding institutionalized knowledge within the controls of the components of the signal chain as "defaults" places constraints on the possibility for human intervention in the functioning of the system. By limiting decision-making through constraining how the systems can function, less training or oversight is necessary for workers, since they are given fewer choices to make, which

appears to run counter to the freedom necessary for the enactment of the epistemic techniques of artisanal digital reformatting. The use of presets resembles a form of *deskilling* in which the necessary mental skills of analysis and decision-making are shifted from the worker to the machine (Orr 1996). In this case, this is accomplished through the restriction of digitizer action to the selection of a limited set of dropdown menus in software settings, or a limited range of adjustments on the video hardware. These presets may have been put in place by earlier digitizers or administrators, or they may be added by digitizers themselves. In the case of one site, L7, the TBC (time base corrector), an important tool for intervening in the video signal was completely black-boxed, having all of its controls (except for audio adjustment) locked to its preset levels. The encoding of human knowledge into presets and default settings, while restricting the activities of participants, has the benefit of reducing the cognitive load of routine decision-making, and helps to prevent mistakes in basic adjustments. Furthermore, these presets are linked to preservation values of authenticity and consistency: "Uhm . . . well we have our defaults set ahead of time, so there shouldn't be too much manipulation" (P1_L6). Using defaults and presets within the technological configuration limits the need for human intervention at key points. This encodes institutional knowledge into the technical infrastructure and reduces the chances of human error or forgetfulness:

> P1_L7 (Interview): You set up something to try to make it simple so that you can, uh, you can adapt to the sort of laziness and forgetfulness of human nature, but we kind of, just as moss and mold will grow if you don't keep up with things, that kind of entropy enters into it as well, I find.

Shaping material forms in order to shape practice fits with a practice theory perspective that acknowledges that the perceived affordances of a technology delimit what actions are possible with it. Andrew Cox (2012) explains how "man-made and other objects' uses or affordances are central to concrete practices" and that "they have a role in shaping practices, because of the way they prefigure what can be done" (179). Presets and defaults ensure that certain forms of knowledge cannot be forgotten, ignored, or circumvented in practice.

The nature of artisanal digital reformatting is in tension with the automation and deskilling associated with mass digitization work, because each tape in a digitization project may need to be treated in very different ways. P1_L3 points out that because the tapes they work with are produced by artists, each is very unique and needs to be treated on a case-by-case basis:

> P1_L3: It's different from doing a "mass digitization situation," because every tape was so different. Every recording environment was different for every tape, for every artist. And so it's very, it's a very "per-tape situation."

By distinguishing their work from the work of "mass digitization," P1_L3 is suggesting that the work of artisanal digital reformatting requires that special attention be paid to the unique properties of each tape, which indicates that there is a limit to what can be encoded in the form of presets and defaults in this context. While important knowledge may be institutionalized, the practice of artisanal digital reformatting still relies on digitizers' trained eyes and hands and their personal engagement with epistemic techniques and situated decision-making to be carried out properly.

Summary

In summary, the work of analog video digitization in the artisanal mode involves a blending of mental and manual labor, and subjective and objective techniques of knowledge construction, as digitizers are seen negotiating a complex epistemological terrain constituted by aging and indeterminate video tapes and the complex assemblage of the signal chain that combines analog and digital tools with multiple points of observation and intervention. Their institutional contexts shape their practice through the installed technology, institutional training and management techniques, and the constraints of presets and default configurations of the systems. Digitizers apply their expert knowledge to negotiate this terrain, and produce digital copies that are perceived as "legitimate" within the context of their professional and institutional contexts.[20]

Discussion

As identified in the empirical findings above, the central focus of digitization work is on signal work, an array of micropractices that integrate manual and mental forms of labor. In order to produce digital copies, digitizers must integrate objective and subjective methods of evaluation and negotiate the constraints of institutionalized knowledge (training regimes, workflows, and technical presets and defaults, etc.). This suggests that this type of technical work, typically invisible, is a blending of intellectual and material practices, which forces the library field to rethink the nature of digital labor. Working with analog video signals and making decisions about how they will appear within the representational system of digital encoding is best characterized as an interpretive act of visual translation, rather than a transfer of signals that can be resolved solely through objective measurements and black-boxed equipment. Unlike Shannon and Weaver's (1949) transmission model of information transfer, the video signals that digitizers encounter in the form of objective, measurable electronic signals and as subjective, visual representations cannot be transferred from one medium to another without human intervention. Instead, these video signals require interpretation by digitizers in order to translate the analog originals to digital copies perceived to be "legitimate" within their professional and institutional contexts.

An integral part of carrying out their signal work is the participant's enactment of epistemic techniques, which integrate embodied and situated knowledge with typified and historical knowledge about video phenomena. Digitizers work to make their visual knowledge standardized and repeatable, even though some of this knowledge is difficult to codify and must be developed through personal experiences. Thus, the epistemic techniques that digitizers put into action in their daily work help them to form cohesive and coherent knowledge in the face of the indeterminate video signal. Developing and enacting these epistemic techniques helps digitizers to become confident in their work. It is within these intellectual processes that the construction of digital objects emerges as a knowledge outcome, a product of artisanal processes that blend mental and manual labor.

Practical and Theoretical Implications

Understanding the entangled mental and manual aspects of digitization work and the lived experiences of information workers has implications for understanding the construction and classification of technical labor in information institutions, helping to draw attention to the hierarchies and divisions that enable its continued casualization and denigration. This knowledge can empower library staff engaged in this type of work to organize and better advocate for the value of their labor. By increasing the visibility of digitization work as both intellectual labor (producing knowledge) and as productive labor (producing digital objects), library administrators will need to rethink how they value and compensate this labor and provide better opportunities for career advancement. If the quality of digital production varies based on the abilities of the workers involved, then it is in the best interests of library administrators to nurture these types of workers to produce the best digital copies possible.

These findings also offer several theoretical insights into questions about the nature of technical work in information institutions and the nature of digital labor as an epistemological process. First, these findings give insight into a typically black-boxed (Latour 1999) context of digitization, understood as digital production, providing new understanding of the complex relationship between "mental and manual" dimensions of technical labor (Barley and Orr 1997) in an emergent context of preservation work. The picture of artisanal digitization that is presented in this research is one of productive labor that constructs new digital objects and relies on physical activities such as loading tapes, cleaning equipment, adjusting knobs on equipment, and swapping cables. At the same time, the work involves epistemological and aesthetic judgments that can be characterized as expert decision-making. This problematizes definitions of "knowledge work," which has been historically seen as nonproductive labor that forms knowledge and provides services, rather than shaping matter into

useful goods (Liu 2004). In fact, artisanal digitization does both: it forms knowledge and it forms new matter as digital copies. Understanding the manual and mental labor of artisanal digitization extends Barley and Orr's (1997) characterization of technical work as taking place "between craft and science." These findings raise important questions about the intellectual labor of digitization, its status as a blend of knowledge production and object construction, and a rethinking of its typically black-boxed status in the context of institutional labor.

Second, by analyzing the material and discursive practices of preservation practitioners as they digitize analog video recordings, this research offers insight into the complex relationship between knowledge production in a community and its materialization within the practices of making. Silvia Gherardi and Manuela Perrotta (2013) develop the concept "formativeness" to describe "the linkage of meaning and matter" (227) in practices of material production. The use of this concept draws attention to epistemological tensions in information research between defining information as an "activity or process of endowing some material entity with form" (Peters 1988, 12) and defining information in terms of the communication of knowledge through the shaping of mental structures. Rafael Capurro and Birger Hjørland (2003) have traced the etymology of "information" from its medieval definition as the ordering of matter in the world, through its modern empiricist and later cognitivist definitions as the shaping of the human mind via sense perception. Applied to the findings of this research, *formativeness* draws attention to the iterative interplay between the unfolding of human meaning-making and the practical work of engaging with the world in order to materialize digital manifestations of visual documents. For preservationists engaging in the practice of artisanal digitization, they are both actively forming knowledge about their work and forming new digital objects in the world as digital translations of analog originals.

Third, these findings offer insights more generally into contexts of visual knowledge construction in which workers make decisions and act under conditions of uncertainty. These insights can be transferred to other emergent communities dealing with knowledge production involving "invisible" or uncertain phenomena in the translation between analog and digital representational systems. Considering the work of video digitization as a form signal work follows Phaedra Daipha's (2010, 2015) research on the "screen work" that meteorologists enact within their practices of knowledge construction using video monitors to display weather simulations and radar visualizations. For digitizers, the present research suggests that signal work is a means for both knowing phenomena in the world and for reducing uncertainty in their work shaping digital copies into meaningful matter in the world.

Limitations and Directions Forward

This study focused on workplace practices and knowledge construction, so it did not generate data on job satisfaction or other affective dimensions of participants' overall work experience. Future studies could investigate how technical workers feel within their institutions, which would enable new understanding about the relationships between technical labor, the valuation of that labor, and the impact on worker morale. For instance, in her phenomenological study on the morale of academic librarians, Kaetrena Davis Kendrick (2017) found "that academic librarians who experience low morale contend with abusers or dysfunctional systems, policies, or procedures from two levels: the immediate library environment and the larger campus climate" (863). Better understanding technical labor will make advocacy that addresses both these levels more effective and help to combat these larger issues that seek to marginalize library labor.

In many ways, the technical work of analog video digitization is very specialized, which may limit applicability of these findings to other types of work. This work is also limited in how much it can tell us specifically about libraries, since only one of the sites studied meets the traditional definition of a library (L5). In many ways, the findings are specific to a particular type of work that unfolds across a variety of information institutions, including academic libraries, museums, and nonprofit preservation labs. By looking at a diversity of institutions engaging in a common type of work, however, this research found a common problem space of practitioners formed around the work of small-scale analog video digitization work that provides a rich portrait of a complex social practice. At the same time, the broader impact of this work in terms of the study of labor in libraries more generally is that it points to a methodological approach that can help give insight into other types of technical work. As Gramsci (1971) has pointed out, all human activity involves intellectual capacities, and it is the social structures that define what specific job roles are or are not treated as intellectual work. It seems likely to assume that other work will similarly blend mental and manual work. The more we can demonstrate this empirically, the more we can make the argument for treating technical labor in libraries with the respect that it deserves.

Conclusion

In this paper I have demonstrated how the practice of analog video digitization is structured around signal work, practices of labor that produce digital copies shaped by the trained perceptual skills and epistemic techniques of preservation technicians. Participants act under conditions of uncertainty and within the constraints of the institutional and technological context of their digitization labs. From this perspective, the creation of digital copies, and by extension, other types of technical work involved in the making of digital projects, is a blending of mental and manual labor.

This has implications for understanding digital labor in libraries and archives, contributes to debates in the digital humanities on the relationship between doing and signifying (Cecire 2011) in the context of how technical work in digital projects is valued, and helps to rethink the value of the invisible technical labor that is essential to creating digital library collections. It is hoped that better understanding of this type of digital labor will elevate the status of digitization and empower practitioners, paving the way for better compensation and conditions of employment.

The case of analog video digitization also speaks to increasing concerns about the status of technical work throughout society, and particularly pressing questions of maintenance and repair in regards to digital systems and infrastructure that are being raised in other fields, such as cultural studies and media studies (e.g., Graham and Thrift 2007; Perlow 2011; Scholz 2012; Parks and Starosielski 2015; Starosielski 2015). The DLF Working Group on Labor in Digital Libraries, Archives, and Museums (2018) suggests "Digital library work is frequently associated with narratives about future-thinking and innovation (Dudley, 2017; Glassman, 2017), yet the role of maintenance in sustaining digital projects and programs may be relatively undervalued (Arnold, 2016; Firunts, 2017; Nowviskie & Porter, 2010; Russell & Vinsel, 2016)" (5). Furthermore, understanding digital labor in relation to digital infrastructure is the tip of the iceberg of a much larger question about environmental sustainability in the age of digitization, digital archives, and cloud storage (Lischer-Katz 2017a).

This area of research emphasizes the importance of studying library labor in the physical sites in which that labor is carried out. The question of how a particular social practice is defined, i.e., what modalities of labor are ascribed to it, has an impact on its social visibility, valuation, and allocation of resources. Rethinking technical labor enables new perspectives on labor in libraries, so often made invisible, hidden in plain sight, or relegated to off-site storage. The future of libraries is tied to the future of research and learning, which are both enmeshed in discourses of labor, knowledge, and their valuation in the dominant world view of "knowledge work" in the age of neoliberal capitalism (McMenemy 2009; Buschman 2017). Perhaps integrating the tools of critical librarianship into thinking about technical work can provide a way out (Gregory and Higgins 2018). Further research should consider how the value of technical and other forms of invisible library labor can be recovered, define the major cultural and political impediments, and activate librarians throughout all sectors of the library to push back against the rising tide of deskilling and devaluation currently facing library labor today.

Notes

1. This paper is an expanded version of "Signal Work: Material Practices and Epistemic Techniques of Video Digitization," chapter 8 of the author's doctoral dissertation: "The

Construction of Preservation Knowledge in the Artisanal Digital Reformatting of Analog Video Recordings" (Rutgers University, 2017).

2. Sites of library innovation are physical spaces in an increasing numbers of academic and public libraries that are being reallocated and reconfigured to provide venues for the use of emerging technologies. In the academic library context, they may be referred to as digital scholarship centers, labs, studios, makerspaces, innovation spaces, or by other names.
3. To be more precise, technical labor is technical *work* that is engaged in as part of an individual's participation in the wage economy. In this paper, the terms are used interchangeably since the technical work being discussed is linked to participants' jobs. This paper adopts Barley and Orr's (1997) definition of technical work, which defines it as work characterized by four loosely associated attributes: "(a) the centrality of complex technology to the work, (b) the importance of contextual knowledge and skill, (c) the importance of theories or abstract representations of phenomena, and (d) the existence of a community of practice that serves as a distributed repository for knowledge of relevance to practitioners" (12).
4. In cultural heritage institutions, the production of digital copies is rarely discussed as the production of commodities. Libraries traditionally provide services and access to resources, rather than acting as producers of commodities. Once digitized, however, objects from cultural heritage collections can circulate and become monetized through digital platforms. One of the biggest digitization projects, the Google Books scanning project, has shown how digitization can be scaled up to the level of mass production through automation and the use of industrial assembly lines. Paul Conway (2015) explains, "today's large-scale digitization programs are relentlessly manual processes that engage a new class of 'information workers,' not unlike the factory operations that fueled the industrial revolution of the nineteenth and twentieth centuries and that continues today" (55).
5. This mode of digital copying is conceptualized as "artisanal," differentiating it from "mass digitization" efforts, such as the Google Books project, that are primarily concerned with producing high quantities of digital output through the routinization and standardization of mass production techniques. Artisanal refers to the scale of production and the quality of the products produced. Elsewhere in the preservation community, this has been referred to as "boutique" digitization (e.g., the Library of Congress uses the term to differentiate between small-scale and mass production techniques at its audiovisual preservation facilities: https://www.loc.gov/avconservation/preservation/). "Artisanal" is chosen in the present article to draw attention to the practices of the digitization worker and to emphasize the "hands-on" and "skilled" aspects of this type of work.
6. This paper treats the distinction between intellectual or mental labor on one hand and material or manual labor on the other as artifacts of the mainstream discourse on work and how it is categorized. From this perspective, mental activities involve primarily processing, interpreting, synthesizing, and otherwise interacting with information and information technologies; and manual work involves primarily physical tasks, such as moving objects, manipulating tools, or other work that produces physical changes in the world.
7. Material production produces physical or digital products that can be consumed or used in some way. They provide utility to the consumer/user and can be bought and sold in a marketplace. Intellectual production refers to the production of intangible goods, such as designs, ideas, texts, information, aesthetic objects, etc. Clearly material and intellectual production are intertwined, since intellectual products cannot circulate without taking material form. For instance, a book is written by an author (intellectual production), but the physical copies of the book are produced in the printing house (material production). History has shown that prestige and financial rewards may be allocated differently to these different types of labor.
8. Cox (2012) suggests that the usefulness of practice theory approaches leads LIS researchers to "think in terms of information in social practice, rather than focus purely on information practices, since information is a feature of almost all activities, but is rarely the center of social actors' attention" (186).
9. Before research began, letters of permission to conduct research at these sites were acquired through contacting site managers and submitted to the Rutgers Institutional Review Board for approval. The project received exempt status on 7/10/15 and received IRB Protocol # E15-834.

10. Site L4 was also visited but was eventually excluded from this research because it was found to be an unsuitable site (i.e., the work of digitization was carried out by nonprofessionals and thus did not fit the definition of artisanal digital reformatting) and sufficient access to the site was not provided for conducting the research.
11. At Sites L3, L4, L5, and L6, administrators who were involved in developing standards and protocols for digitization activities in these sites and were overseeing the work of digitizers were also interviewed. Their views were seen as helpful to understanding the digitization work since they had been involved in the initial setup of the preservation labs being studied. Sites L1 and L2 had higher-ranking administrators in their organizational hierarchy, but they were neither involved in the digitization work nor responsible for the initial configurations of the system.
12. Future journal articles in preparation will present additional research findings that will provide insight into the phenomenological, institutional, and moral dimensions of participants' practices of artisanal analog video digitization.
13. The digitization system that preservationists work with can be viewed as a configuration of social (practices, discourses, shared understandings, etc.) and technical (electronics, machines, technical standards, etc.) that together support the work of digitization in socially shared and "accountable" ways (Suchman, Trigg, and Blomberg 2002, 75).
14. Objective measures in this context refers to using technical tools that visualize signals as graphic forms that are superimposed and made measurable on standardized and calibrated grids of numerical values. These enable judgments that minimize the distorting influence of the digitizer's perceptual system and personal aesthetic taste. As Lorraine Daston and Peter Galison (2007) note in *Objectivity*, scientific objectivity aspires to "knowledge that bears no trace of the knower—knowledge unmarked by prejudice or skill, fantasy or judgment, wishing or striving. Objectivity is blind sight, seeing without inference, interpretation, or intelligence" (17). Thus, digitizers use scopes and other visualization tools to remove themselves as much as possible from the judgments and adjustments they make to the signal. Subjective measures, on the other hand, involve viewing the video signal visualized as a complete image on the screen of the video monitor. While the digitizers try to control this process as much as possible by calibrating their equipment, they make judgments on the video image based on their knowledge of the era in which the tape was created, the particular technical characteristics of the source tape, as well as how they expect video images to look. Subjective judgments ensure that the final digital copy has the look and feel of the original copy. Objective measures supplement subjective measures to ensure that the final product is not biased by the digitizer's judgments.
15. The display devices in the world of analog video are CRT (cathode ray tube) monitors that function by emitting a beam of electrons that scans across the back of a screen of phosphors, forming lines of glowing pixels that make up the video image. Once analog video signals are digitally encoded, they are displayed on a flat-screen LCD (liquid crystal display) computer monitor. Whereas the CRT works by emitting light via the activation of glowing phosphors through electron excitation, the LCD screen works by blocking and unblocking a continuous light source through small liquid crystals that are electrically controlled to allow more or less light to pass through the screen. In comparing the same image presented on these two types of imaging devices, digitizers must learn to see beyond the specific characteristics of the devices to evaluate the quality of the final digital copy and how it compares with images and signals at earlier points in the signal chain.
16. Video scopes, i.e., waveform monitors and vectorscopes, can either be analog in nature (an analog video signal comes into the scope and directly drives the CRT that displays the video signal on the screen of the scope); or, scopes can be digital, either in the form of software-based scopes that display on a computer screen a visualization of the video signal after it has been digitized, or a standalone equipment-based scope that accepts a digital signal and visualizes the digital video signal on a screen that resembles the analog scope. The analog scopes are used to measure the analog video signals before they are routed into the analog-to-digital converter, and the digital scopes are used to measure the resulting digitally encoded video.
17. A time base corrector (TBC) is a piece of equipment common to digitization labs that enables digitizers to make adjustments to the signal. It is an electronic device (often containing analog and digital processing components) that corrects for timing errors in the video signal (stabilizing the signal and the resulting video image), but also often has

built-in processing amplifiers that enable adjustments to be made by the digitizer to the chrominance, luminance, and position of the image frame. Digitizers adjust these elements and watch as changes appear on the video scopes. They then confirm how the changes are shaping the visual appearance of the video image on the monitors.

18. Comparing visualizations of the signal at different points in the signal chain helps the digitizer to detect differences in the signal at different points, identify the sources of those differences, and take action to adjust components in the signal path to compensate for those differences. The aspects of the video image that they observe include brightness ("luminance"), saturation ("chroma"), and color balance ("hue"). Other differences they look for are visual "artifacts," which are errors that can crop up at any point in the signal path and can be due to problems with the tape or with another component in the signal path. Some participants referred to the *AV Artifact Atlas* as a reference source for providing specimens of common types of video errors, which is available as a collaboratively created website: https://bavc.github.io/avaa/. Participants suggested that such atlases of error specimens are useful in their work for learning what errors to be aware of when doing digitization work, and for diagnosing errors that they are having trouble identifying.
19. Susan Leigh Star and Karen Ruhleder (1996) identify two relevant attributes of infrastructure, among others, that suggest that presets and defaults may be difficult to change: infrastructure becomes "transparent" with use and is often "learned as part of membership" when joining a particular community of practice (113). This suggests that decisions made about how the physical space and technological components of a digitization lab are configured may develop inertia and resist change over time.
20. This paper has discussed findings from this research project relevant to the question of digital labor in information institutions. A future paper will analyze the research data from this project further and explore how knowledge circulates across personal, institutional, and community zones of knowledge, and the ways in which participants form and maintain moral commitments to their professional values through their workplace activities.

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