The Digital Leap:

16mm Film Content in Cultural Heritage Institutions

by

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INTRODUCTION

In recent years, archivists and content providers of all sorts have paid increasing attention to digitizing and expanding public access to their moving image collections. There has been particularly strong public demand for access to digital forms of commercial narrative works on 35mm motion picture film. This thesis examines what is happening with respect to a different set of moving images, however, ones not as well known publicly but of great cultural and historical significance, ones for which the move to digitization and online access is still in its early stages.

The works on which this thesis focuses are the vast stores of 16mm films now held by cultural heritage institutions in the United States. 16mm films are primarily associated with cinema outside normal Hollywood distribution. They include many industrial, sponsored, educational, amateur, avant-garde, and experimental films, as well as films of record, historical film footage, television news, ethnographic works, government productions, home movies, and reduction prints of feature films made for nontheatrical use. These films were generally not viewed at movie theaters, but rather cinema clubs, colleges and universities, corporate training sessions, family homes, and similar sorts of venues.

These 16mm works are worthy of increased public and scholarly attention. Digitization and online availability have the potential to expand who views these films as well as how they are used and understood. The cultural heritage institutions that hold many of these films are taking their first steps in this direction, and this thesis is one of the first attempts to collect information and assess what is happening in this regard.

The thesis develops a portrait of this important transitional moment in 16mm film history in four ways: 1) assessing why 16mm film is important and what might be gained by making it more accessible, 2) developing an understanding of the technological, copyright, and metadata issues that cultural heritage institutions must consider in undertaking this transition, 3) presenting the results of the first survey of what a purposive sample of U.S. cultural heritage institutions are actually doing in terms of 16mm digitization and online access, and 4) offering some general thoughts on what the digital leap means for this distinctive and important body of films.

In other words, this study examines the development of digitized content in the newest telecommunication form and transmission standard for 16mm film works that were created with completely different distribution and production models and are now housed in cultural heritage institutions. This process inherently involves a struggle to make such content accessible in relevant ways, while being faithful to the original objects. It also asks these institutions to grapple with a myriad of technological details and the copyright complexities of this particular body of films. It requires difficult decisions about which of these generally very large holdings to digitize and how to find the staffing and funding to do so. Different institutions are at different stages and have developed different ways of approaching such issues. Despite these difficulties, however, the institutions surveyed for this thesis have generally reached the conclusion that enabling greater audience engagement with their 16mm films has carried significant benefit, both expected and unexpected.

Through digitization and online access, this distinctive body of film is reaching new users and receiving unexpected analysis and commentary from source communities and individuals who recognize themselves in these works. This process has enabled cultural heritage institutions to approach their mission of public engagement and historical preservation in new ways. It has

fostered collaboration, standardization, and interconnectivity among institutions. And it has opened up 16mm film for the creative analyses and projects now undertaken through the emerging field of digital humanities.

PART ONE: CULTURAL HERITAGE INSTITUTIONS AND 16MM FILM

This section defines the main actors in this analysis: cultural heritage institutions, 16mm film works, the forces impelling the former to consider digitizing and streaming the latter, and the intersection of this work with changes in cinema studies and the rise of digital humanities.

Cultural Heritage Institutions

Cultural heritage institutions are organizations concerned with preserving and presenting culture, in both its present and past forms, with both its material and immaterial outputs, for current and future generations. The phrase "cultural heritage" pulls together two concepts, culture and heritage. The International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) has compiled a number of definitions of the phrase, noting that most use it to describe cultural material that "is conceived as worth safeguarding, protecting or conserving."[1] ICCROM finds the 2002 definition offered by the International Council on Monuments and Sites (ICOMOS) to be particularly useful in pointing out the broad scope of such material,

> Cultural heritage is an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values.[2]

The ICOMOS definition invokes the concept of culture as a way of life and thinking among a group of people. Its forms are both ephemeral (performing arts, rituals, traditions) and tangible (art works, monuments, historic sites).

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[1] J. Jokilehto ed., *Definition of Cultural Heritage: References to Documents in History* (ICCROM, 2005) 4, accessed February 11, 2014, http://cif.icomos.org/pdf_docs/Documents%20on%20line/Heritage%20definitions.pdf

[2] *ICOMOS, International Cultural Tourism Charter. Principles And Guidelines For Managing Tourism At Places Of Cultural And Heritage Significance*. ICOMOS International Cultural Tourism Committee. 2002.

Thoughtful approaches to cultural heritage also recognize that culture is a dynamic entity that is constantly changing and adapting as new inputs, interactions, and circumstances make themselves felt. As one cultural heritage website (South African History Online) puts it,

> Culture refers to the way of life of a specific group of people. It can be seen in ways of behaving, beliefs, values, customs followed, dress style, personal decoration like makeup and jewelry, relationships with others and special symbols and codes. Culture is passed on from one generation (parents) to the next (children). Culture is not static but always changing as each generation contributes its experience of the world and discards things that are no longer useful to them.[3]

Culture feeds into individual and group identity formation, something that must also be seen as a dynamic process, reflecting a wide range of interactions with the various social and cultural networks, both local and global, in which individuals now participate.

The dynamic nature of culture and identity formation mean that what is passed down as cultural heritage differs from one generation to the next. Cultural heritage institutions thus often see themselves not as presenting the one true form of a culture but as recording, documenting, and preserving its many forms as it changes over time. Like culture itself, cultural heritage is a dynamic entity that is constantly being defined, produced, and changed.

Following the destruction wrought by World Wars I and II, there has been increasing international interest in safeguarding and preserving many forms of culture heritage, both within nations and more broadly. Establishment of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) was a landmark in bringing international attention to the importance of such work. UNESCO's involvement with planning for the Aswan High Dam in Egypt in 1952 was a particularly compelling moment. This structure would have flooded and destroyed the ancient Abu Simbel and Philae temples but for the efforts of UNESCO and several

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[3] "Defining Culture, Heritage, and Identity," *South African History Online*. 2005. www.sahistory.org.za/topic/defining-culture-heritage-and-identity

other organizations to see that the temples were dismantled, moved, and reassembled in a safe location.

Following this critical event, UNESCO and ICOMOS then spearheaded drafting of the Convention Concerning the Protection of the World Cultural and Natural Heritage. This document defined both cultural and natural heritage protection not just as regional or national concerns, but world-wide ones. The treaty states that heritage does not belong to any one group but to all, and establishes safeguarding and access as universal responsibilities.

> Heritage is our legacy from the past, what we live with today, and what we pass on to future generations. Our cultural and natural heritage are both irreplaceable sources of life and inspiration. Places as unique and diverse as the wilds of East Africa's Serengeti, the Pyramids of Egypt, the Great Barrier Reef in Australia and the Baroque cathedrals of Latin America make up our world's heritage.
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> What makes the concept of World Heritage exceptional is its universal application. World Heritage sites belong to all the peoples of the world, irrespective of the territory on which they are located.[4]

This document resonated with the growing move to protect cultural heritage in the United States, which had begun in the late 19th and early 20th century as the relatively new nation strove to define its identity in relation to history and place, and which gained momentum with the sense of loss felt in the aftermath of World War II.[5]

Cultural heritage institutions arose from these forces, as organizations dedicated to keeping current and past manifestations of culture viable so they could be passed down to future generations. Some of the most established and visited forms of cultural heritage institutions are museums, archives, and libraries. These institutions collect, preserve, and make available various forms of cultural heritage output (objects, buildings, films, books). Museums are institutions that conserve a series of collections of similar objects for study and general access. The most

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[4] "World Heritage, " *UNESCO World Heritage Centre*, 2014. http://whc.unesco.org/en/about/

[5] Frick, Caroline, *Saving Cinema: The Politics of Preservation,* (New York: Oxford University Press, 2011) Introduction.

common way museums display their objects has been through curated exhibitions for the public. Libraries are institutions that collect sources of information, preserve those sources, and organize and make them available for reference or for borrowing. These sources can include films, DVDs, books, e-books, and a variety of other formats. Archives are organizations that collect documents or audiovisual materials that have been selected due to their cultural, historic, and evidentiary value. The materials are organized by subject matter or donor (person, organization). Some cultural heritage institutions focus on just one of these functions; some combine all three.

With the recent rise of digital information, cultural heritage institutions have taken on new roles, activities, and self-definitions. Their mission remains the same, but the way they organize and present their holdings, as well as their interaction with users is evolving. This is due to the nature of digital information (objectless itself, although needing a machine) and to changing expectations on the part of their audiences, both established and new. Institutions are increasingly creating new virtual spaces accessed remotely to increase their user base and impact beyond the physical confines of their buildings. This new kind of content - interactive, digital, and online - has come to be expected by their users. Content at cultural heritage institutions is increasingly freed from a single physical space with limited user interaction, and is spreading into virtual environments across the world, yielding a range of highly individualized uses. In a networked world of social media and digital interactions, this is also creating new forms of collective memory and community activity. As Rick Prelinger states for audiovisual material in general,

> YouTube is the standard of what users expect – comprehensiveness, interactivity, (the ability to embed videos from the collection and upload one's own), instantaneous accessibility and allowing social networking (link individuals to their uploads and favourite videos send material to other people and maintain friends). Platforms like

> YouTube thus widen the definition of 'archive' to any easily accessible, dynamic, and interactive collection of information and knowledge-based technologies.[6]

Or, as Michael Loebenstein characterizes the YouTube phenomenon in *Film Curatorship* (2008),

> The curatorial principle is individual, idiosyncratic, and collective at the same time; it's as if the idea of the 'moving image archive' had taken a huge leap to where historical sciences have taken us during the last decades: from artefacts-as-documents, the archive as a repository of historical records, to a *lieu de mémoire* – a site of memory.[7]

Two digital public libraries, Europeana for Europe and the Digital Public Library of America (DPLA) for the United States, serve as prime illustrations of the changes occurring for cultural heritage institutions in the digital age.[8] Both have created spaces for users to access different types of content from many different cultural heritage institutions using the Internet. Users interact with holdings in a different way than when physically visiting the institutions that participate; they are able to create individualized pathways through the content that are saved for later, the holdings are organized in different ways, and content is delivered immediately.

DPLA and Europeana are dynamic, featuring optimization processes for users working with digital content in virtual environments. The result is a democratization of knowledge and materials for these users. The two organizations also increasingly feature digitized versions of analog sources rather than just born-digital works, thereby transferring older content into this new realm, sometimes including 16mm film.

16MM Film

Historically, 16mm film was used primarily for educational, amateur, television, avant-garde, cine-clubs, corporate training, and instructional films up through at least the 1970s. Like other

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[6] Noordegraaf, Julia, "Who Knows Television? Online Access and the Gatekeepers of Knowledge" *Critical Studies In Television*, Vol. 5, 2 page 2.
[7] Cherchi Usai, Paolo, David Francis, Alexander Horwath, and Michael Loebenstein, *Film Curatorship: Archives, Museums, and the Digital Marketplace,* (Vienna: Synema, 2008) Page 214.
[8] http://dp.la/ for the Digital Public Library of America and www.europeana.eu/ for Europeana.

lesser-used gauges (9.5, 28, 8, etc.) 16mm was originally created to fulfill the needs of a home market. Nitrate film base, used for 35mm commercial productions, was highly combustible and deemed unsafe for home use. As Paul Read and Mark Paul-Meyer report,

> At almost exactly the same time in 1923, Kodak and Pathé presented new film stock formats for use, in principle, for home movies. In both cases, a safety base, cellulose diacetate, was used, a non inflammable base being much safer for the home user.[9]

16mm was quickly picked up for home use as well as the other markets mentioned above. Fifty years later 16mm began to fade as cheap and portable video equipment took over its market. And as this happened, its preservation increasingly became a matter for cultural heritage institutions.

Most 16mm films are positive prints from reversal stock, meaning that the film in the camera has been developed into a projectable positive print. 35mm film, on the other hand, is generally shot on negative film, meaning that the film in the camera is developed into a negative print from which a projectable print is then struck.

> Reversal materials are those film stocks processed to a positive image in one processing stage. Some films processed by reversal have negative images: for example, an image from a negative printed onto a reversal film will be a negative. Colour Reversal Intermediate is a stock designed for copying negatives in a single stage, but generally reversal films are either camera original materials or are for copying existing positives.[10]

16mm film has mainly used reversal stock because it is cheaper than negative film, and because 16mm works were not destined for large studio commercial releases aimed at generating large profits. Anyone who did not have the funds to produce and distribute in 35mm film was attracted to 16mm film. According to Jan-Christopher Horak,

> In the post-World War II period, distribution on 16mm expanded dramatically, as many libraries, universities, museums, and other nontheatrical screening spaces either began building up 16mm film collections or rented 16mm from distributors. Throughout much

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[9] Paul Read and Mark-Paul Meyer, eds. *Restoration of Motion Picture Film* (Boston: Butterworth Heinemann, 2000) 22-23

[10] Read and Meyer, 66.

> of the twentieth century, then, 16mm remained the primary medium of distribution for the nontheatrical film market.[11]

The use of 16mm reversal stock was, for example, widely used for television news reporting, even when improvements in 16mm negative stock grain structure and printing techniques were made in the 1970s.[12]

As well as these format-specific works, 16mm films also served as a secondary market for 35mm studio releases. As Dominic Case states,

> Kodak introduced the Kodascope Library of commercial shorts and features for home projection on 16mm as a means of increasing sales of their 16mm cameras and Kodascope projectors. Bell & Howell, as well as Universal Pictures (Universal "Show at Homes") and others followed suit with their own libraries. As a result, many Hollywood features from the silent era have survived in 16mm and are now treated as original masters from which 35mm dupe negatives and prints are generated.[13]

In other words, a number of lost feature films now only survive through 16mm prints. These 16mm prints from 35mm films were created through a process called reduction printing, in which the 35mm film was run through an optical printer and transferred to 16mm film.

Cultural Heritage Institutions with Film Collections

Motion picture films are tangible expressions of culture that should be preserved for future generations. All three common types of cultural heritage institutions have instances of film collections, including 16mm film. Film is, however, most frequently associated with archives (including archives attached to museums and libraries), as these are the institutions that began preserving such works in the 1930s.

> Stockholm was the first in 1933, then Berlin, London, New York (MoMA), Paris and Brussels followed in the years to follow. In 1938 the International Federation of Film Archives (FIAF) was founded and today more than 100 archives in over 60 countries

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[11] Jan-Christopher Horak "Archiving, Preserving, Screening 16m" *Cinema Journal* Vol 45 Issue 3, 2006 p. 113
[12] Dominic Case, *Film Technology in Post Production: Second Edition,* (Boston: Focal Print, 2001) 36
[13] Jan-Christopher Horak "Archiving, Preserving, Screening 16m" *Cinema Journal* Vol 45 Issue 3, p. 113

> collect, restore, provide access, exhibit films and document the entire history of film cinema, from the early days up to today.[14]

There have also been corporate film archives in addition to such non-profit cultural heritage ones. Such corporate archives were designed to keep the financial interests of the production or distribution companies viable and exerted more control over permission to use and view the films. Historically both theatrical and cultural heritage archives initially focused on commercially released 35mm prints.

As cinema studies has opened up to more than commercial releases, however, such archiving and preservation activities have expanded in scope. The National Film Preservation Foundation (NFPF), one of the largest funding bodies for film preservation in the United States, triumphs this expansion.

> We associated filmmaking with Hollywood sound features and knew little about non-theatrical films held by museums, libraries, and archives. These one-of-kind works often lay untouched in the stacks or were simply too fragile to be shown to the public. Now, thanks to preservation work over the past two decades, these films are beginning to be seen. A more inclusive picture of national filmmaking is emerging to enrich our understanding of cultural history.[15]

Despite the efforts of William Hays to have moving images included in the National Archives and Records Association, however, the economic interests of corporate archives kept any film except government-funded works out of NARA.[16]

Thus it was that U.S. cultural heritage institutions assembled collections of many different kinds of films, prime among which, however, became 16mm. As NFPF states, 16mm is the film gauge most commonly associated with such institutions. Most of these works date from the 1920s to the early 1980s. Some institutions hold 100,000's of such films; some even hold

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[14] Paul Read and Mark-Paul Meyer, eds. *Restoration of Motion Picture Film* (Boston: Butterworth Heinemann, 2000) 3.
[15] National Film Preservation Foundation (U.S.). *The film preservation guide: the basics for archives, libraries, and museums*. (San Francisco, Calif: National Film Preservation Foundation 2004) Page 1
[16] Frick, Chapter 1.

millions. Most are original reversal prints, and many are unique items according to the 2004 *Film Preservation Guide: The Basics for Archives, Libraries, and Museums*. Another perspective negates this statement, Rick Prelinger, archivist and founder of the Internet Archive and Prelinger Archives, 16mm film is on negative stock and publicly screened in nontheatrical settings according to.[17] Either on reversal or negative stock, 16mm in cultural heritage institutions is associated with non-theatrical works, production, and distribution.

Some of these 16mm films are in cultural heritage institutions with missions focused elsewhere than film, but which nevertheless have some film among their holdings. Many historical societies, regional archives, museums, and libraries have some film collections scattered among their holdings, housed as much for their historical and cultural content as their aesthetic or artistic qualities. The world-renowned University of Pennsylvania Museum of Archaeology and Anthropology, one of the institutions surveyed for this thesis, falls under this category. The Museum describes itself as "… the largest university museum in the United States. With roughly one million objects in our care, the Penn Museum encapsulates and illustrates the human story."[18] The Penn Museum is not dedicated to moving images, but it nevertheless has a dedicated film archive that consists primarily of 16mm films. Here is how the museum represents its film collection.

> Thanks to the generosity of the Internet Archive, nearly all of the archives' collection of films is available online. Film collections include the documentary footage of Watson Kintner and his travels to Guatemala, Guyana, Ecuador, Morocco, Pakistan, India, Indonesia, Nigeria, Australia, Iran, and Ethiopia, all filmed with a 16mm camera from 1933-1969. We also hold a few episodes of the well-loved television show "What in the World?", a museum-sponsored game show in which a panel of experts was asked to identify the culture, place and use of an obscure object taken from the museum's storerooms. While we encourage the use and re-use of our films for creative purposes, please note that the museum archives holds copyright to this content. To protect your

[17] Rick Prelinger, "Field Guide to Sponsored Films", (San Francisco: National Film Preservation Foundation, 2006).
[18] "About Us" *Penn Museum,* 2014, http://www.penn.museum/about-us.html

> interests, please be sure to contact the archives so that we can grant permission for the re-use of these films.[19]

Cultural heritage institutions that actively collect and focus on film are a distinct and relatively small subset and relatively uniform in nature, as opposed to the varied institutions that have some film in their collections. These film-dedicated institutions are also more likely to have current and older or legacy technology to view and project film. The Motion Picture Study Center of the George Eastman House illustrates the way such dedicated film archives make their photochemical collections available for study. The Center is open from 10:00 AM to 4:30 PM, Tuesday through Friday. Interested individuals can contact the Motion Picture Department about holdings and viewings. To book a time slot to see a film or films, one needs to send a list of titles to the Film Study Center. If there are prints available, times are booked. Three to six weeks are necessary in order for the center to be ready. $15.00 an hour is charged to use a flatbed viewer, $30.00 per hour for the Screening Room that accommodates 16mm and video exclusively, and $125.00 an hour for the Dryden or Curtis Theaters for 35mm and 16mm. These Theaters charge $350.00 an hour for an evening (minimum 3 hours). Such time and monetary considerations deter the average viewer. Photocopies of written materials are $0.25 each, and the free Study Center Library[20] provides secondary materials providing additional information about the works.

The Forces Moving Cultural Heritage Institutions to 16mm Digitization and Online Access

The forces impelling cultural heritage institutions toward 16mm digitization and online access are several: 1) the importance of 16mm films in terms of the mission of the institutions, 2) increasing user interest in accessing materials online, 3) institutional interest in expanding their

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[19] "Film Archive", *Penn Museum,* 2014, http://www.penn.museum/archives.html/film-archives.html
[20] "The Motion Picture Collection", *George Eastman House,* 2014. http://www.eastmanhouse.org/collections/motion-picture.php/motion_picture.php

user base, 4) institutional need to keep analog film elements and their content preserved and accessible for the foreseeable future, 5) declining infrastructure for exhibiting 16mm film in analog format, 6) growing demand for an interdisciplinary and inclusive film history, and 7) growing interest in the insights and applications that are coming out of the new field of digital humanities. While this section focuses on what has led cultural heritage institutions to begin the digitization and online access process, the later section presenting the survey results reveals that these institutions are also discovering some additional unexpected benefits once they get started.

As stated above, cultural heritage institutions house some of the most important collections of 16mm film in the U.S. These organizations are dedicated to preserving this heritage and making it accessible with an obligation to filmmakers, the film objects, and the audience to present these works within their historical contexts. The ways in which users have previously accessed 16mm films in these institutions is proving increasingly problematic, however. This system has always been somewhat cumbersome and largely for the dedicated film researcher. It now faces additional issues.

It is well known in film exhibition, distribution, and production circles that the expertise and infrastructure needed to project 16mm has been failing in recent years despite the recent appreciation in cinema studies, cinematheques, and the general public for such films. 16mm laboratory and projection infrastructure is decreasing at a greater pace than 35mm. This infrastructural decline stands at odds with the need to access and keep 16mm film history alive. William Fowler points out this contradiction.

> In the same week that Goldsmiths lecturer Richard MacDonald stressed (in a talk in the BFI National Library) how important the use of 16mm film was in building the post-war film-society movement, a potential crisis emerged regarding the future of the very same format. On 22 February, Turner Prize-winning artist Tacita Dean reported in ‘The

> Guardian' that Soho Film Lab has stopped producing 16mm prints and called passionately for a reversal of this decision.[21]

In short, in many cases, it is extremely difficult or even impossible for cultural heritage institutions to provide access to their 16mm films through projection to live audiences. The institutions must look to other ways of making these works available.

One way cultural heritage institutions have done this in the past has been to transfer the film content to video. This has usually been at the request of users, but also sometimes reflected institutional needs. Instead of projecting a film in-house, loaning a film print, or striking a new print, the institution created a video copy. During the conversion to video, the institution also made a video copy for itself. This process reduced the wear and tear on the film print and enabled better conservation for that object. In some cases today, the video copy is the only one that exists because the archival prints have deteriorated or been lost. The current move to digitization and digital access owes much to the lessons learned from such earlier video transfers.

Video transfers are now giving way to the growing expectation from both the general public and academia to view films digitally and often online. This parallels the industry changeover to digital cinema in movie distribution and presentation on many different platforms, including movie houses, multiplexes, micro-cinemas, computers, phones, tablets, and Blu-ray as well as DVDs. The vast majority of movies are shot and created digitally today, and for the past decade digital copies have been the standard output for movies. Digitization and online access are now the norm for many 35mm commercial works. The rise of YouTube and similar online streaming portals providing images of the everyday, remixes, industrial films, and a variety of other outputs from amateurs and non-commercial cinema have heightened the expectation that these processes will become the norm for works found on 16mm film as well.

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[21] William Fowler, "Format War", *Sight and Sound,* Vol. 21 Issue 4, 2011, p 13.

Cultural heritage institutions are responding to this increasing interest by users of all sorts to access film materials in digital and online format. Many institutions are moving into this realm through specific projects and individual initiatives. A few are approaching the change in more comprehensive and systematic ways. And a few are debating whether or not this is what they really want to do. Those who go down this road, also see it as a way to expand their user base, drawing in more and different sorts of users, both nearby and further afield. Analog presentation and understanding of film is increasingly the domain of film scholars and enthusiasts, while online access to digital versions of analog film content opens up moving images to a larger and interdisciplinary community of academics and the general public, far beyond those who can visit the institutions themselves.

Digitization also provides the opportunity for more detailed cataloging as well as digital conservation and preservation strategies for 16mm film. This breaks from the traditional conception of film preservation as film-to-film copying. Many 16mm film holdings are unique and individual works of art on original reversal film stock and should be treated carefully and projected less. As a result, there are a number of initiatives in cultural heritage institutions that focus on creating digital surrogates for presentation and distribution, in much the way that video surrogates were created a decade or more ago. In so doing, they are also creating new metadata and catalog records that enhance research and understanding of these works.

In the world of film archives, preservation refers to the duplication of one film print onto new film stock, and conservation refers to the care and storage of existing film prints. Digitization decreases the duplication of film prints but increases the conservation of those that exist. The fact that content from the original film object can be accessed and analyzed digitally creates less wear and tear from use. Film prints or objects are damaged anytime they are run

through a projector, even when run perfectly. Some of this damage can be repaired, but combined with the natural decomposition of the film object eventually results in its destruction or need to be migrated photochemically to another print.

Negative film stock can create multiple positive prints from one negative that was shot originally in the camera. 16mm films were mainly shot using reversal stock and therefore require careful handling since they are usually the only versions in existence. Digitization replicates a film object using digital technologies by creating a digital surrogate, one that is cheaply and easily replicated. After digitization, the film object is placed into storage conditions that mitigate the major factors of deterioration while simultaneously allowing for digital accessibility, something particularly beneficial for these unique 16mm films. Reversal stock creates a unique imperative for digitization.

The intersection with cinema studies and digital humanities

Mining the Home Movie: Excavations in Histories and Memories is a landmark study echoing an increasing call to broaden the canon of cinema studies from theatrical cinema to a much larger corpus. This broadening is part of a larger shift in social history known as "history from below." *Mining* invokes this shift to examine amateur and home movies as sources that reveal the personal in relationship to grand histories. The book locates 16mm non-theatrical works as part of the trauma of lost and forgotten objects that are now being rediscovered and analyzed.

> The range of amateur films discussed in this volume represents a diversity of voices operating within different discursive formations-travel films, missionary works, narratives, amateur ethnography, industrials, family films-which suggests the latent hereogeneity and polyvocality in the term *amateur film.*[22]

[22] Ishizuka, Karen L., and Patricia R. Zimmerman, *Mining the Home Movie: Excavations in Histories and Memories,* (Berkeley: University of California Press, 2008). Page 6.

This shift is, of course, directly relevant to the 16mm film collections held by cultural heritage institutions, many of which are now seen as warranting discovery, multidisciplinary scholarship, and public attention. These collections now attract individuals from many academic disciplines and communities beyond cinephiles. Their evidence is similar to oral histories, accounts that are diverse, confusing, and contradictory, but also truthful and human; accounts that run counter to canonical histories and reveal the ways in which different individuals and communities experienced their moments in time. By creating increased accessibility to amateur films, cultural heritage institutions move our general understanding of various periods beyond past sins of omission to create polyvocal accounts. These works create a broader social history of film in specific and the periods they represent in general. Just as the Internet has democratized information, so can greater access to amateur and non-theatrical films democratize film history. 16mm works are often films of record and history, as opposed to entertainment or art. It takes an interdisciplinary and collaborative approach to fully understand and unearth their meaning, and it will take greater access to these works for that to happen.

The desire to explore and make non-theatrical film more accessible also intersects with the rise of digital humanities. Collections of humanities materials are being made available online, so that they might be analyzed using computer technologies by an audience interested in the ways information is encoded and represented in the digital realm. These actions enable new forms of research as well as new connections among users and scholars. Digital humanities sites are creating new tools for analysis and online access to materials previously only available in print or analog versions. These sites and projects are more than simple online collections of movies or documents. They are structured to provide a range of ways of looking at these materials as well as connecting them to and mining relevant data sets.

By way of simple example, a digital humanities project might make it possible to locate and compare all the different images of a particular animal found in the film holdings of multiple institutions, thereby providing a deep understanding of the iconography of that animal.
A more complex example might be the WGBH Open Vault project that digitized all of the station's archives and library, making them open to the public in ways that facilitate connections and discoveries not previously possible with an analog experience. In a similar vein, the Media Ecology Project (MEP) at Dartmouth College provides online access to moving image materials in ways intended to stimulate new forms of scholarly production and online publishing across disciplines. By connecting a range of different archives, MEP facilitates "close textual studies of the subject matter, production, reception, and representational practices of media, in relation to research within and across the collections of participating archives."[23]

Digital humanities is a growing part of many Ph.D. curricula in various humanities disciplines, with the result that an increasing number of scholars are familiar with the computing tools of data mining, data visualization, information retrieval, and similar activities for online streaming collections. The 16mm film collections on which this thesis focuses can easily become part of this realm once digitized and made accessible online. They just require the right tools, projects, and mindset for such analyses to occur.

I return to the value of 16mm digitization and online access for increasing user diversity and engagement, preserving and conserving works, and developing new forms of cinema studies and digital humanities analyses in the concluding section of this thesis. First, however, I examine the technological, legal, and record-keeping issues involved in 16mm digitization and access,

[23] The Media Ecology Project website http://sites.dartmouth.edu/mediaecology/.

and then turn to an analysis of what a purposive sample of cultural heritage institutions are actually doing in this regard and how they evaluate their experience.

PART TWO: WHAT IS INVOLVED IN A 16MM DIGITIZATION AND ONLINE ACCESS PROJECT

When cultural heritage institutions embark on a project of digitization and online access from their 16mm collections, there is much they must consider: what happens during digitization itself, as well as digital preservation, storage, and encoding, creating metadata for analog and digital instantiations, making changes in catalog records, how best to provide online access for multiple concurrent users, various online presentation formats and tools, whether to do this work in-house or through a service, copyright issues, and how all of this relates to their institutional responsibilities to the film and its interested parties. Institutions must pursue such projects in ways that reflect the history of the film under consideration and the correct solutions for their budget, sense of stewardship, and institutional mission. These activities are best undertaken through long-term institutional planning that sets strategic goals, addresses sustainability and impact, preserves as well as produces the digital materials, and considers what it will mean for the institution to expand its audience and develop a more participatory relationship with its users.

Such processes are demanding. They require the development of new knowledge and the expenditure of institutional resources. The potential for deepening our understanding of the films being digitized is great. There is much to be gained, but also much that can be lost.

This section assembles several different streams of evidence and expertise to establish the key elements that cultural heritage institutions must consider as they embark on digitization and online access. The section sets the stage for understanding the responses that institutions gave to the survey presented in the following section, a survey that explores how these institutions made decisions and carried out the elements described in this section, as well as their assessment of what worked and what did not. This section also establishes what transformations occur as

16mm film is digitized and streamed, hence what records must be kept and how the new digitized object must be understood. Finally, this section is intended as a guide and source of information for institutions contemplating new digitization and online access projects.

This section begins with a discussion of the traditional methods of preserving and conserving film, the nature of film, the nature of digital film surrogates, what happens during the process of digitization, and issues of digital preservation, metadata, and cataloging. The section next considers various forms of online digital access, including discussion of downloads, streaming, compression, codecs, and the Internet architecture and server infrastructure that are needed. It ends with a brief examination of the issues of copyright that many of the institutions surveyed for this thesis list as particularly vexing for 16mm film.

Traditional Film Preservation, Conservation, and Restoration

Traditional film preservation and conservation involve the care and handling of the film object (expressed as various elements), including its duplication with a goal of long-term viability and minimal loss. Motion picture film naturally degrades over time. Archival storage conditions only slow the process. If a film print is too damaged for projection or there is risk of information loss, then it is conserved (repaired and cleaned) and sometimes duplicated onto more stable stock for the purposes of preservation. Duplication is the creation of a new print from existing materials, ideally from the original elements (negatives, camera originals, reversal prints). A more active process is that of restoration which David Bordwell sees as "working to bring the film back to something like an original state,"[24] while others see it as replicating the entire original viewing experience.

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[24] David Bordwell, *Pandora's Digital Box: Films, Files, and the Future of Movies* (Madison: Irvington Way Institute Press, 2012) 178

In writing about the restoration of Charles Burnett's *Killer of Sheep*, Ross Lipman describes the process as a marriage of technical limitations and artistry, oftentimes forcing the restorationist to make qualitative decisions that affect the overall product. Lipman feels it is impossible to restore the work to an original viewing experience. The specific methods of production, film stock, and exhibition can rarely be replicated, and the caretakers of the film have to weigh such a goal against creating something that captures the essence of a work.

> We here encounter a variation of the goal of recreating an 'original viewing experience'- the notion that our job is to allow a film to be presented 'in the way it was intended to be seen.' This variant phrasing of the question moves away from the historical aspects of a viewing experience and toward the issue of authorial intent. But as we all know, clear traces of the filmmaker's intent don't always exist, and the interpretation of what does exist can be highly idiosyncratic.[25]

Restoration involves research and complex decisions concerning what constitutes the original form and viewing experience of a work, based on all the potential versions and prints that exist. Cultural heritage institutions in the service of safeguarding the film object for long-term access employ all three strategies of preservation, conservation, and restoration. The last, however, is the rarest of the three, and some receive no treatment at all.

Motion picture film is comprised of three fundamental layers, the base (carrier), the binder that adheres the emulsion to the base, and the image material (emulsion) comprised of silver or dyes. The carrier or base layer is comprised of cellulose triacetate, cellulose diacetate, cellulose nitrate, and/or polyester. Each kind of base reflects a different period in the production of motion picture film stock and the look of the resulting object. The emulsion layer contains the image information and is made of light-sensitive materials in gelatin. Black and white film is processed so the image is comprised of silver-halide grains. Color film contains three dyes (cyan,

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[25] Ross Lipman, "The Gray Zone: A Restorationist's Travel Guide" *The Moving Image* Vol. 9, 2 page 11

magenta, and yellow) as well as the light-sensitive materials in the gelatin. During further processing the silver-halide grains are removed leaving dyed areas.

There are also several additional components to a film print, namely the topcoat, subbing layer, and backing layer. The topcoat is made of gelatin and meant to help with even winding for storage of the film as well as improving image quality. The subbing layer helps the emulsion stay connected to the base and is comprised of a formula of gelatin mixed with the film base chemicals. The backing layer is designed to counteract any changes in the film due to temperature and humidity change. It is usually comprised of gelatin, but sometimes other polymers such as poly vinyl acetate (PVA).[26]

Encoded Film Information

Part of the cultural value of a piece of film derives from the information it contains that goes beyond its image material. Each film print contains information about how, why, when, and where it was created and shown. One example comes from the change from silent film to sound film. Before the advent of sound on film and the resulting standardization of playback, frame rates were variable, but generally around 18 frames per second. Sometimes film would be hand-cranked and played back at a truly variable rate. After sound and the need for a standard playback so that the image would sync with the sound properly, the standard frame rate became 24 frames per second (fps). The sound that was recorded onto the film or meant to be played with it also needed to be played at an appropriate speed; otherwise it would become distorted and

[26] This section mainly references "Film Construction," *National Film and Sound Archive.* Last accessed February 16, 2014 www.nfsa.gov.au/preservation/handbook/film-construction/ It also uses "Film Structure," *Kodak Motion*, Last accessed March 17, 2014, http://motion.kodak.com/motion/uploadedFiles/US_plugins_acrobat_en_motion_newsletters_filmEss_04_How-film-makes-image.pdf

the illusion would be lost. This change in projection is part of the information carried by films that were made after it occurred.

In short, every film print was created for a particular audience and times, and constrained by technical and transmission standards of the day. Film prints do not just carry information about the images on them, but also about their own creation, distribution, and reception. As society changed, so did technology, and each print is representative of the technological limits and social expectations for moving images of that period. Understanding the film requires understanding what went into its production and what was expected from it.

16mm Film Elements and Production

16mm films all begin with the film shot in the camera, called the camera original. There are a number of ways to process camera originals, just as there are a number of different film stocks. As mentioned earlier, most 16mm films in cultural heritage institutions are on reversal film stock. Such stock is processed directly to a positive image or positive print; there are no elements beyond the camera original. Since reversal stock is cheaper than negative film, it was primarily used outside the Hollywood system, which used negative film. For 16mm films shot on negative stock, the camera original is processed to a negative print. This negative print is then processed again to produce a positive image or projectable print. In such a situation, both negative and positive prints of a film might exist, and either or both might end up in a cultural heritage institution. Sound is also an important part of 16mm films and is sometimes contained in separate elements as well. All of this information is part of understanding any particular film object and important to keep with any digital surrogates that may result.

As mentioned above, the only element for reversal film stock, unless a separate sound element exists or additional prints have been made, is the camera original. Making other prints from the reversal original often involved making a negative print called the "internegative," which was then used for producing the desired prints. Reversal stock can also be used to duplicate reversal originals, in which case a new positive print is struck directly from a positive print.

Because Hollywood used the more expensive negative film stock used for its movies, this is what people generally associate with motion picture filmmaking (as opposed to reversal). Most 16mm films are on reversal stock, but some are on negative stock. Negative film is designed to be a reproducing medium, enabling many copies to be made without damaging the camera original. This situation can lead to multiple prints in the post-production process before getting to the final release print seen by the audience. Instead of the single step and element to get a projectable print from reversal stock, negative film often results in the creation of multiple elements even before reaching a film print that can be projected, any one (or more) of which may end up in a cultural heritage institution, along with any of the projectable prints that were ultimately generated.

Sound is a separate element for most 16mm films, recorded in what is known as double-system sound or after-the-movies-completion sound. The sound component for a 16mm film can be optical, magnetic, digital, or recorded on a separate piece of film. Sometimes other elements such as 1/4" audiotape, cassettes, Compact Discs (CDs) are meant to be played in tandem with the projected film. Only what is called a "composite print" involves the combination of sound and image elements onto one film print.

Sound can be recorded directly onto 16mm film, but this was rarely done, except for television news and documentary footage with specialized cameras. Sound recorded on film at the time of shooting is called single-system sound or sound-on-film (SOF). It is done through a variety of technologies and methods, including optical (created by photosensitive film stock), magnetic tracks (similar to audiocassette tapes), and digital representations (DOLBY). All require specialized sound pickup devices (heads) to accurately recreate the sounds encoded. Magnetic tracks are at risk due to delamination in addition to natural film decomposition.

Digital Video Characteristics

Analog signals are continuous representations of captured information, while digital ones are representations that convert analog signals into samples and numerical values. Film and analog moving image formats such as video are able to capture a continuous analogous wave of light, while digital formats are more like points along the wave represented as a series of set numbers. Film is an inherently analog technology, while video began as analog but started widespread conversion to digital in the 1990s. Both forms of video are in operation, with digital video now dominating the market place. Phrased another way, video can either present complete analogous waves like film or represent such waves through a series of distinct points that are communicated in binary code.[27]

Digital images are represented by arrays of picture elements or pixels. Pixels contain brightness as well as color information to represent an image. A full pixel array or display for an image that has been interpreted is called a raster. Charles Poynton, an expert in digital video states describes the way that rasters become standardized and set in motion. "*Raster scanning,* whereby the samples of the pixel array are sequenced uniformly in time to form scan lines,

[27] Weise, Marcus and Diana Weynand. *How Video Works*. Focal Press: New York. 2007. Pages 111-120.

which are in turn sequenced in time throughout each frame interval."[28] Similar to film, digital video is a series of images that are set in motion to give the illusion of movement, but instead of photochemical encoding of images, there is digital encoding, comprised of pixels.

There are two main components to digital video, the essence (codec) and wrapper (file format). To put this in other terms, the image and audio components that are the essence of the video have been encoded with a codec. H.264, DV, and MPEG-2) codecs provide a way to encode and compress the bits of digital content. The encoded content is then placed in a virtual container or wrapped in a specific format (.mov, .mp4, .avi) for storage. As JISC, the U.K.'s expert on digital technology for education and research puts it a

> wrapper can be thought of as an envelope which contains elements such as video, audio, and metadata. The video portion of this data usually encoded by a specific 'codec' (COmpression-DECompression algorithm).[29]

The encoded essence, like a letter, is placed into an envelope for delivery. Once received, the envelope is opened and someone then correctly reads the letter or essence. There are many codecs and wrappers that can be applied to digital video. The codec and wrapper determine what software or media players can read, decompress, and playback the video properly. For digital video there are two parts to the content, audio and image. This thesis focuses on video encoding and codecs, but it is important that whatever streaming implementation is chosen takes into account both parts of the content and their synchronization.

Digital Surrogates for 16mm Film

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[28] Charles Poynton, *Digital Video and HD: Algorithms and Interfaces*, (New York: Morgan Kaufmann, 2012). Page 83

[29] "Choosing a Digital Video File Type", *JISC Digital Media*, 2014. www.jiscdigitalmedia.ac.uk/guide/choosing-a-digital-video-file-type

Digital surrogates are representations in the digital realm of an original analog source. Digital surrogates are of varying quality and serve to represent information in a variety of ways. For film, possible digital surrogate forms include digital photos of the film object, digital video showing different aspects of the object, and digital still images of each individual frame of film. Regardless of the form and quality of the digital surrogate, not all information in the original can be digitally represented. Some information will be lost due to the technical specifications of digital representations, and others due to choice. It is important to note that digitizing always produces a digital surrogate for the film. These can be high-resolution and high data-rate versions meant to serve as preservation level surrogates or low-resolution and low data-rate versions meant purely for access.

Creating a digital surrogate for film requires identifying key elements, technological limitations, and many other factors. As mentioned above films contain evidentiary information beyond just the images and sounds on the film. These include the film base, gauge, perforation size that can date a film and its production methods, the image size and ratio, edge codes and key codes, how many splices, specific system of production and processing, which element in the production process, as well as its audio components separate from the image.[30]

All of this information cannot necessarily be translated to the digital representation. Instead adherence to standards and the selections of information as well as how to represent them must be made. As for the standards there are no hard-and-fast standards on how to represent film information digitally and after it is digitized, the digital file will be compressed and changed depending on how it is to be accessed. There are now varying standards for digital film scanning involving the Digital Picture Exchange (DPX) format: 10-bit 4:2:2 YUV DPX files and 10-bit

[30] Paul Read and Mark-Paul Meyer, eds. *Restoration of Motion Picture Film* (Boston: Butterworth Heinemann, 2000) 55.

4:4:4 RGB DPX scanned at 2K resolution or the equivalent of the high-end 1080 progressive frame HDTV standard. YUV and RGB relate to specific color spaces of the digital files, YUV refers to what is known as color difference space while RGB is a full representation of all the color information. There is, however, no consensus on whether the perforations, edge code, and information other than image and audio should be part of digital representations, but dependent on its use.

An understanding of what information can be transferred to the digital realm as well as the information and representation desired is the key to creating a digital surrogate. A particular organization may care only about the information within the frames, so it will scan a film and create files only containing that information. Another may want to show the perforations as well and will produce a different surrogate. Whatever information appears in the surrogate, other information can be included in the metadata and/or catalog record that accompanies it.

There are few differences between16mm and 35mm film in terms of digitization. 35mm film is a larger size with a correspondingly different area for the photographic information. This means it has a different aspect ratio and perforation count per frame of picture information. This difference can correspond to different resolutions or number of pixels (digital picture information) needed to appropriately represent the information. More area for each frame means that there is more information to transfer into the digital realm for 35mm frames. An additional technological constraint for 16mm film is finding a film scanner that can handle the gauge; that is, one with gates and a transport mechanism for that specific width. Most 35mm film scanners have modifications or settings for 16mm film, but some do not.

Digitization

Digitization is the process of converting something into a digital representation. The resulting product is a digital video file, a series of still images, and/or an audio track. There are two main ways to migrate film to digital video: telecine (or datacine) and film scanning. Film scanners make one image per frame that can later be turned into video, while telecines convert to video automatically. Anytime a film is moved to a different format or version, something in it basic nature is changed. Telecines represent an older process of converting film to video (originally analog video, now also digital), with inherent complications relating to changing film to fit video specifications. Film scanning comes with fewer issues. Both telecines and scanning were developed to work with films in the post-production process for the purposes of editing. Telecines involve converting film to telecine video standards, which differ from film standards in terms of frame rate and lines of resolution among other technical specifications. Film scanning was specifically designed to represent film in the digital realm, sometimes leaving it in that realm, sometimes outputting it back to photochemical film. The goal of film scanning is accurate representation of film as a single or series of digital files, converting to video specifications. While scanners began as an intermediate step in the post-production process for films, they have since been adopted for archival and purely digitization purposes as well.

Telecines that create a video signal rather than individual scans of the frames present more concerns for conversion. Whether digital or analog, however, video consists of either progressive or interlaced scans. Interlaced scans need two fields to complete an image, while progressive scans have no fields and display a full image all the time. Interlaced scans draw the odd number lines for the first field and then the evens for the second field. Progressive scans, also called sequential, have all lines drawn for each image; progressive scans do not technically have fields, but full frames that can be refreshed up to 72 times a second. The NTSC standard is

interlaced video for standard definition, and two standards for HD, one progressive frames and the other interlaced; thus most video has two fields for each frame.

Film, on the other hand, has no field structure, only complete frames. This is not a significant problem in film-to-video conversion in Europe, which uses the PAL standard for video, with 625 lines and 50 fields a second. Film can be converted to video at an easy one-film frame for both fields of each video frame. Converting film images to video at 25 frames per second (rather than film's normal 24) results in only a slight flicker effect and some minor audio adjustment. The United States, however, adheres to the NTSC standard for video of 525 lines and 60 fields a second for standard definition and HD has 720 or 1080 lines that has 60 fields a second for high-definition. If one film frame is converted to the two fields of each video frame in NTSC, the film is transformed to 30 film frames per second, a condition that creates a noticeable dissonance between picture and audio, and requires adjustment[31].

Standard definition forms of digital television are the same as analog video except for encoding in lines of pixels and digital. There are the same number of interlaced fields and frame rate of 30 frames per second (fps), but with 640 pixels in 480 lines. For PAL or the European standards there are 760 pixels in 580 lines in standard definition at 25 fps. HD has a higher pixel count and varied frame rates not based upon electronic current including 24 fps similar to film. HD in the United States can be interlaced and progressive at 30 fps for black and white and 29.997 fps for color. These have resolutions called 1080i (interlaced fields) and 1080p (progressive frames) with 1080 horizontal lines with 1920 pixels per row. There is also a 720p

[31] Cvetnicanin, George D., Stuart Blake Jones, and Richard H. Kallenberger. *Film into Video: A Guide to Merging the Technologies.* Focal Press: Boston. 2000. Pages 39-42.

that runs at 30 or 60 fps with 720 horizontal lines with 1280 pixels per row. Both HDTV standards also have a 24 fps standard with the same number of pixels.[32]

Aspect ratio or size differences also create conversion issues between film and video. Up until the 1950s many films were shot in the same aspect ratio as video, 1.33:1 (4:3), or the Academy format. Standard definition video, however, allows for more action or material near the edge of the frame to be lost due to individual playback device accuracy in image registration. The concept of safe action deals with how the image is framed within the 4:3 aspect ratio, hence the amount of space away from the edges allotted for important content information. Film allows more important information to be closer to the edges of the frame, both vertical and horizontal. Video or broadcast needs more space from the edges to the important content information. As film switched to wide screen aspect ratios greater than 1.33:1, size conversion became a much larger issue.[33] Current HDTV standards have the aspect ratio of 16:9 that creates less frame conversion issues for films shot in widescreen, but is not completely analogous to film aspect ratios.

The North American standard for film aspect ratio became approximately 1.85:1 during the 1950s and 1960s. There are several options to address the size difference that resulted from this change: pan and scan, center crop, and letterbox.[34] Pan and scan is a process whereby a 1.33:1 frame is moved around each film frame in order to best capture the action on screen. There is a loss of information, but the best composition and content information is selected for

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[32] Weisse and Weynaud, pages 129-31.
[33] Enticknap, Leo. *Moving Image Technology from Zoetrope to Digital.* Wallflower Press: New York. 2005. Pages 47-73. Discussion of film standards and formats.
[34] James, Jack. *Digital Intermediates for Film and Video.* Focal Press: New York. 2006. Pages 399-402.

display. Pan and scan can cause awkward sequences when the frame is moving in addition to registering camera movement; the process is also labor intensive.[35]

The center crop process is less dynamic.[36] The 1.33:1 or 16:9 frame is applied uniformly in the center of the film regardless of content or composition, and there is a significant loss of information. The letterbox or hard mask method involves no loss of picture information. The full film frame is displayed but the hard mask appears as black lines at the top and bottom of the frame (I-box). When converting an Academy ratio film (1.33:1) to HD video, which has an aspect ratio of 16:9, there will be a hard mask on the horizontal edges of the rather than the vertical.[37]

Resolution in a film to video transfer also has incongruences with color and color registration. Film uses multiple color layers in its base and does not have color registration issues in its photochemical form. Color video uses separate scanning beams or chips for individual color components of film that can have errors in alignment when recombined or in the image pickup. These color registration errors lower the resolution and should be monitored when transferring from film.[38] Rather than accurately picking up color information and translating it to the digital realm, color itself is rendered differently in separate spaces and mediums.

Gamma refers to the tonal or dynamic range; that is, how much time and light are acceptable for each image. In both the computing and film realms, gamma is the combination of contrast and brightness of the image. Contrast is the difference in brightness between the lightest and darkest elements.[39] Film can have contrast ranges of over 100:1, but video is generally

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[35] Weise, Marcus and Diana Weynand. *How Video Works*. Focal Press: New York. 2007. Page 136.
[36] Cvetnicanin, George D., Stuart Blake Jones, and Richard H. Kallenberger. *Film into Video: A Guide to Merging the Technologies*. Focal Press: Boston. 2000. Page 44.
[37] Weise, Marcus and Diana Weynand. *How Video Works*. Focal Press: New York. 2007. Page 136.
[38] Association of Cinema and Video Laboratories. *Handbook: Recommended Procedures for Motion Picture and Video Laboratory Services*. ACVL: Bethesda. 1982.
[39] Ibid. Page 45.

limited to a contrast ratio of 20:1. Some scenes do not translate well when reduced this much and appear muddy due to a loss of tonal separation. Video and digital video are not able to differentiate among tonal values as they appear in film, but offer an image that combines a number of these differences. One video value of contrast conveys more than one value from the original film, giving an unacceptable picture quality during transfer. If gamma is not within the proper range, then there will be a limited range of shades seen from the original film object. In film transfers to video files, it is recommended to use a system whereby the most important part of the overall tonal range is uncompressed while compressing the remainder of the range.

Film responds to light non-linearly, and this relates to its density and color representation. According to *Digital Intermediates for Film and Video,* linear light and color space are "proportional to illumination levels in the physical world."[40] Instead of increasing in intensity by going 0, 1, 2, 3, non-linear registration follows an exponential or logarithmic growth patterns such as 0, 1, 4, 9.[41] This creates problems when converting to other color spaces such as videos that only record two channels of color in compliance with NTSC and current HD standards, computing the remaining color to save transmission and bandwidth space.

Non-linear color space is difficult to translate to other color spaces due to the fact that very high and low values of light and color are stored in the same image. These values can be converted with some algorithms and programs, but artifacts can potentially be introduced and information lost. The density of the film itself, not just its response to light, also affects the gamma and color space. Fortunately most film to digital machines are calibrated to capture as much as possible, and if not, then the methods discussed above can be applied. Color and gamma in the digital realm are tied to the bit depth of the files. The more bits, the more possible tones,

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[40] Kennel, Glen. "Conversion of 10-bit Log Film Data To 8-bit Linear or Video Data For The Cineon Digital Film System" Kodak. Version 2.1 July 21, 1995

[41] James, Page 109. Full discussion of color space and its relationship to gamma.

brightness, and colors can be represented. For instance, 2 bits can represent 4 tones, 3 can represent 8, 4, can represent 16, and 10 bits can represent 1,024 tones.[42] For color the bit depth or color depth represents how finely colors can be represented, while gamut expresses how much range of color can be expressed. These can be red, green, and blue (RGB) for digital images in a linear fashion, RGB logarithmically for film, and cyan, yellow, magenta, and black (CYMK) for printed works.[43]

Computer monitors represent color in full RGB space and light in a non-linear fashion that is corrected using gamma correction. Unlike film, digital images themselves are generally coded to the linear color space for this reason.[44] Film can be transferred to non-linear color space in the digital realm, but accurately seeing this representation can be difficult. For true visual representation of the digital files on a computer monitor the luma or light representation should be adjusted and the monitor calibrated. While it is unlikely that users who access works on computers will adjust their monitors for the ideal color space, transferring so as to be accurate to the original film object best preserves and represents this information.

Resolution differences, or differences in the capacity for capturing picture detail, between film and video also need to be considered during the transfer process. Optics, emulsion, processing, and the display device limit any film's resolution capacity. Resolution for video including digital video is limited by optical and electrical components, number of lines, bandwidth and its display. Video is also limited vertically by the number of lines and horizontally by bandwidth and display attributes.

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[42] Read and Meyer, page 221.
[43] James page 108 and Poynton page 282.
[44] James page 110 and Kennel page 3.

The general rule of thumb is to capture the film at the highest resolution and largest pixel count available due to the need for preservation. It is useful for the originating medium (film) to have a higher resolution than the transferring medium (video). Starting with a high resolution means more can be sacrificed in the transfer process with a more than acceptable result.[45] This means that during the process of compression the original information is more detailed so derivatives made will reflect that original quality, especially since most compression is based upon human vision and hearing.

Film scanning and other digital intermediary methods of creating digital video simply scan each photochemical image or frame as one digital image and then set the sequence into motion. The output is a file sequence of all the individual film frame scans that will playback as a moving image. Since film scans make each frame a single image, there is no need for adapting the frame rate, it plays back at the frame rate of the film, including the industry standard of 24 fps as well as others (18fps, 30fps, 42fps, etc). Film scanning was used to color correct, introduce special effects, and other post-production processes whose output was intended to be printed back on film originally. Unlike telecines, film scanners and their outputs were designed to accurately represent film in the digital realm as opposed to convert it to another moving image format in video. The file(s) created by scanning adhere to their own logic and standards aimed at being viewed on computers and the digital realm as opposed to television. Issues of resolution, gamma, and color registration nevertheless apply to film scanning, while framing and field differences do not.

Most film scanners have the resolution of 2000 (2K) pixels or higher for each individual frame of film. The general formats for the digital essence of the scanned film frames are DPX,

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[45] Cvetnicanin, George D., Stuart Blake Jones, and Richard H. Kallenberger. *Film into Video: A Guide to Merging the Technologies*. Focal Press: Boston. 2000. Pages 47-9.

TIFF, and the proprietary Cineon. These formats have the feature of storing color information as raw data, or a much more flexible form. Since all of these formats are designed for film scanning, they have specialized metadata for the film conversion as well. DPX (Digital Picture Exchange) is an American National Standards Institute (ANSI) and Society of Motion Picture and Television Experts (SMPTE) standard and has become the de facto international format for film scanner output. These are generally 8-bit or 10-bit resolution in RGB color space but also can be output to YUV or color difference space.

Film scanners scan and create a separate image file for each individual film frame. The motion of the scanners is relatively similar to high-end telecines in that they offer capstan and servos to move the film without too much wear and tear on the film object. They can fast shuttle and rewind without unnecessary risk to the original object unlike film projectors. Telecines and film scanning in professional post production houses generally look and operate in similar ways with the film going through a film safe path before passing by either a flying spot scanner using an electrode from a Cathode Ray Tube (CRT) or a photosensitive microchip like a Charged-Coupled Device (CCD). The electrode from a CRT is reminiscent of analog video cameras and television sets that used CRTs for recording and playback. The CRT in these telecines and film scanners, however, converts to digital rather than analog signals.

Some film scanners and telecines have pin registration to accurately register the frame within their scanning area. If not registered by pins then the frame has a tendency to move around the frame creating distortion on playback. These pins increase wear and tear on the film as they create an intermittent pulldown effect similar to a projector, but create a higher quality scan or conversion to video. Some new scanners offer optical pin registration that senses the

perforations of film and uses that as a guide for image placement.[46] This keeps the film moving without the need to use a mechanical method to stop and register the frame accurately. Such an option is especially useful for shrunken or damaged film whose perforations do not come in standard sizes.

Film scanners take longer to transfer film than telecines but result in a higher quality final product. Scanning is also significantly more expensive as machines cost $100,000s and this outlay is rolled into the cost of scanning. There are a few other methods to convert film to video, such as using a modified projector with a pulldown scheme. These are more reasonably priced, but sacrifice the safety of the film, reliability of processing, and sometimes resolution and other transfer features for the film. A method that creates purely access files, not recommended by this thesis, is using a digital video camera to film a movie as it is being projected. These methods offer a significant price reduction from the professional models of telecines, datacines, and film scanners,[47] but also a significant loss of control, adjustment, and quality.

Rather than purchase one of the more expensive devices, cultural heritage institutions can negotiate with a post-production house or film laboratory that has already invested in film-to-digital transfers. These operations have a variety of options and the technical expertise to create any level of digital files, including preservation (the highest quality master file), mezzanine (a working or editing file), and access (distribution file, usually lower quality). Their staff can also explain the different quality of scans from best light, one light, as well as resolutions, color corrections, and other technical aspects. The digital files resulting from these scans can also be done to whatever specifications and further processes are wanted, such as digital film restoration and color correction. The rate for any of these processes is by the hour as opposed to quantity of

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[46] "Film Registration", *Lasergraphics,* 2014. www.lasergraphics.com/film-registration.html.

[47] *Final Report*, The Center for Home Movies Digitization and Access Summit, January 2011. pdf.

feet. A five-minute 16mm film will cost the institution the same amount as doing a 45-minute one using one of their own machines.[48] In this light, cultural heritage institutions often seek to develop a working relationship with an outside vendor in order to obtain services at a cost-effective rate.

Digital Preservation

Preserving digital content comes with its own unique challenges and one of them is youth. It is a relatively new development and one that is constantly changing in technology and mediums. Film prints, regardless of process or stock, can be stored in archival conditions and last for hundred of years; the same cannot be said about digital preservation. As reported in the European Commission's "Challenges of the Digital Era for Film Heritage Institutions,"

> The Preservation of digital works, either born digital or digitised, is at a very early stage of maturity by comparison to film. No digital storage technology exists with a lifetime comparable to analogue film separation masters.[49]

This line of thought leads to the possibility of digital representations of film being a format for access, while analog representations remain the archival format. Regardless of whether this happens, we still need to think systemically about long-term storage and access for digital assets, whether born-digital or not. Too much of contemporary culture is becoming digitized to do otherwise. As much as film technology has changed over its lifespan, so will digital technology. Nothing currently has the automatic lifespan of 100 years that film does, but with planning and thinking this might begin to happen.

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[48] In-depth discussions of the transfer process as well as what technical aspects to take into consideration during the transfer as well as the final product see "Chapter 20 Video Images & Digital Restoration of Archival Film" Paul Read and Mark-Paul Meyer, and "Chapter 5 Acquisition" James.

[49] "Challenges of the Digital Era for Film Heritage Institutions", *Digital Agenda for the European Film Heritage,* European Commission, DG Information Society and Media, December 2011. Pdf.

Digital preservation comes with its own set of strategies and actions that differ from analog film preservation. For digitized works, this includes ensuring analog preservation of the original object as well. Digital preservation strategies include format migrations and standards, detailed metadata, storage, refreshing, emulation, replication, and encapsulation. All work to ensure long-term viability, preservation, and access of digital data. These services can be done in-house or out-sourced to organizations that have the infrastructure and means to preserve digital assets. Even though streaming files are generally for access, they should be treated to digital preservation strategies. The Library of Congress outlines the basic steps that are needed,

> Identify and select what to save, organize the files selected to be saved, save copies on at least two different storage media (e.g., USB drive and external hard drive) and keep these in separate physical locations, migrate saved copies to a current storage medium about every five years.[50]

Replication refers to creating one or more copies of files in different digital storage systems. These should be in separate geographic locations in case of natural or man-made disasters. A system used by many libraries and other cultural heritage institutions is LOCKSS (Lots of Copies Keep Stuff Safe).[51] LOCKSS consists of a series of networked organizations that share files and create redundancy for their collective assets. If anything happens to one of these organizations, there will still be sufficient copies of the data held by other participating members.

The OAIS (Open Archival Information System) Reference Manual[52] views migration of digital data as a commitment to preserving the full information on the file by creating a new file that replaces the old one.[53] Even with digital asset management, data redundancy, and backups

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[50] "Frequently Asked Questions", *Library of Congress,* 2014. www.loc.gov/preservation/about/faqs/reformatting.html
[51] "Lots of Copies Keep Stuff Safe", *Stanford University,* 2014. http://www.lockss.org/
[52] The Consultive Committee for Space Data Systems", *Reference Model for an Open Archival Information System (OAIS),* (Washington: CCSDS, 2012). Pdf. http://public.ccsds.org/publications/archive/650x0m2.pdf
[53] "Digital Preservation Strategies", Digital Preservation Management, *DPWorkshop,* 2014. www.dpworkshop.org/dpm-eng/terminology/strategies.html

with geographic distance, organizations periodically need to upgrade or migrate their storage media. This is due to the possibility of storage media failure, decay, and obsolescence over time. Since digital files and information can be copied without loss, exact copies can be migrated to and from different storage devices. If a primary file becomes corrupt, then a copy is made from the backup that is on another storage media unit. If the organization is switching to different storage media, then exact copies can be made to the new media. These processes can be automated or deliberate, depending on the circumstances and the digital asset management (DAM) system. Refreshing occurs when information content is copied to the same storage medium. Reformatting occurs when information is copied to a different storage medium.[54]

Unlike media migration, format migration changes the structure of information and its representation in a digital file. It is done for a variety of reasons. If a specific file type is proprietary, owned by a company, where information about it is restricted and can only be opened with their software, the file contents might warrant format migration. Proprietary file types stand in contrast to an open-source approach where information is in the community and can be accessed by any number of software and hardware components. Specific formats also can become obsolete whether they are open-source or not, in which case format migration is warranted. Specific software and hardware dependencies can also sometimes limit future access. Some digital repositories only accept specific types of formats or standardize what is acceptable in their repository to limit format migration once stored. Both format and media migrations generally need to occur every five years.

This is why it is important when digitizing 16mm film to chose codec and formats that have long-term viability and access. Institutions want to consider the openness of the file, how

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[54] "Introduction – Definitions and Concepts", *Digital Preservation Handbook, Digital Preservation Coalition,* 2014. www.dpconline.org/advice/preservationhandbook.

accessible it will be in future, how widely adopted the format is, how much support exists for the format, if it is an ISO or professional standard, and if it is unencrypted or does requires passwords or key codes to open content. A good resource to examine when choosing formats is www.digitalpreservation.gov/formats/intro/intro.shtml, an updated site that gives opinions on the long-term viability of specific formats and encodings.

Digital content should also be uncompressed or compressed using codecs similar to chosen file formats for ease of replication. An uncompressed 10 bit DPX file structure or 10 bit uncompressed video file is preferable to an access file using H.264 codec since more information is accurately represented. If compression is applied for preservation files, it should be lossless and the full data and representation available upon decompression. Lossy compression codecs including H.264 should be simple and standardized for ease and likelihood of proper decoding in the future. It should be noted that digitization to preservation level should be done whenever possible, but even access files deserve preservation and thinking about formats and codecs. Metadata in the digital realm is more important than ever. It is generically described as data about data, in the digital realm about the digital objects, these can be catalog records, information to decode the object, its requirements for playback, and information to locate it among others. For digital preservation and the resulting DAM, the most important metadata is preservation metadata. According to the Digital Curation Centre, an organization dedicated to data management for educational institutions, "Preservation metadata is information that supports and documents the process of digital preservation. The term is usually reserved for metadata that specifically supports the functions of maintaining the fixity, viability, renderability, understandability, and/or authenticity of digital materials in a preservation context."[55]

[55] "Preservation Metadata", *DCC,* 2014. www.dcc.ac.uk/resources/curation-reference-manual/completed-chapters/preservation-metadata

Preservation metadata contains all the information necessary for files to exist in a DAM and also be accessible in the future. What specific preservation metadata is selected and necessary for each institution or project depends on their DAM and digital repository. A lot of this metadata may be embedded within digital files, using software such as MediaInfo,[56] which can extract it and populate necessary metadata fields. With projects that aggregate records into a single access portal for works that are placed online, such as streaming metadata, interoperable metadata standards that work with the records of other organizations are recommended. A good source of information about metadata standards, especially for interoperability of digital content is found at the Library of Congress, http://www.loc.gov/standards/mdc/.

Other preservation strategies mentioned earlier are encapsulation and emulation. Both are important to overall digital preservation systems, even if given only a cursory explanation in this thesis. Emulation is a process whereby obsolete hardware and software environments are recreated or imitated in current computing environments. This strategy is mostly employed in videogames and is often done illegally. Encapsulation is the process of building everything needed to access the digital materials into encapsulated information. Encapsulation creates containers or wrappers that provide information and metadata about the relationships between the various components of the capsule as well as other supporting information and metadata.[57]

Demand of digital access goes hand-in-hand with support for digital preservation. Digital preservation comes with year-round costs as well as periodic significant investment in infrastructure. In order to provide support for long-term preservation and sustainability, value

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[56] Site for MediaInfo is www.mediaarea.net.

[57] "Digital Preservation Strategies", Digital Preservation Management, *DPWorkshop,* 2014. www.dpworkshop.org/dpm-eng/terminology/strategies.html

needs to be added to digital access.[58] A variety of methods to create value and sustainable digital preservation and access can be found in "Sustainable Economics for a Digital Planet: Ensuring Long-Term Access to Digital Information" by the Blue Ribbon Task Force on Sustainable Digital Preservation and Access. One sees value added systemically in the cases of digital access initiatives in collaborative partnerships with private organizations, sharing expertise and personnel, and creating incentives for stakeholders to invest and care about the digital assets such as licensing and social media. Digital access creates support for digital preservation and makes it economically sustainable, while, in turn, digital preservation makes streaming initiatives possible. There could be no survey on streaming initiatives for moving images without digital preservation.

Metadata and Cataloging

As mentioned above, metadata is data about data. Mike Cox, Linda Tadic, and Ellen Mulder expand on that definition in their 2004 volume concerning metadata and catalog records for moving images in both analog and digital instantiations.

> The traditional answer is that word 'metadata' comes from the Greek 'meta,' meaning 'about,' so that metadata literally means 'about data.' To most people, this is about as helpful as Humpty's explanation to Alice. In the simplest terms, metadata is a particular detail of information about something else.[59]

Cox et al. go on to state that metadata is of increased importance for moving images since these images are not experienced as they are created, but reproduced through mechanical, electronic, or digital forms. Users need to know basic information – title, creators, how to locate the item,

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[58] Arguments in this section from the publication and website Blue Ribbon Task Force on Sustainable Digital Preservation and Access, "Sustainable Economics for a Digital Planet: Ensuring Long-Term Access to Digital Information", *Blue Ribbon Task Force on Sustainable Digital Preservation and Access,* 2010. Pdf http://brtf.sdsc.edu/biblio/BRTF_Final_Report.pdf

[59] Cox, Mike, Linda Tadic, and Ellen Mulder. *Descriptive Metadata for Television,* (2006: Elsevier, Inc. 2006). Page 2.

when it was created, etc. – to access and understand the work. Institutions need information such as the previously discussed preservation metadata, for internal records and information structures in order to preserve, keep, and make accessible the moving image materials.

Metadata is something separate from the resource itself that describes that resource. This is true even if it is extracted from the resource such as technical information for digital files. Metadata consists of sets of properties also called elements or fields and a set of values for these properties. When different bits of metadata are grouped together concerning one resource, they form a record representing selected properties of that resource.[60] Each record holds different types of metadata that serve different purposes in the record. Some are used for discovery and retrieval of the resource for users, others are meant for the cultural heritage institution to preserve the resource itself.

Ultimately metadata is compiled and chosen due to its ability to perform some kind of function for the resource. From the users perspective, the largest function is being able to locate and retrieve the resource. They are also interested in contextual information for understanding the work, especially if it has been digitized from an analog resource. The information captured in metadata also allows users to understand moving images separate from watching the content. For streaming, instances can include thumbnails to represent information or the ubiquitous symbols for sharing on social media or placing the work onto maps to illustrate geographic locations in the work.

Descriptive metadata provides intellectual access to the resource through descriptions of the content that serve as access points for users allowing identification and retrieval.[61] Administrative metadata includes all legal or business aspects of the resources. Such metadata

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[60] Miller, Steven J. *Metadata for Digital Collections: A How-to-Do-It Manual*, (New York: Neal-Schulman Publishers, 2011). Chapter 1

[61] Cox et al.

describes what the status of the work is in terms of copyright, what access restrictions apply, and other legal or rights issues associated with the work. Two other metadata categories are sometimes included under administrative metadata and sometimes held separate: technical and preservation metadata. Technical metadata describes the technical process used to create or use a resource. Preservation metadata contains all the information necessary to ensure the long-term care and access of all elements of a resource. Structural metadata represents the physical or logical structure of a resource.[62] For a book, these might be chapters. In the digital realm, structural metadata describes the internal data elements that comprise a complex digital object or closely related set of digital objects – for example, the audio file associated with a DPX scan of 16mm film. Such metadata can be said to represent the intellectual and physical elements of a digital object.[63]

Beyond having all the information necessary to create a comprehensive record of a resource, metadata needs to be structured and standardized. Standardization is achieved by using either local or larger standards. The more standardized metadata is, the more likely it is to be interoperable with and useful for other cultural heritage institutions. As Steven J. Miller describes in *Metadata for Digital Collections*, there is an easy way to understand and implement the different standards.

> A fourfold typology has been used in the topic, distinguishing metadata (1) structure, (2) content, (3) value, and (4) encoding/exchange standards (Gilliland 2008; Zeng and Qin, 2008; Elings and Waibel, 2007; RLG, 2005; Boughida, 2005).[64]

Data structure standards cover metadata elements (fields, properties, tags). These are commonly referred to as schemes, schemas, or element sets, and examples include PBCore,

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[62] "Best Practices for Structural Metadta", *Yale University Library,* 2008. www.library.yale.edu/dpip/bestpractices/BestPracticesForStructuralMetadata.pdf
[63] "Metadata, Structural", *Federal Agencies Digitization Guidelines Initiative,* 2014. www.digitizationguidelines.gov/term.php?term=metadatastructural
[64] Miller Page 13.

Dublin Core, EAD, MARC21, and others. What schema is correct relates to the nature of the collection, the cultural heritage institution itself, and whether or not the collection is digital. Data content standards provide rules for how to input data into the different elements. These describe a standard way to abbreviate, how to enter names, and enter other elements. Examples of these include AACR2, DACS, and CCO. Data value standards set forth a list of established and standardized terms including resource types, authority files for names, thesauri and subject headings.[65] Examples include Getty *Art and Architecture Thesaurus* (AAT) and *Library of Congress Subject Headings* (LCSH). Data format standards describe the way that metadata is encoded to be read by computers and shared with other institutions. Right now the most common data encoding and interchangeable format is Extensible Markup Language (XML).

Different cultural heritage institutions use different metadata implementations depending on their mission, the ways they want to describe their collections, and the nature of their collection. Museums generally describe their collections in different ways than do libraries and archives. Traditionally museums are much more idiosyncratic due to the idiosyncratic nature of their collections, and the fact that individual objects are grouped with a larger set of objects in the museum. The way one museum describes an object is likely to be very different from the way another museum describes a similar object. Library metadata implementations are traditionally more interoperable and standardized, due to a lack of unique resources, their open mission statements, as well as extensive cooperation among different libraries.

Even if cultural heritage institutions have traditionally used local implementations that do not work with collections from other organizations, in networked and online environments it increasingly important that they move toward interoperability with other organizations. Various

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[65] Metadata Working Group. *Metadata Guidelines*, UMASS Amherst Libraries, 2013. www.library.umass.edu/assets/aboutus/attachments/Metadata-Guidelines-v4.pdf

implementations crosswalk to other forms of data in order to be interchangeable and intelligible by different systems. Current projects such as Europeana aggregate records of online content from a large number of institutions to make them available through a single portal. This kind of interoperability and discovery is relatively new and in many ways the future of metadata and catalog records. Digital humanities research uses metadata and catalog records across institutions to create projects where one can search all images for, let us say, sheep in 1924, thereby creating new contexts and understanding of such representations, data, and images.

Interoperable and online records of resources also have the ability to be discovered by web search engines such as Google through a process of structuring and populating data. If an organization makes its record Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH)[66] compliant, then it is indexable by web searches. This means that instead of going to a web portal or the institutional website, a simple search for content or subject will return the resource. With the semantic web being another way to structure data and metadata, there is more impetus than ever to implement interoperable structuring of content online. The semantic web uses a Resource Description Framework (RDF)[67] to structure web pages and online content to represent information in new ways. Individual connections between the various parts and information of a web page are created in order to enable computers to perform complex searches more easily. Searches for a specific moving image work will return all the information from a variety of pages.

In the current networked environment in which cultural heritage institutions find themselves, metadata is critically important for their digitization and streaming initiatives.

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[66] "Open Archives Initiative Protocol for Metadata Harvesting", *Cornell University,* 2014. www.openarchives.org/pmh/

[67] "Resource Description Framework (RDF)", *W3C,* 2014. www.w3.org/RDF/ This resource also contains more information about the semantic web in general.

Instead of physical instantiations being accessed in a physical location, users are now creating connections, discovering works, and viewing works using a networked computer. Data is being structured and restructured all the time through networks that use semantic web protocols and usable metadata is essential to this work. In addition, scholars who use cultural heritage resources are demanding access to such metadata for their research. It can be as important as the resource itself. As this transition occurs and records are placed online, it is important to incorporate older analog record systems and new online records together. The case of Northeast Historic Film, which still relies on physical catalogs for full access to its collection, shows that this integrating online and offline catalogs is a lengthy and on-going process. Also the more value, use, and demand for online and digital resources provided through having metadata and catalog records online, the more institutions can garner support for their digital initiatives.

Digital Access

Cultural heritage institutions now operate in an era where film laboratory and projection infrastructure, especially for 16mm films, is declining. There are no longer resources or expertise available at affordable rates to replicate 16mm film onto photochemical stock or provide access for users. While it might be better for the film if it were copied to new photochemical stock, this is an increasingly unlikely option. The capacity to screen such films is also very limited.

The growing response to this situation has been to digitize film and make the resulting files available to users. Not only does this get around declining 16mm film expertise and infrastructure, it opens the possibility of providing the content to a much wider audience than could be done at an individual screening. Turning films into digital content and data also allows institutions to place their content onto web pages that appear in various search engine results,

supplementing what is found through localized search portals specific to institutional webpages. The new content can be placed on institutional websites or widely used third-party websites such as YouTube. Digital forms and access for film content arose largely out of necessity to deal with declining capacity to screen films; it has produced benefits that go far beyond this original motivation.

The present moment is also one in which users also expect digital access with a range of functionality and do not necessarily expect to see film on film. This is partially due to the rise of digital cinema and its Digital Cinema Packages, as well as online services such as as Hulu, iTunes, and Amazon that offer streaming and download of content. Cultural heritage institutions are increasingly aware of such user expectations. Their response is increasingly to provide online digital access, a move that goes far beyond even their previous practice of delivering content on videotape and similar forms for a fee paid by inquiring users.

Putting content into the digital realm and online increases the institutional web presence and audience. Users are likely to discover the content through a simple web search, see what institution and collection it came from, remember it, and use it either virtually or in-person in the future. The placement of both records and content online allows for holdings to be placed into digital collection aggregators that create federated catalogs across institutions such as the Europeana, Digital Public Library of America, and the Smithsonian Audiovisual Archives.

The variety of users that access to the content also increases with digital access. Instead of individuals needing to travel to see or study a 30-minute film, they are able to access the content anywhere on the Internet or receive it in the mail on DVD or hard drive. Users who could not attend screenings at cultural heritage institutions in the past now have an opportunity to view and study the content.

If an institution chooses, it can also charge a fee for downloads of its digital material, thereby creating more value from the holdings. A number of institutions now allow download for such a fee either through their own website or a third-party website such as Amazon. This arrangement supplants the need to transfer and disseminate materials on physical media such as DVDs in response to individual user requests. Sometimes download services also have an option for both download and the receipt of an optical disc in the mail a few days later. One of the advantages of digital access is the ability to create exact replicas with ease. The process to create the DVD is generally automated and the storage and servers used to create online access can make the file compatible and available on disc as well. This service is generally associated with third party retailers such as Amazon.

Users also now expect video on demand services through their cable boxes and computers through streaming, which delivers moving image content immediately. This is fast becoming the primary way that users access and expect moving image content from any provider. In this process, specific content available for distribution on servers can be accessed at will by the user, but cannot be downloaded or copied without piracy issues. Cultural heritage institutions do not have cable boxes and that form of video on demand distribution, they nevertheless create similar functions as these services through streaming content on the website. Individuals find the website with the video file and play it on their on time table. Institutions have responded to this expectation of video on demand content and integrated into their own needs beyond just webpages of content.

In the interest to serve digital humanists who demand more tools for research and generally ask for download cultural heritage institutions sometimes place more functionality into the streaming environment and files than found in commercial services. While some collections

and institutions make the files available for download free, most do not provide this service. Instead they adopt a compromise position of integrating the digital humanities tools into their webpages. This is limiting for some researchers who want to take the content and use their own tools, but it still provides new interactions and ways to view moving image content that is expressly networked and digital.

In many ways streaming and downloading content through the Internet is the future of digital access for cultural heritage institutions as it increases web presence and audience, allows for new tools and connections to be embedded into the webpages, and satisfies various user groups demand for content in an increasingly video on demand environment. In contrast to film infrastructure, digital and networked distribution infrastructure as well as digitization infrastructure is increasing in terms of quality, reliability, and support.

In-House Access

One way that institutions can provide access is in-house. The process is relatively similar to film viewing rooms such as MoMA's. The user accesses the facilities at the institution, using computers and/or digital projectors to view the material. Unlike remote access forms that are dependent on bandwidth and user machines, the files that can be accessed can be much higher resolution. The user can also sometimes view the material in specified theater or viewing spaces that are more reminiscent of traditional 16mm viewing. Most of the time, however, these materials are accessed in a series of media villages involving computers and more personal viewing stations. The content is either loaded onto a computer for the user or sent from servers.

An example of this setup is the Paley Center that allows users to search databases and access content on-demand, but only on site. This can be frustrating for the casual user who

locates desired content online but lives far away from an on-site access point. Having users come in and access services either for a fee or free increases the amount of traffic in the institution, the use of materials including analog or non-digital. Sometimes users pay for exhibitions or other services that increase revenue stream and value of the materials for the institutions.

Remote Access

One part of any digital initiative is to create enough value so that the initiative can be sustainable for the institution. In-house access increases the value of materials for visitors who come to the physical space of the institution; remote access increases the value for a much larger user base. This leads to greater revenue for institutions that are investing a significant amount of money into digitizing their materials. As a result the digitizing of 16mm film is more likely to continue and not be contingent on specific grant or project funding if content can be accessed in ways that users want from the institution. Remote access specifically through the Internet helps create the conditions that justify and help sustain digitization and larger digital initiatives.

Remote access also changes the nature of the experience from a communal one in a specific place to a more individual and isolated one. Somewhat ironically this shift to individual experience also expands the user base and opens up institutions to more diverse and larger communities. Users are no longer just from a certain region or within travelling distance, but constitute online communities that can be distributed anywhere with Internet access and a computer. The number of people who can find and use content dramatically increases and is theoretically as large as the Internet infrastructure of the institution can handle. Interested users who would not have access previously to collections or holdings now have access and help provide value for the institution.

Remote access also situates the viewing environment as less dependent upon the institution, but rather on the Internet connection or bandwidth and machines of the user. On-site access necessitates that institutions have the requisite playback equipment, while users accessing remotely view the content on their own equipment. One of the benefits of remote access is that institutions do not need to have the full infrastructure to stream content to a large volume of users, but can outsource to companies that have the requisite equipment for efficient distribution over the Internet. Companies or groups like Internet Archive, Ubuweb, YouTube, Real, Windows Media, etc. allow institutions to upload content for remote access from user requests. This sometimes costs money and is sometimes free, but means that institutions do not have to invest heavily in infrastructure to provide content online. Remote access helps provide content in ways that users expect and demand as well increase institutional presence and use to larger communities while adding values to individual projects and holdings to larger digital initiatives.

Download

This remote access process is one in which the user downloads an exact copy of the file that is available online. Rather than being dependent on available bandwidth for playback during download, this system can provide any size and type of file to the end user. The file can then be played back on any of the decoders or players that are on the user's machine. Accurate playback is determinant on the decoders and speed of the machine rather than encoding and embedded players. Instead of creating compressed versions of files for streaming, a full preservation level resolution file can be downloaded and used.

While download allows for accurate playback as long as the file is downloaded completely and without error, it also allows for more copyright infringement as well as less

control from the providing institution. If moving images are made available for download the institution has to be confident in copyright clearance and willing to cede control over the file. Instead of just providing access to content for a limited time, the user has a permanent and exact replica of the institutions digital surrogate for 16mm film. This means the file could potentially be posted to YouTube and reused in other ways. Different forms of research are available for files that are downloaded, but so are other uses that are not friendly to the institution. Downloading also allows the user to leave the institutions website and potentially never visit again or use other holdings. Streaming however allows users to stay on institutions website, but limits the way the use of content in much more stringent ways.

Streaming

At its most basic, streaming refers to moving image and audio content transmitted from a content provider to an end-user online. For the purposes of cultural heritage institutions media content is transmitted through the Internet, private networks, and wireless networks. Such streaming requires a server that encodes and serves the moving image and audio materials through the Internet to an end user's device (e.g., computer, smart phone, tablet) with an application that decodes the transmitted content (e.g., web browser with media player and plug-in) also connected to the Internet. Steaming is a new major transmission method for moving image content. What separates streaming from other forms of file and data transmission over the Internet, such as download and file transfer services, is that it is possible to play stored streaming content while it is being transmitted.

Streaming is generally used as a catchall term, but can refer to a number of different processes, progressive download, "true" streaming, and adaptive streaming. Progressive

download is a process where a copy of the file is stored in a temporary file on the computer, while “true” streaming allows caches, buffers, or stores a portion of the file. A complete copy of the file is stored in a hidden file for progressive download, while a complete copy of the file is not completely stored for “true” streaming. Adaptive streaming is one where available bandwidth and transmission speed is noticed, and a series of files with different resolutions, sizes, and encodings. It is a process where available bandwidth and file resolution and size are optimized in a dynamic process during transmission. However, streaming is generally used to refer to all of the processes without distinction.

Internet streaming can occur over the World Wide Web (series of web pages and contents), wireless networks, and private networks. It can be live (webcasting), such as television broadcasts, or can offer a library of static content (video-on-demand). Digitized 16mm films will form static content of video-on-demand Users can access streamed digital video content using a number of devices and processes, iPads, televisions, computers, smart phones, wireless, Ethernet cables, etc. It is much more dependent on transmission speed or available bandwidth from both the supply and user sides. Quality of service for streaming transmission relates to the ability for enough content to be received so that playback is uninterrupted, that means that the available bandwidth and data or bit rate encoding is able to transmit and playback the file at a speed where it can be decoded and cached faster than playback. This means that files sizes and bit rates are smaller and resolutions generally lower regardless of available bandwidth. Download and file transfer is the service that allows for larger files size and higher resolution content since it is not being played during transmission. There are a variety ways to optimize bandwidth using Internet transmission infrastructure more intelligently as well as selecting file types and encodings that does not exceed available bandwidth.

The technical requirements for streaming projects involve digital storage, servers, network transmission, as well as web browsers and plug-ins to play the content. The web browsers are generally part of any user's computer and display web page content. Individual plug-ins that make video content displayable are sometimes necessary. This adds a layer and additional activity for the user to access the content. The most common plug-in is Adobe flash player that services such as YouTube employ. It is readily installed in most browsers due to its ubiquity, but sometimes involves a separate download or update by individual users. The digital storage and servers are on the cultural heritage institutions side and determine how the content is placed kept and made available from users request. The network transmission path is variable and does not rely on infrastructure from the cultural heritage institution, but through a series of services and applications can be optimized to deliver the content faster.

Unlike download, streaming services offer more insurance from piracy and unauthorized use of the materials. The user does not receive a copy of the material and has to go through a series of steps to copy the content from a stream. The steps involve downloads add-ons to the browser or applications that store streaming content as a file. It should be noted that some institutions, particularly the Prelinger Archives and AV Geeks, do not view reuse or copying as theft or problematic. Most cultural heritage institutions, however, see the situation differently. This unwanted copying is often mitigated by the fact that streaming files are not high-resolution and of inferior quality to the original digital files of the cultural heritage institution. There are other steps such as watermarking or adding bugs into the stream that prevent effective copying of the digital file itself. Streaming lends itself to such protection of materials much more than download.

Streaming itself also keeps users on the collection or institutional website instead of allowing them to download content and never return. This increases the chance that users will discover more material and return to the website.

Streaming workflow

Successful streaming requires safeguards and workflows that maximize service to users and minimize the problems that can occur at various stages throughout the process. Keeping synchronization information through the process of transmission intact is fundamental. Content providers also have to take into account user knowledge and the user's quality of service. Low or variable data rates from user Internet connections, error rates, and delay in delivery of content are also important.[68] There are five main components to any streaming workflow: capture of content, preparing video for streaming, servers, distribution and delivery, and web browser or decoder.

Digital Video Characteristics and Streaming

With the advent of native video and audio elements and support in HTML5 in and HTTP in 2007, the language of web pages, streaming video online has more options and support than ever before. There have been a number of stages of streaming implementations since the 1980's that have brought us to its current state. The commercialization of streaming processes with Netflix, Hulu, and YouTube, has led to the rise in support and options for making video available online to users. High quality streaming of digital material begins with compression of the material to be streamed. During this preparatory stage content providers also need to make key decisions

[68] Inglis, Andrew F., and Arch C. Luther, *Video Engineering*. 3rd ed., New York: McGraw-Hill, 1999, Print, Page 504.

involving the way the video will be streamed. These include what mechanism(s) will stream the video (players in HTML, YouTube, Google Video), how many files to encode or compress from the original file, and what format and codec, among others.

Compression

Encoding or codecs offer a chance to provide compression as well as a way to encode the video. Most digital video files from analog sources like film are generally captured in an uncompressed or lightly compressed form for preservation. These digital video files are often too large to be streamed without losing quality of service or providing an adequate streaming video for the user. The uncompressed versions of the files are too large and contain too much information to be transmitted over the Internet without any problems in playback unless the Internet connection is extremely high speed. The preservation file sizes as a result need to be reduced or compressed to a size suitable to video streaming. This process is called transcoding where the encoding is changed from one codec (encoding) to another one. In order to compress the video and audio files number of bits that represent content need to be reduced while retaining enough to be usable and faithful to the original.

Digital video consists of pixels that comprise picture data, which changes from one complete field and frame of video to the next. In uncompressed form, digital video has a number of redundant or unnecessary pixels and bits that can be removed or encoded to smaller size without losing too much picture quality. The new encoding and codec used will reduce information hopefully without sacrificing too much video quality and information. Digital video compression has some standards, algorithms, and techniques that are used to reduce the information. In order to compress video either propriety applications such as Apple Compressor

or open-source applications such as FFMPEG are necessary to apply compression techniques to the files. Proprietary applications have a tendency to cost money, while the open-source applications are generally free. I recommend the free applications that contain high-quality libraries of codecs and algorithms to compress the files.

Codecs and Formats for Streaming

Codec and format selection will vary by the way video is streamed and the players used to decode the digital video characteristics, but should offer a high quality picture while significantly reducing the file size for low bandwidth requirements. There is no true baseline codec or one that is universally supported by all browsers, web players, streaming services, or HTML for video streaming. There is a de facto standard encoding or codec of H.264 MPEG-4 Part 10 wrapped in a number of containers and paired with Advanced Audio Codec (AAC) for the audio component. H.264/MPEG-4 Part 10 is also referred to as MPEG Advanced Video Coding (AVC). When both bit streams for audio and video are encoded to MPEG-4 stipulations the overall result will be compliant with MPEG-4 Part 14 requirements. MPEG-4 is part of the Motion Pictures Expert Group's (MPEG) internationally recognized transmission standards that are used for DVD (MPEG-2) and digital television. H.264/MPEG-4 combines a number of patents and technologies to provide high-quality video compression at a low file size that conforms to various transmission standards. The specifications for the different standards of MPEG-4 do not stipulate specific container formats or wrappers.

H.264/MPEG-4/AVC encodings can easily be wrapped in the container format MP4, but some web streaming services require other formats. The biggest container format for web viewing is the Adobe Flash format .FLV that demands a plug-in for access. YouTube and a

number of other popular streaming websites use Adobe Flash as their preferred way for viewing video on the web. It is very proprietary and as a result a number of websites conform video uploaded in a number of wrappers to .FLV themselves. Another major container format is Apple Quicktime's format (.MOV) that receives native support from a number of web browsers as well as the QuickTime service itself. As Jan Ozer, someone who creates web videos for streaming distribution and lectures on the subject states in *Video Compression for Flash, Apple Device, and HTML5,*

> I like to say that H.264 is a present that comes in many wrappers (or formats), including QuickTime, Flash, Silverlight and the H.264 standard wrapper. According to Part 14, MPEG-4 files containing both audio and video, including those with H.264/AAC, should use the .mp4 extension, while audio-only files should use .m4a and video-only files should use .m4v. However, different vendors have adopted a range of extensions that are recognized by their proprietary players, such as Apple with .m4p for files using FairPlay Digital Rights Management and .m4r for iPhone ringtones. Adobe has adopted the .f4v extension for H.264 files bound for Flash playback, and H.264-encoded video produced for mobile phones typically uses the .3gp and .3g2 extensions.[69]

As one can see H.264 encoding can be wrapped with many different containers that can be used with many specific decoders and situations.

There are many reasons that H.264 has gained the market penetration that is has of late and that is its standardization and adoption by proprietary streaming applications and portals. Rather than be controlled by one source it sets a standard to the algorithms or compression schemes that are used during encoding. This means that H.264 defines the way the bitstream or video representation can be stated and organized as well as the way it is read or decoded, but does not state how this is to be achieved. As a result there are many different ways for encoders to properly compress and encode H.264 video.[70] The specific stipulations that H.264 offers are three types of frames, I frames, P frames, and B frames, and the types of compression that can be

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[69] Jan Ozer, *Video Compression for Flash, Apple Devices and HTML5*, (Galax: Doceo Publishing, 2011), 44.
[70] Benny Bing, *3D and HD Broadband Video Networking*, (Boston: Artech House, 2010) 63.

used to adhere to the standard. As a result the specific encoding application offers a series of specific algorithms that can be called a true H.264 codec, while another encoding application offers a different set of algorithms. Encoding application also offers different profiles that adhere to the H.264 standard.

Other systems exist beyond H.264/MPEG-4/AVC, however, and have their advocates for a variety of reasons. H.264 encodes videos with high compression while retaining high quality meaning a high-resolution yet small digital video file suited to streaming. It is, however, a proprietary format demanding royalties for encoder and decoder developers among others. In contrast, some web developers want an open-source royalty-free system and have tried to set the baseline codec as Ogg Theora, which is natively supported in HTML5. Ogg is the container format, while Theora is the codec for video that comes with the audio codec Vorbis. WebM is another widely utilized container format for web video that was launched by Google in 2010 that does not require plug-ins or royalties for anyone. It is an open-source format owned by Google that is coupled with the now royalty-free codec VP8, but does not have wide support in a number of heavily utilized browsers. Due to a large support network and despite the inherent royalties, H.264 remains the most widely utilized codec for streaming video.

Open source formats, like WebM and Ogg Theora and Vorbis, are recommended for preservation and for compatibility, the fact that the source code and other information is readily available means that anyone can improve and understand the format. The open source movement arose directly as a result of the Internet and in response to more centralized production models. Communities of developers and users come together to create the application, understand its uses, and lead its evolution. The source code being readily available and supported from many sources instead of a single proprietary one ensures that if the format fails, there is way to

understand and get at the data in meaningful ways. It is a more collective model of information and distribution that is reflective of the structure of the Internet as opposed to old models of distribution and proprietary technological information.

The proprietary nature of H.264 can be problematic in that certain aspects of the technology are not released as well as licensing rights. The royalties are not charged to the end user or cultural heritage institutions in this case, but rather the developers of encoders and decoders. The licenses are compiled and administered by a firm completely separate from MPEG, the Motion Pictures Experts Group, entitled MPEG Licensing Authority (MPEG-LA). As stated on the MPEG-LA website their royalty program is intricate and affects developers of encoders.

> MPEG-LA proposed a four-part royalty program. There's a royalty of $.25 per encoder and decoder, compared to $2.50 for each MPEG-2 encoder or decoder. More importantly, there's a cap of $1,000,000 for both encoders and decoders, so Microsoft, Real, or Apple can pay $2,000,000 and ship as many encoders or decoders as they like. There's also a $.02/hour fee for packaged goods shipped with MPEG-4, compared to $.035 for MPEG-2 based DVDs.[71]

H.264 and MPEG-4 Part 10 are also considered standards by international recognizing bodies[72] as well as the Motion Pictures Experts Group (MPEG) and implemented by various distribution companies, including web products. Before the release of H.264 and MPEG-4, individual companies, Microsoft, RealNetworks, and Apple, and their formats dominated the web video and streaming markets. The release of an official standard created a universal format that was readily agreed upon and used for distribution in other forms including broadcast television. There now was one format that combines technologies that allow video and audio to be played on HD television sets as well as phones and computers with one major encoding. Jan

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[71] "MPEG-4 Everyone-at a Price", Jan Ozer, Emedialive.com, 2003.

[72] International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) Joint Technical Committee 1 ratiefied MPEG-4 as a standard under ISO/IEC 14496 *Coding of Audio-visual Objects.*

Ozer gave a strong endorsement of H.264 and MPEG-4 for streaming in 2003. "Standards mean universal support across many markets and devices, and prevent one company from acting arbitrarily regarding their technology. I also like the theory of MPEG-4, the ability for publishers to post one file on their Web sites, as opposed to the politically correct three formats that many now post, and have any media player play back the file."[73] The source code may not be public knowledge, but due to the wide implementation and standards associated with MPEG-4/AVC/H.264 there is ample support and improvement on a number of proprietary formats, H.264 is suitable for access in the long-term.

Streaming provides an interesting case study for open source. While it would be ideal for compatibility and understanding if streaming codecs were open source, streaming is used for access rather than preservation. Also as a major form of transmission that includes distribution companies that invested in the patents that comprise MPEG-4, rather than just YouTube posters and cultural heritage institutions. For them, they need to distribute in a variety of ways and whose previous standards for distribution and encoding have influenced previous decisions for formats, from the frames per second of sound film and the format encoding for DVDs as well as the type and quality of images associated with transmission standards. Oftentimes, cultural heritage institutions and other non-profit video and audio providers follow the major transmission standards and distribution companies. These standards help with the overall consolidation into a small number of codecs and container formats, just do not offer the other benefits and openness of open-source encodings and formats. Michael Geraci of the Pacific University of Oregon Center for Internet Studies stated in 2010,

> Any time we create a digital video and post it on the web, we are, at some point, formatting that file to conform with technological standards put in place by corporations

[73] "MPEG-4 Everyone-at a Price", Jan Ozer, Emedialive.com, 2003.

> that lay down the ground rules for that videos encoding. Such ground rules exist because they, in small or large doses, benefit the private interests of the corporations that created them.[74]

It is true that H.264 expressly benefits the patent-holders and other stakeholders, like Apple, that have invested heavily in its adoption and support.

Despite the potential advantages of open-source formats, none of the cultural heritage institutions that have digitization and streaming initiatives use the open source formats. H.264 is still being widely utilized even for such sites as YouTube, that noted earlier is conforming previous uploads to their WebM format with VP8 encoding. It is recommended that streaming video be encoded with H.264 and wrapped in QuickTime .mov or MPEG-4 wrappers from the results of the survey. Unless an institution is streaming directly through in HTML5 with institutions' own coding and its player, most of the submitted digital video files are transcoded and reformatted by the proprietary video hosting sites like YouTube. The initial compression sets a base-line look of the video and should not be overlooked.[75] In addition to compression algorithm codecs and wrappers, there is another layer that digital video goes through during streaming transmission, called the network abstraction layer.

Potential Changes for Web Video Codecs and Formats

If it were open-source and royalty-free, H.264 would be the ideal baseline codec. It provides high quality compression with near universal support and is a broadcast standard. H.264 has the benefit of being related and in the family of other forms of distribution like HDTV and Blu-Ray; it represents what people expect to see with digital video. Ogg Theora would have to be more

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[74] "Google Enters the Web Video Fray with WebM", Michael Geraci, June 1, 2010, Pacific University of Oregon Center for Internet Studies.

[75] Jennie Bourne and Dave Burstein, *Web Video: Making It Great, Getting It Noticed,* (Berkeley: Peachpit Press, 2009) 215.

widely implemented and supported before it is a true baseline codec. WebM is an exciting format and includes implementations and support from services such as YouTube, but does not wrap enough codecs, for it to be widely adopted. For the open-source royalty-free codec and wrappers to gain ground on H.264 and AAC, they need to be adopted by more proprietary sources and more browsers. This is conceivable, but in the meantime H.264 will remain the way to reach the most people with a single encoding standard. It will take a service like YouTube and Google demanding that only Ogg Theora and Vorbis are supported for their videos for H.264 to lose market penetration. Regardless of whether they become royalty-free and open source, web video formats will also increase in terms of quality of compression and smaller sizes while retaining certain quality markers, as will other digital video transmission methods.

Streaming Infrastructure and Delivery: Introduction to HTML Encoding

Once compressed and uploaded to the content provider's computer, the video content that is to be streamed must be encoded, delivered, and decoded over the Internet. Most formatted webpages are transmitted and understood by a browser using HTTP or Hypertext Transport Protocol using TCP/IP. According to David Austerberry, HTTP is an "application level communication between the web browser and web server in distributed, collaborative hypermedia information systems,"[76] and a delivery mechanism for HTML or Hypertext Markup Language. This communication is based on a request-response from a server that stores the desired information. The server receives the request and forwards a response with the desired content.[77] HTTP and HTML before HTML5 were useful for most web content including images

[76] Austerberry, *The Technology of Video,* Page 44. Other definitions in Dostálek and Kabelová, *Understanding TCP/IP: A Clear,* and Goralski, *The Illustrated Network: How TCP/IP*.
[77] Weinsten, Stephen, *The Multimedia Internet*, ed. Jack Keil Wolf, New York: Springer Science+Business Media, Inc., 2005. Print, Page 252.

and text, but not large true streaming video or animated content. Since progressive download is halfway between streaming content and traditional file download, it was possible to use older versions of HTML using normal web servers with embedded proprietary players. HTML5, which was fully deployed in 2007, added the <video> and <audio> elements that allow for native video and audio support in HTML. Other basic programming languages besides HTML that help with video streaming sent by HTTP are CSS3 and JavaScript.

HTML Principles

HTML formats, organizes, and links text, graphics, and other information into documents. It sends messages that have a header for information about the content and a body for actual content separated by tags. HTTP delivers the HTML message and is an application-level stateless generic protocol for communication between various parts of Internet systems. "Stateless" in this case means that all of its commands happen in isolation and are not related to any previous commands in a given communication session. Cookies are part of Internet communications that store data in the web browser to be accessed later, it stores the state of communication; they include username and passwords for certain sites or other activities that are transmitted to the web site when the user accesses it again. Adding cookies that store state information decreases the burden on servers of maintaining connection to the browser and eases the burden of concurrent user requests. Servers can recognize the user and previous activities or previous states so that connections can be broken without losing information freeing up connections for other users.

HTML Before HTML5

Before HTML5, neither the hypertext neither language nor transport protocol of HTML was suitable for streaming video services. Progressive downloads and true streaming often involved embedded video players on web pages that used HTML for other web content. Before HTML5, even dynamic HTML that allowed for content to be changed after it loaded and was used for hidden menus that displayed when the mouse moved over them or other objects along a programmed path could not fully support video on the Internet. Streaming media and other images were often referenced by links to specific video players. There were two web players (Flash and Shockwave) that could add animated or video in various forms to HTML but both required plug-ins to the web browser. Users are generally reluctant to install plug-ins and this created an additional barrier in delivering content to users. Flash is an animated vector-graphic format that supports small file sizes, user interaction, and short to medium animation. Shockwave is for longer content, including flash content.

HTML5

Adding video and audio elements to HTML was first mentioned in 2005, followed by a trial run in February 2007 and full deployment in November 2007 from the working group WHATWG (Web Hypertext Applications Technology Working Group). Some web browser companies, such as Microsoft, did not fully support HTML5 until 2010.[78] The video element is simple and allows video to be integrated in all layers of web applications including DOM, CSS, and JavaScript; plug-ins is not required. This corrected the problems of native video in HTML and browsers and allowed streaming video to be served over basic web servers. The issues discussed in the previous section concerning the lack of a baseline codec that is supported and implemented by

[78] Pfeiffer, Silvia, *The Definitive Guide to HTML5 Video,* New York: Springer Science+Business Media, Inc., 2010, Print, Chapter 1 Introduction.

all browser vendors remain, but HTML5 greatly increases the capability of video to be streamed over networks. Its video element has features that connect to when video is played, how it is presented, and other key aspects of the process. HTML5 reflects the growing demand, need, and importance of streaming video.

Basic Streaming Architecture: How Streaming is Transmitted: IP Stack

An understanding of network and Internet architecture is fundamental to streaming. Most Internet communications occur using Transmission Control Protocol (TCP) over Internet Protocol (IP), employing several network layers stacked on top of each other with the number of layers depending on the model. The TCP/IP model has an application layer at the top, followed by transport, network, data link, and physical layers, in descending order. There are other models for Internet architecture[79] that are more detailed and have different types and numbers of layers, but the TCP/IP model is stable, scalable, and useful for understanding the basic principles at work.

IP Stack Layers

Each layer in the TCP/IP stack has an interface with the layer above and below it, adding services to what it receives from below and passing them on to the next layer. Services refer to communication between layers within the same process, while protocols refer to communication

[79] Austerberry, David, *The Technology of Video & Audio Streaming* 2nd ed., New York: Elsevier, 2005, Print. Page 15. Beaumont, Leland R. and Markus Hofmann, *Content Networking: Architecture, Protocols, and Practice,* San Francisco: Morgan Kaufmann Publishers, 2005, Print, Page 25. International Standards Organization (ISO) and the Open Systems Interconnection (OSI) model details seven rigid network layers, U.S. Department of Defense, DoD, DARPA model details five layers.

between processes.[80] The physical layer holds the functions necessary to transmit the bit stream of content over a physical medium to another system, for instance an Ethernet cable. The data link layer contains the details of interfacing with the physical communication medium or network layer. It organizes bits into data units called frames and delivers them to an adjacent system. The network layer forwards data packets across as many links as necessary, ensuring proper reconstruction by adding a header that contains destination information.[81] The network layer forwards these encapsulated data packets to and from endpoints (host and end systems) and routers (connectors between two computer networks). The application layer involves implementation of the application software including HTTP and File Transfer Protocol (FTP).[82]

Transport Layer Protocols

The transport layer coordinates data exchange between both end points (host and end systems) and can add value to services provided by the network layer using TCP or User Datagram Protocol (UDP). TCP sends TCP segments and UDP sends UDP datagrams to individual applications by arranging a connection between applications on remote computers. The main difference between the two protocols is that TCP requests a missing data packet from a missing receipt of that packet's arrival at the end system, while UDP datagrams do not require a receipt and can intelligently request missing packets only as necessary.[83] TCP while more reliable is not

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[80] Goralski, Walter, *The Illustrated Network: How TCP/IP Works in a Modern Network,* Burlington: Morgan Kaufmann Publishers, 2009, Print. See Chapter 1 Protocols and Layers in Kaufmann for more detailed discussion of Internet stacks and systems.

[81] Dostálek, Libor and Alena Kabelová, *Understanding TCP/IP: A Clear and Comprehensive Guide to TCP/IP Protocols,* Birmingham: Packt Publishing, 2006, Print, Section 1.2.1.

[82] See in particular Dostálek and Kabelová. *Understanding TCP/IP: A Clear* Section 1.2.1, Goralski *The Illustrated Network: How TCP/IP* Chapter 1, Inglis, Luther, *Video Engineering*. 3rd ed.,Pages 504-10 and Austerberry *The Technology of Video* Page 16, Beaumont and Hofmann. *Content Networking: Architecture, Protocols* page 25 for more information about basic Internet architecture and communication.

[83] Dostálek and Kabelová, *Understanding TCP/IP: A Clear,* Section 1.2.2

suitable for many streaming video applications since the single biggest issue for users is timely reception. At most a lost packet will result in a lost frame, hardly noticeable to most users and time is spent in retrieving it as well. UDP with its ability to send and receive information without receipts or retransmission is better aligned for streaming video uses.[84] TCP automatically requests packets even when they will not be useful for playback in streaming video, when the video has already passed that point in time. UDP can be configured to request only packets that will be used in playback of the video stream.

Network Transmission

A system connected by the Internet generally can be mapped to two different groupings, host or end systems (ES) and intermediate node (i.e. router) or intermediate systems (IS). Every connection uses the bottom three layers, physical, data link, and network, which are collectively called the network support layers. While host or end systems may use other layers as well, intermediate systems only need these three since they are not processing the data transmitted, just sending it from a host system to an end system.

Packetization and Encapsulation

Internet communication is predicated on encapsulation and packetization.[85] It relies on breaking down information, placing these segments in different containers to send, and then unpacking these containers at the receiving end. Starting with the host system, each segment or packet passes through the various stack layers starting at the application level, with each layer adding

[84] Austerberry, *The Technology of Video,* pages 15 – 19.
[85] Dostálek and Kabelová, *Understanding TCP/IP: A Clear* Chapter 1, Goralski *The Illustrated Network: How TCP/IP* Chapter 1, Inglis, Luther. *Video Engineering*. 3rd ed., Page 504 Beaumont and Hofmann, *Content Networking: Architecture, Protocols,* page 25.

information for the next. For instance, the network layer adds a header containing information to ensure correct transmission, and the data link layer adds a header and a trailer. After passing through the five layers of the host system, the packet is known as the protocol data unit (PDU). As the PDU is processed by the end system, each layer unpacks everything that was done by the host system so it can be processed by the application. Such packets serve as the basic units of data of Internet communication.[86]

Basic Principles of the Internet

There are some basic principles associated with the TP/IP model and stacks including end-to-end, robustness, and network transparency.[87] The end-to-end principle is a concept that has evolved to reflect changes to the Internet. Originally it meant that the functions needing services were the shared responsibility of the connected ends and hosts; support was focused on the edges (ends) of the network. Over time, services such as firewalls and web content caches demanded that the network or intermediary nodes also be supported. The robustness principle means that the host should only send out a well-formed packet or datagram, although it should accept any packet it can interpret even if it is not well formed. Network transparency asks that the packets arrive in the same order they were sent, aided by a single universal addressing scheme and without transport modification.

Basic Server Infrastructure and Communication

Basic communication of web pages and online content happens over web servers. Servers are designed to handle multiple concurrent connections through a variety of mechanisms. Servers

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[86] Dostálek and Kabelová, *Understanding TCP/IP: A Clear,* Section 1.3.2

[87] Hofmann, Markus, and Leland Beaumont, *Content Networking: Architecture, Protocols*, pages 28-29 Beaumont and Hofmann, *Content Networking: Architecture, Protocols*, page 12.

can be as simple as a personal computer attached to a network or as complex as a large-scale collection of web servers known as a server farm. Hosting is the process of using servers to make content available over the Internet. Hosting services providers make available servers that deliver content for content providers.

The model of communication for requesting, sending and receiving data like web pages and their content between a server and user mimics general internet communication; messages pass down through the IP stack from a host system, through intermediate systems like routers, and up through the IP stack of the end system. In addition to a host processer there is also sometimes a separate data storage unit. Data storage is beyond the scope of this paper, other than to recommend that content providers select a digital repository suitable to their needs. Options include RAID arrays, hard disks, cloud storage, or a single dedicated computer, among others that is connected to a computer and server to be accessed and transmitted for streaming. A user asks for a resource using the Uniform Resource Locator, the server locates the specific file, reads the file, and then transmits it in HTML using HTTP. The content is delivered through packets that flow from the host through the network that arrives in any order but are then reassembled in proper order by the end user.

Servers are located through the domain name system that gives all content hosts a user-friendly name and a numeric IP address. The system translates from the name to the IP address. There is also a readily available table of names and IP addresses for many hosts, organized in a tree-structure starting from top level domain names (Internet Listing Displays) and general domain names (.edu, .com, .net), followed by domain name space and zones. This allows hosts and their content to be located more quickly for a variety of end users and requests.

Security

Authentications, state information, secure web communications and other functions provide security for a variety of transactions including video streaming. User authentication provides access control by requesting a user ID that is used to verify that that specific user is allowed to access content. Netflix, for example, employs user authentication; only once paying users are verified can video be streamed to their computers. Cookies enable state information of a web session to be stored. They are useful for tracking as well as security and user authentication. SSL (Secure Sockets Layer) and TSL (Transport Layer Security) are also used for secure web communication. These methods use certificates, data encryption, server authentication message integrity, and client authentication over a TCP/IP connection.

Video and Streaming Servers: Specialized Servers

There can be problems, including lag and security, in streaming certain types of content, including video. In these cases specialized servers are created to streamline and improve delivery of this specific content. For media, such servers offer more control of stream delivery rates beyond the standard buffer overflow in TCP/IP stacks. Specialized servers should be used for large-scale projects, ones that require more quality control, or when normal HTTP over TCP/IP is not satisfying users.

On Demand Serving

On demand serving involves non-live content being stored and served with VCR-like functionality, including pause, rewind, stop, and fast-forward options among others. Live or simulated live streaming does not have such functionality as information is sent as it is created.

The on demand servers function more like typical web servers where a client has unicast connections with a server that retrieves the data from storage and serves it. The basic setup is a fast computer with plenty of RAM and at least two network-interface cards (NIC). Due to high loadings or a lot content that is served to users, on demand servers need their own network port for control messages for them. This means that their communication between server and end user is separated from general web traffic, and all information (control messages) pertaining to their transmission, reception, and any changes along the way is separated as well. It is best to have several streaming servers engaged in the process to provide redundancy and reliability.[88]

Server Deployment

A streaming server should read media files from storage, packetize them, and deliver at the correct rate with synchronization information for real-time playback, all for multiple concurrent streams. Such servers should be evaluated in terms of disk drive performance, net card performance, system and input/output devices bus (theoretical amount of data transferred in a given amount of time along a designated data pathway named after the vehicle that transports people) bandwidth, and whether they have enough system memory to manage multiple high speed streaming buffers. The servers should be scaled wide with multiple small servers to create better tolerance to potential faults. The available bandwidth with number of users should be used to design and optimize servers.[89]

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[88] Austerberry, *The Technology of Video,* page 222 for more detail of possible network setups and Hofmann, Markus, and Leland Beaumont. *Content Networking: Architecture, Protocols,* pages 49–52 for different Internet layer support for multicasting.

[89] Austerberry, *The Technology of Video,* Chapter 13 has a more detailed discussion of server deployment. Hofmann, Markus, and Leland Beaumont *Content Networking: Architecture, Protocols,* Chapter 9 focuses on how to build a content delivery networks for specific circumstances.

Servers and storage can be hosted in-house if the available bandwidth and Internet connection is sufficient. Alternatively, they can be outsourced to a hosting facility or content delivery network (CDN, an intelligent overlay to the internet), an option that usually has the benefit of physical security, multiple services, and a variety of ways to upload or transfer content. The hosting facilities and CDNs should have the benefit of a dedicated T-1 or T-3 line and the revenue to invest in needed architecture.

Servers: Outsourcing Options

There are a variety of readily available services for online video content. Some apply more intelligence structures and have more options in serving clients. Two of the largest and most important services are among the most simple in terms of delivery, YouTube and Vimeo. Both offer only progressive download over basic web servers with some intelligence and infrastructure applied to their networks. Since the services use the larger standard web server infrastructure, serving content to remote users is not a problem. They are not as secure as other options and their content is easily ripped or copied during transmission, but they are easy to use and have built-in audiences. YouTube is the largest form of online video content delivery today and reach the largest audience possible. Vimeo was originally designed for the independent film or movie making community and retains some barriers to discovery for users, but like YouTube offers an easily embeddable player for any device and decoder. Neither of these options offers permission controls or other security methods to safeguard content. They are, however, easily discoverable through a simple web engine search.

The Internet Archive is a fully dedicated digital library and archive designed to collect, preserve, and make accessible as much content as possible. It uses standard web servers for

online video delivery offering adaptive-bit-rate streaming, progressive download, and regular file download. Adaptive-bit-rate streaming uses more protocols and provides a higher degree of security than progressive download. It transmits small segments of the video using 128-bit encryption through a Secure Sockets Layer for security. The Internet Archive is widely available, but does not have the market penetration or reach of YouTube.

There are a variety of services that offer full-range and highly personalized solutions for any online video or online content delivery. These include the Real Media Helix Server, Windows Media Server, Apple QuickTime, Wowza, Brightcove, Kaltura, and Akamai. These services offer full content delivery network solutions, security measures, specialized servers, web servers, infrastructure, and support for online video delivery. They, unfortunately, are not free and in comparison to services with large and free user-bases like YouTube, and suffer as a result. The benefits and options these services present, however, oftentimes outweigh these costs. They can setup and run video delivery services to any specifications.

Copyright

One of the biggest impediments to digitization, digital preservation, and digital access online is copyright. Instead of being one right, copyright is actually a collection of various rights awarded to the copyright holder. Some of the rights are the right to reproduction. This right covers temporary copies made in the RAM of computer while loading programs, files, or streaming video. Another right is to create adaptations and derivative works. Digital surrogates or digitized versions of an analog work like 16mm film are covered under this right. Another right is the right of distribution to the public. The copyright owner also holds the right to perform the work publicly with or without the aid of a machine. In conjunction with this is the right to display the

work publicly. A webpage on a network constitutes a public display or performance. Individual types of works hold specific privileges under this right, for instance sound recordings and books are treated differently. Also more restrictions can apply when there is an attempt to create an economic market for rentals or licensing. Ideally the rights to digitize and stream 16mm films were secured when the work was donated or obtained by the cultural heritage institution. This makes the explanation and remedies to secure the rights, permissions, or licenses to do so moot. A comprehensive donation and collecting policy mitigates the concerns over copyright and streaming works.

Copyright extends to original and qualified derivative works (works made from other works in the public domain) in tangible mediums including those who can be only perceived with the aid of machines like 16mm film. Works that do not have copyright restrictions are said to be in the public domain. For 16mm films the works in public domain will generally be from expired contracts, but also works from the United States government. Copyright is conferred automatically today without registration, renewal, and notice. For most works copyright extends the lifetime of the author plus 70 years. Works for hire have copyright for whichever is shorter 120 years from its creation or 95 years from its publication since the owner is a corporation or legal entity that may never end. Originally all of these actions had to take place for a work to qualify for copyright protection. Copyright for works published before 1978 had to be renewed 28 years after publication. Since 1992, the copyright for works before 1978 were automatically renewed if it was under copyright in 1992. This means that the maximum protection for a work published before 1978 is 95 years. Works before 1978 still had to follow proper procedure to ensure copyright and not fall into the public domain. Only and needed to be under copyright protection during 1992 to receive the automatic renewal.

International works that did not follow proper copyright procedure of registration, renewal, and notice in the United States were generally placed in the public domain. Since then the United States has entered into international treaties that have restored these works to copyright protection starting in 1996. For current international works, they are subject to international treaties namely the Berne Convention and WIPO (World Intellectual Property Organization). Cultural heritage institutions that make works accessible internationally can also be sued under foreign copyright. For a deeper understanding of foreign works and copyrights, I recommend visiting the WIPO website, www.wipo.int/portal/en/index.html.

The creator(s) or author(s) of the work generally own(s) copyright. If more than one person creates the work, then copyright is shared equally between them. Works for hire are when an employee creates or prepares a work within the scope of their employment or work by an independent contractor specifically commissioned by an employer. In this case the employer is the creator or author of the work is the employer. For independent contractors the agreement for work must be explicitly in writing and signed by both parties for it to qualify as a work for hire. Rights can be transferred only through signed agreements individually or in a bundle. Transferring rights can take the form of a license that can last for a long-time and get complicated with new technologies and distribution methods including networked ones for streaming media.

The owners of copyright can often be found in the records of the Copyright Office specifically those of registration, renewal, and others that might have clues to the copyright owners. These records will contain information about copyright holders generally for published works as opposed to unpublished ones. Published works are ones who have been made public through sale, rental, lease, or license, and not publicly displayed or performed. For unpublished

works there is a stricter interpretation of fair use, and different reproduction rights for libraries and archives. This is due to respect for confidentiality and privacy especially regarding personal or business correspondence. These works are also covered under copyright automatically and do not have to register with the Copyright Office.

There are some exceptions and limitations to copyright. With books, films, and other analog works, this right is limited by the "first sale doctrine". Once a work is sold, then the rights holder forfeits this right over that particular copy. Unfortunately, the first sale doctrine does not apply to digital works or copies. Another exception to copyright is the fair use doctrine that allows use of the work with certain conditions. This doctrine has four factors to judge if a work is fair use or not, purpose and nature of the use, nature of the work, amount and substantiality of the work that was used, and effect on the potential market and value of the work. A work that is for non-profit or educational uses as well as adds creative authorship is more likely to be deemed fair use. Criticism, news, teaching, research, and scholarly uses are favored in fair use. Owners of a computer program are allowed to make a copy of the program. Also if institutions or individuals act in good faith to not infringe on the copyright owners rights, they generally will not be prosecuted or held financially or injunctively liable.

There are exceptions for specific types of cultural heritage institutions, archives and libraries, but not museums. These are found in Section 108 of the copyright law. For unpublished works up to three copies of works can by made including digital surrogates for research and scholarship of patrons, but only made accessible on premises and not through networks. Published works can only be copied up to three times if they are damaged, deteriorating, lost, or format has become obsolete and cannot be replaced at a fair price. There are also other exceptions for individuals who are blind or other disabilities. Certain institutions are able to

create specially formatted versions of published works for this purpose. Specific to audiovisual works is the exception to make copies of news programs for educational purposes in libraries and archives. For more information for specific exceptions for libraries and archives see section 108 of Copyright Law and the website for the Section 108 Study Group, www.section108.gov.

Another exception includes allowing displays and performances in face-to-face teaching. This works in conjunction with the TEACH (Technology, Education and Copyright Harmonization Act) act to allow for streaming to be used in educational settings. The TEACH act expressly allows copyrighted works to be used in distance learning or online environments as if they were in a conventional classroom. The TEACH act only applies to a government body or an accredited nonprofit educational institution. Proper copyright accreditation and notice must be given under the TEACH act and technological restraints on reuse and dissemination must be in place. This means that works streamed in university systems or cultural heritage institutions expressly for educational purposes in classrooms including content from digitized 16mm films. This concept was held up in the courtroom as well when in November 2012, *AIME et al. vs. Regents of UCLA et al.* was thrown out for the second time. Educational video publishers sued UCLA for streaming videos in classroom settings specifically and with its dismissal setting precedent for streaming video use in the classroom. If all of these exceptions cannot be met, cultural heritage institutions can also turn to fair use as a defense.

Cultural heritage institutions can digitize and stream copyrighted works with certainty if they secure the rights, granted permission from the rights holder(s), or receive a license for use. First make sure that permission is necessary, the work is in the public domain, fair use, other exceptions, or if the donor agreement already specifies this use. The first step is to identify and contact the rights holder for the work starting with the U.S. Copyright to locate them. Then draft

a specific or general permission request through direct contact, e-mail, or standard mail. A lot of works are also ruled by a number of licensing organizations and they may offer an easy remedy for a small fee. If the effort to secure the rights, permission, or license fails then decide if the risks outweigh the benefits, return to fair use, or do not stream the content.

If the rights are cleared and the holdings can be made available, Creative Commons allows organizations to stream and put content online with specific allowable uses. From their website "Creative Commons is a nonprofit organization that enables the sharing and use of creative and knowledge through free legal tools. Our free, easy-to-use copyright licenses provide a simple, standardized way to give the public permission to share and use your work – on conditions of your choice of CC licenses let you easily change your copyright terms from the default of 'all rights reserved' to 'some rights reserved.'"[90] This allows flexible statements of copyright that make clear the permissible uses of content. This way users can use the content without fear of copyright infringement, while protecting the interests of copyright owners. Places like the Prelinger Archives make clear the uses that are possible with their content including streaming and downloadable video files. Creative Commons licenses. Others just post copyright statements of their own creation stating their organizations rights and permissible uses, such as the University of South Carolina – Moving Image Research Collections.

[90] "About", *Creative Commons,* 2014. http://creativecommons.org/about

PART THREE: SURVEY AND CASE STUDIES

Through what is called a purposive sample, I surveyed a range of cultural heritage institutions with 16mm film collections. In each case, the detailed survey instrument was completed by an individual quite knowledgeable about these specific collections. The purposive sample of institutions was chosen due to their having16mm film holdings, their importance in the moving image and film archiving world, and recommendations from colleagues. Four of the institutions that completed the survey were then approached for follow-up interviews to develop a fuller understanding of what they are doing, as well as detailed work flows. These particular cases were selected from the survey list are due to their interest, responses, and digital initiative programs. In selecting them, I also sought a range of approaches from full-scale digitization to more limited initiatives.

The survey and case studies not only provided insight on how information about and on film is being transferred to the digital realm and its access routes, but also about the decision-making, problem-solving, and unexpected consequences of undertaking such digitization projects. Responses include their thought process, metadata practices, workflows, as well as the frustrations and successes of their digitization projects. Such factors as designated community of users, levels of digitization (access, mezzanine, preservation), the effect of streaming services on data and end-users, and other rationales before and after digitization as well as digital access were probed.

Ten cultural heritage institutions responded to the survey out of 25 that were contacted. The survey targeted major factors and decisions involved in 16mm film digitization and online access. The results are attached to this thesis in two appendices; one that organizes the results by

question (keeping all the answers to each question together) and one that organizes the results by institution.

These results document what has been happening as U.S. institutions begin to transition their 16mm collections from analog with physical access and preservation to digital representations and digital preservation. The results reveal some debate over what constitutes true preservation and access for such works, but near unanimous agreement that the shift to online digital representations is inevitable. In the future, 16 mm film access will be online and through surrogates for the film objects, not in person or study rooms. At the present moment, institutions are devising ways to get their 16 mm content online, but most do not yet have a concerted plan. Regardless of whether such digitization is intended as a preservation strategy, the resulting files are being stored and made accessible using digital preservation techniques.

This section presents an analytical overview of the survey results, sketched with broad strokes and presenting the major issues and opinions of cultural heritage institutions as they set about digitizing and streaming 16mm film. The focus is on general issues: what cultural heritage institutions are doing in terms of deciding whether or not to digitize and stream their 16mm film objects, how they make decisions about which films to digitize, their overall process of planning with regard to these activities, what technological options they are using, how users are responding, what problems they have encountered, and their overall assessment of the process.

These survey results are given even greater texture by information collected in follow-up telephone interviews and case studies conducted with four of the responding organizations. These follow-up studies provide in-depth coverage of what these four institutions are doing and thinking. They also enabled me to construct individual workflows for these institutions and to follow a 16mm film, step by step, as it is digitized and made available online.

Certain demographics and statistics about the institutions and individuals who responded to the survey provide a framework for assessing what follows. Most of the responding organizations had multiple components, totaling 7 archives, 4 libraries, 4 institutions that were part of larger university or educational systems, and 3 museums. Their total number of holdings (including items that were not 16mm films) varies from the millions to the 10,000s, with most having between 100,000 and one million items. The percentage of such holdings that are 16mm films range from less than 5% to 70%, with most being somewhere between 30% to 50% of total holdings. Their standard user bases include scholars, the general public, filmmakers, researchers, and students. Some also include family members or source communities connected to some of the films. The survey was sent to those individuals most able to answer questions about the organization's 16mm film digitization and streaming initiatives. The positions of these individual respondents include: 3 founders of the organization, 4 directors of the organization, 1 board member, 2 managers, 1 archivist, and 1 curator (with some individuals holding multiple positions).

General Survey Results

The survey results are straightforward and unambiguous about digital representations as the future of access for 16mm film in cultural heritage institutions. All but one institution felt that future access to 16mm films will be largely or entirely online, and the reason given by that one dissenting institution is simply that there is too much 16 mm material for all to be digitized. The respondents who saw streaming as the future for 16mm did so because this is how a majority of users now request access, there are fewer copyright restrictions for 16mm films than some other formats (thereby making the process straightforward) doing so increases the audience for this

material (and for the institution), there is insufficient support or infrastructure for creating or projecting 16mm film, and they see as part of a now inevitable trend for institutions to provide content online.

All but one institution felt there were no specific issues for streaming 16mm film versus other film gauges. This coincides with all but one respondent stating that they handled 16mm film the same as other gauges. The one anomalous respondent on this matter mentioned specific copyright issues regarding unpublished works and publicity rights of individual performers, the derivative quality of 16mm film reduction prints versus 35mm camera originals, and the belief that preservation and access files were different for 16mm. The difference between the preservation and access files meant that 16mm since it holds less information than 35mm require less resolution in digital files to fully capture the analog information. The derivative quality of some 16mm films derives from the fact they were reductions of 35mm originals, created to be released in the non-theatrical settings, such as classrooms and cultural heritage institutions. Any time a new print or derivative is made of a film, there is loss of information and quality.

When asked what was gained and lost through streaming, respondents were unanimous that increased access was the largest gain. Closely following access, greater size and diversity of audience was the second most listed benefit. Other gains mentioned by respondents included that once overlooked works were now becoming known, new experience for the content, and streaming has opened up a variety of ways that users can access the material. New experiences mean instead of classroom, study rooms, flatbed viewers, or projection, 16mm works are now on computers and access alone. Users also have the ability to access the content whenever they want as opposed to in conjunction with the institutions time frame. Digital provides a totally different experience than analog film in those ways and a variety of others. The most frequently

mentioned losses were the original communal viewing experience for these films and image quality. Other reported losses included object information, accuracy in viewing these materials for research purposes, and context. One respondent negatively compared streaming to downloading a file, feeling that streaming provided imperfect delivery and lack the reuse capacity of downloading.

Responses to which collections or types of 16mm films should be digitized and streamed varied by institution. Four felt that nontheatrical, unreleased, and orphan works were the ideal candidates. In a closely related vein, two said that works that were not fully preserved or currently exhibited should be prioritized for digitization and streaming. One favored composite prints containing both sound and image due to the ease of transferring one element versus multiple elements. One stuck to its institutional mandates, stating that any collection that served its scholarly community was a good candidate for streaming. Another favored collections that would not violate copyright regulations, and yet another saw local television news films as ideal for streaming.

The question concerning how 16mm film digitization and online access relate to larger digital initiatives at the organization yielded a variety of responses. Seven respondents reported that their institutions were in the processing of digitizing their whole collection, not just 16mm films. Their 16mm initiatives were part of a larger institutional push to develop digital representations for all their holdings. Two respondents saw digitization and online access as an outgrowth of former telecine and migration-to-video efforts that generally emerged from specific institutional needs and user requests. Only one institution stated that it digitized and streamed on a project basis with collaboration. This means instead of collection wide initiatives, they work on small part of their collections often with other organizations to create online access for those

works usually centered on a specific theme. This institution also mentioned it targeted humanities content in particular.

Six organizations digitized for both preservation and access, three digitized for access only. Two comments accompanying this question provided more detail. One institution scans film to preservation quality when using a digital intermediate for preservation and transfers to lower resolutions to provide access copies for partner institutions. Another only scans for preservation when the film is too damaged to replicate or show. After the digitization, the damaged film is discarded.

Something that jumps out from the survey responses is the lack of consensus or standardization concerning what constitutes a true digital surrogate. Two institutions saw 4K scans as true surrogates, one felt a 2K 10-bit RGB 4:4:4:4 DPX log qualified, another stated that it depended on circumstances, yet another said it went after the highest bit rate and resolution possible, one favors edge-to-edge scans at 2K or higher, and two stated that a true digital surrogate is not yet possible. In short, digital preservation standards for 16mm film are not yet standardized, and the current discussion focuses mainly on resolution, rather than what information (perforations, edge code, etc.) is included in the digital representation.

When asked about specific formats and codecs for their preservation and access files, respondents went into more detail. Several use more than one type, resulting in the following table.

7	10 bit uncompressed video,
6	H.264
6	.MOV (Quicktime) formats
4	DPX format

4 MP4 format

4 MPEG-4 Part 10

1 WMV formats

1 Adobe Flash formats.

The meaning and relationship of these specific formats and codecs to both digital preservation and access are discussed later in this thesis. What should be noted even at this point is that, with the exception of MOV (QuickTime), the chosen formats are open source or non-proprietary.

Eight institutions said they already stream 16mm film content, while one does not and one said not yet, indicating it might do so in the future. The reasons for streaming this content varied, except that all included improving access on the list. The second most cited reason was to improve the size of the user base (eight institutions), followed by increasing web presence and visibility (seven institutions). Six stated that they stream in response to user requests and digital humanities projects. Four did so as part of larger institutional digital initiatives and place film content in a larger and growing digital environment. Two expressed the belief that there were no other options for access or preservation at this point. Only one institution stated that it streamed to keep up with other institutions. And one explicitly streams in order to repatriate works and/or provide source communities access. Looking at these responses in the aggregate, it becomes clear that streaming initiatives focus on the access capabilities of putting content online, with only one institution mentioning format obsolescence as a factor in deciding to stream.

Only one of the institutions surveyed has a formal plan for streaming, although three more state that they are developing a plan. The one plan that does exist includes institutional goals for streaming; copyright considerations; plans for outsourcing work; long-term digital storage and access; digital preservation standards; partnerships and collaborations with partner

institutions; ways to expand, rotate, and curate the digital content; plans for long-term sustainability of the streaming; funding; metadata; and building in online access to new donor agreements. Even though most of the respondents do not have a formal plan, they recognize certain considerations as important in their decision-making process for digitizing and streaming 16mm films. The actual decision-making process takes into account such factors as funding, infrastructure, staff, expertise, and a host of other factors that affects their ability to digitize film objects and stream video. The most commonly mentioned factor is copyright; three stated that having rights to make the work available free online was the biggest factor in their selection of what to stream Several other factors that feed into deciding what to digitize and stream were put forward, each by a single institution: research and conservation needs, available funding, importance or uniqueness of the works, high usage rates, user requests, and curatorial decisions. One does its 16mm streaming as part of mass digitization projects, in which entire collections are processed,

One of the largest impediments to digitizing and streaming film content is the cost of the infrastructure needed for digitization, storage, and access. For this reason a number of institutions use partnerships, collaborations, and outsourcing to accomplish their digitization and streaming initiatives. Only two respondents stated that they do all the work to get 16mm film content online in-house. Most outsource, a process that comes with its own advantages and disadvantages. Respondents saw high-end equipment and services as well as speed in accomplishing large-scale projects as the advantages. They also recognized the benefit of not having to spend time or money to maintain such equipment themselves. The disadvantages of outsourcing include the cost, loss of control over materials and work, and time restrictions of being on someone else's schedule In-house digitization and streaming also present both

advantages and disadvantages. The benefits that respondents reported include greater control, less paperwork, and being on their own schedules. In-house work is also less expensive once an initial equipment investment is made. Its disadvantages are those initial equipment costs, the demands such work makes on staff time, lack of staff expertise, and the time needed to train staff.

These 16mm digitization and streaming initiatives are also prompting institutions to pursue other forms of collaboration in addition to outsourcing. Seven respondents stated that collaboration has increased not only between their institution and others but also within their own organizations, while only two said it had not. The reasons behind such outreach include compiling resources for curated web projects, offering services that others do not have, sharing expertise, and countless others. The strict boundaries between departments and institutions are breaking down in order to digitize and provide streaming content in meaningful and professional ways. The comments accompanying this question are informative. One respondent felt that collaboration had increased because scholars and researchers had access to various historical moving images for the first time. Another stated that he reached out to other people in his organization to date and identify films and also developed relationships with film archivists in the area who had greater expertise on certain topics. Two institutions collaborate with other organizations to share lectures and workflows.

Respondents expressed a variety of viewpoints on the ideal workflow for digitization and streaming. One felt that having files move seamlessly from one workstation to the next (scanner, editing computer, compression computer, streaming server) was key. Another favored having a high-end film scanner that could simultaneously output to multiple file formats, while still another stated that having everything done in-house was the ideal. Other responses included

digitizing everything before cataloging to make both the streaming and catalog record available at once, and having the appropriate equipment and staff to pull, prepare, and digitize the works.

Respondents also answered questions about their metadata and catalog records. Six provided basic filmographic information, two included digital file metadata (codec, file format, etc.) as well, and two mentioned that they tagged content making it available via informal and person language for web searches and browsing. Various metadata schemas were used by the respondents: 4 use PBCore, 3 use DACS, 2 use AACR2, 1 uses Dublin Core, 2 use idiosyncratic metadata, 1 uses MOD and EAD, and 1 uses a custom metadata scheme in ContentDM digital asset management (DAM) system. Three also added technical and other metadata about the content of the digital file (edge-to-edge, element, part or whole of original, or edited for curated program).

Three respondents make their catalog records for streaming files available through the Internet Archive, rather than their own websites. They provide links between the Internet Archive website and where their digitized 16mm films files, records, or access points are stored. Two have not integrated the records for digital files into their older legacy catalogs, resulting in two different records for the same item: one for the analog elements and one for the digital instantiations. One has a Wordpress site derived from their FileMaker Pro database of records that allows for embedded files along with catalog records. Three have integrated the new records into their old catalogs and published them online, but did not state if this has occurred through search portals, blog sites, or Google and web search engine indexable and retrievable. One institution has not published its digital catalog records online, but mentions them in its on-site physical catalog by stating that its holdings have a digital instantiation.

Copyright has historically been an impediment to access for moving image works, and survey responses make clear that this extends into the digital realm. Copyright as it relates to nontheatrical 16mm films is discussed in detail later in the paper. Here I present what the survey respondents feel about the issue. Five of the respondents feel that copyright is too restrictive and make their collections available for download and streaming, as well as allow users to use and reuse their content as they see fit. These institutions deliberately push the boundaries of copyright law in order in their online and digital initiatives. For these institutions there are not too many legal restrictions they would care to follow, but mainly questions of sensitive content (erotica, ethnographic films, etc.). One had YouTube flag music in a film so YouTube could add advertisements, receive royalties, and compromise the intended viewing experience to the institutions detriment. YouTube also refuses to remove their advertisements from the work. Other institutions make sure that all material clears copyright or that they control copyright for all materials, so that there are no pressing legal issues when they digitize. For the remaining 4 respondents the biggest legal issue mentioned is copyright and their right to disseminate the materials. One stated that its legal concerns were "COPYRIGHT, COPYRIGHT, COPYRIGHT." When asked why other institutions are not streaming, content copyright was also the most frequent answer. Three of four responses listed copyright as the reason, followed by funding, cultural issues, and staff/institutional support with one response each.

In order to avoid theft and unwanted use of materials several institutions use a variety of countermeasures. The most frequent are adding watermarks such as the logo of the institution and providing only low-resolution files, which also help with streaming transmission. If users steal the content they have an inferior copy that also gives attribution to the cultural heritage

institution. As mentioned above, however, there are a number of institutions that accept reuse and stealing of content as an inevitable part of putting it online.

When asked what problems have arisen in their digitizing and streaming of 16mm films, reuse and copyright appeared again, but most respondents focused on more technical matters. The two who brought up reuse issues stated that content has been ripped from their websites and uploaded to other sites such as YouTube and Vimeo. Moving in another direction, one felt that workflow and proper training of staff was hard to accomplish, especially as staff sometimes did not keep quality of the process or the digital surrogates in the front of their minds. Others had issues with previous transfers to video that were mow being transferred to digital, including frame rates or having an interlaced rather than frame structure for the video. One felt that labor and digital storage are the single biggest issues for streaming projects, another stated that getting the funding and energy to do large digitization projects was difficult. While copyright traditionally has dictated when and how moving images are distributed, these projects add heavy doses of personnel and technical issues.

Respondents report, however, that user response to content streaming online is unanimously positive. Institutions are receiving emotional responses to the material from all over the world, being contacted by people who are in the films themselves, and receiving more requests for footage by filmmakers. All but one respondent saw an increase in viewers from new geographic locations. One saw an increase in requests for archival footage as a result, and another saw that the more content they placed online, the larger was their user base. When asked about any unexpected benefits of their streaming initiatives, a number of respondents mentioned increased use and knowledge of their collections. Institutional exposure, user base, stock footage sales, contact from source communities, and donations have all increased. Respondents also felt

that there was something exciting for users and institutions alike in the increased discovery of older materials due to their web presence and that this was leading to more digitization and streaming initiatives.

A number of institutions also use streaming media as an opportunity to include social media, such as blogs, to publish and discuss objects and texts from their collections. An online presence along with digital surrogates such as streaming movies seems to be attracting and interacting with users in ways that analog objects have not. Institutions feel that digitizing and streaming 16mm films despite the time, infrastructure, and financial demands involved, provide substantial benefits and are the future for access to film objects. As mentioned above, almost none of the cultural heritage institutions surveyed, however, had a formal plan or thought-out approach to their 16mm digital initiatives. Neither have they developed an in-depth understanding of how networked content can be used in different research methodologies such as digital humanities. They are at the first stages of the digitization and streaming process, and their emphasis is on ways to increase access, users, and institutional web presence. In later sections of this thesis, I discuss various aspects of digital humanities, digital technologies, metadata schema and standards, 16mm film and its digitization, copyright matters, and other factors that institutions such as those surveyed might want to consider as they move forward with their initiatives. First, however, I use four case studies to give a more detailed and institutionally integrated understanding of what has been happening.

The Four Case Studies

The following case studies were developed through telephone interviews with four of the institutions responding to the survey: Indiana University Libraries Film Archive (IULFA),

Northeast Historic Film (NHF), Moving Image Research Collections (MIRC) at the University of South Carolina, and the Berkeley Art Museum and Pacific Film Archive (BAM/PFA). These institutions are pursuing a range of different initiatives, from campus-wide digitization of all holdings at IULFA, project-based digitization at NHF and BAM/PFA, collection-wide digitization and streaming at MIRC, to digitization of former telecine transfers to video at NHF, the results of which are streamed upon user and institutional requests and made available through Amazon digital for a fee. The sheer variety in approaches, technologies and infrastructure among different institutions comes across very clearly.

University of South Carolina - Moving Image Research Collections

The Moving Image Research Collections (MIRC) at the University of South Carolina (USC) began in 1980 with the donation of the Fox Movietone News Collection. Since then, the archives have expanded to over 6000 hours of materials, including local television news and commercials, home movies, and other unaired or underappreciated moving images. MIRC is part of the larger USC library system. MIRC's goals are to preserve its holdings while providing access and attracting scholarly attention to its materials.[91] A major form of access to MIRC's collections is its Digital Video Repository (MIRC-DVR). The webpage for the repository highlights that digitization provides access without adding wear-and-tear to the film originals.[92] It also invites user discovery and participation in cataloging and providing information about the materials. MIRC has high-resolution digital preservation masters for long-term storage of its collection but provides lower resolution files for online access.

[91] "Fedora Repository Project", *Fedora and Duraspace,* 2014. www.fedora-commons.org/about
[90] "About Us", *Northeast Historic Film,* 2014. www.oldfilm.org/

I interviewed Heather Heckman, the Director of MIRC on several occasions about their 16mm digitization and streaming initiatives. MIRC uses a Spirit DataCine capable of 2K and 4K scanning as well as conversion to video signals for its high-resolution preservation masters. The DataCine also has a sound pickup option, so optical and magnetic sound tracks that MIRC does not own, but can be added to some works. MIRC's preservation quality files are 10 bit uncompressed DPX RGB log with 2000 pixels or 4000 pixels. 16mm film is transferred using the 2K DataCine, while the 4K scanner is used exclusively for black and white 35mm film since it is so time intensive. For streaming files, 16mm film is transferred using the telecine portion of the Spirit, converting directly to digital video standards. These files are encoded with Apple ProRes in MOV (Quicktime) format then transcoded to H.264 with the MOV format.

Heckman feels that a true digital preservation surrogate format is a 4K edge-to-edge scan that not only captures the image content, but also perforation and other information on the film as well as showing the top and bottom of the previous and next frames. This represents the work as a film object (as opposed to just content), records the metadata encoded on the film itself, and reminds the viewer of the distribution and material context of the work. Heckman made specific mention that such a representation is particularly useful for early tinted and toned film.

Two types of soundtracks are most common in the MIRC collection, optical and magnetic. They can be on separate print elements or combined in a composite where image and sound are on the same film print. With optical sound, the sound is recorded using a photochemical similar to that used for film images with a photosensitive light source (bulb or chip) in one of two different methods, variable density or variable area. In variable density, the less reliable form, the density of the film in response to light is recorded in varying degrees of black to white, often looking gray. The variable area method records what looks like a sound

wave as a clear image, with the rest filled by black or dense film around the wave. Scanning film can capture this information and then use computer applications to recreate the sound. The second of the two types of soundtracks, magnetic sound, does not have this luxury of visual representation. It consists of magnetic particles arranged so as to record and reproduce the sound with proper playback. This poses a difficulty when scanning film without a proper magnetic sound head. The magnetic track has to be transferred to the digital realm then recombined with the digital image representations. MIRC makes preservation, mezzanine, and access level files for audio in the MXF (Media eXchange Format).[93]

Heckman was able to go into much greater detail on issues concerning 16mm versus 35mm film than had been possible on the survey. MIRC collections of 35mm are generally nitrate prints that are the highest priority for preservation. Its 16mm collections, except in very rare situations, are on safety film, which means a non-flammable alternative to nitrate, either acetate or polyester. The most common type at MIRC is acetate-based 16mm film that degrades into vinegar syndrome. This form of degradation can be monitored and slowed by storing the film in archival standard climate-controlled vaults. Heckman stated that the biggest issues facing 16mm film were color and sound. This refers to magnetic sound tracks in particular, which have a tendency to delaminate and be damaged and should be transferred to digital formats as soon as possible. Color on acetate-based film also has a tendency to fade, making a print look pink. These issues concern the physical degradation and nature of 16mm film, in other words what shape it is in prior to its digital transfer. The only issue Heckman raised for the transfer process itself, assuming the film is in sufficient shape to be transferred, is making sure the scanner has 16mm film support.

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[93] "Material Exchange Format (MXF)", *Library of Congress, 2014.* www.digitalpreservation.gov/formats/fdd/fdd000013.shtml

Before film is transferred to digital at MIRC, it undergoes basic inspection along with physical film conservation and preservation. Damage is noted and repaired by thorough cleaning and splice removal and replacement. If funds allow, MIRC transfers its nitrate and acetate films to newer, more stable stock for photochemical or analog film preservation. Even if MIRC makes such a new preservation print, however, it does not have the facilities or staff to project. Researchers can examine the print on workbenches and film rewinds, but can never see the film projected. This is one reason that MIRC has a large digitization and online program.

Part of transferring to digital with a telecine system as opposed to film scanning means adjusting the frames per second (fps) using a method discussed later called a 2:3 pulldown. This converts the frame rate from that of 18fps for silent film and 24fps for sound film to the video standard of approximately 30fps made of two fields per frame. It does this by adding in film frames to more fields than do scans, which create one digital image per film frame. Heckman also discussed the former archival practice of using telecine transfers to analog and other video formats.

Heckman also stated that the MIRC files available online are always low-resolution copies watermarked with their logo. These are security measures and even if the file is stolen while streaming, MIRC is accredited and only a non-theatrical version is copied. Creating such streaming access files is less time-intensive than higher-resolution ones, despite the extra manipulation of adding in a watermark. Due to their lower resolution, such files are smaller file and require less storage. Currently MIRC is running low on storage and is looking for ways to expand their capabilities. This means that access file transfers are gaining precedence due to these storage constraints.

Heckman stressed that providing online, even in low resolution, enhances support for both digital and analog preservation. Access creates the conditions for interest and funding for the long-term preservation of moving image materials. She has not seen too much increased funding thus far, but expects it in the future, as more content is placed online.

Once a film has been digitized either to the preservation (10bit DPX) or mezzanine (ProRes MOV) files, it is then transcoded to make streaming access file. MIRC uses the open source and free program FFMPEG to turn the mezzanine and preservation files into H.264 MOV files for streaming. This transcoding is done on a separate server and computer than where the files are stored permanently. Watermarking is also done at this time for content that will be served over the Internet. The files are then stored on spinning disk hard drives in a redundant array of independent disks (RAID) that are grouped together in what is known as a Gluster cluster. MIRC also has partnerships with other organizations for storage off-site which helps create geographic separation and redundancy of information as well as connectivity to the Internet with higher speed than MIRC has.

Cluster storage or clustered file systems are those in which one file system is shared over multiple servers attached to a single network. A user can remotely access any file that is stored and shared using any server. This creates redundancy among the servers and storage, such that if a file is corrupted on one server, it is still accessible from another server in the cluster. Gluster is an open source platform that enables the servers to be linked together over the network. It was acquired by Red Hat and incorporated into their Linux platforms. For content delivery, these Gluster clusters are known as server farms enabling faster delivery over the Internet.

These files are placed within a digital asset management (DAM) system called Fedora (Flexible Extensible Digital Object Repository Architecture). This is another open-source

software that operates on Linux and owned by Red Hat. The Fedora website states that Fedora "was originally developed by researchers at Cornell University as an architecture for storing, managing, and accessing digital content in the form of *digital objects* inspired by the Kahn and Wilensky Framework."[94] Technical metadata about the files is automatically gathered using a variety of software uploaded to Fedora, including Image Magic and MediaInfo, to create a Microsoft Excel document. This information is then mapped to the metadata scheme of PBCore designed for moving image works.

Each file (preservation, mezzanine, and access) is a separate digital object in the Fedora system. The extracted metadata include technical metadata about the file (codec, format, bit depth, etc.) and title. Fedora packages this in a way that makes it semantic web compatible in an RDF framework. All of these processes are automated when the files are ingested in the DAM run on Fedora. Preservation files in the DPX format pose a problem, however, for this automated metadata extraction and compilation. MediaInfo does not run on DPX files, and information from such files has to be recorded manually The metadata information is then placed into a FileMaker Pro database along with previously recorded descriptive metadata. This information and database is then pushed into Fedora to mix with existing records. Heckman reported that Fedora is the permanent site for metadata and the way for files to be managed and accessed from the Gluster clusters.

The overall response to the digitization and streaming initiatives by MIRC has been positive. Their website has been able to handle the number of requests and traffic efficiently. The site has only crashed once, when MIRC had 268 users request content at the same time (a phenomenon known as "concurrent requests"). Heckman and MIRC view streaming as a better way to access content than DVDs and other physical copies. Streaming enables individuals to get

[94] "Fedora Repository Project", *Fedora and Duraspace,* 2014. www.fedora-commons.org/about

content at home without having to make additional requests. Heckman sees the only issue being that users do not have access to the edge-to-edge scans of the films and the resulting encoded metadata.

The long-term plans for MIRC are to continue digitizing and providing content online. Heckman does not see all of their content being digitized and online even after 10 years, however. The start-up costs have been in the millions of dollars for the storage, access, and digitization infrastructure as well as labor costs. Heckman feels the largest initial cosst were the film scanners and the true preservation storage infrastructure. MIRC's funding comes from the National Endowment for the Humanities (NEH), which MIRC has agreed to match with its own funds, endowment, licensing footage, and donations. Despite its great costs, Heckman feels that digitization and streaming access has been worth it. It saves researchers time and provides a public service. She does, however, wish they had more funds and requests for licensing to cover the costs of operating archives and hosting content.

Northeast Historic Film

Northeast Historic Film (NHF) is a moving image-specific archive founded in 1986 and located in Bucksport, Maine. It is dedicated to collecting and providing public access to the film and video record of northern New England, specifically Maine, New Hampshire, Vermont, and Massachusetts. NHF hosts exhibits, screenings, symposia, and workshops for professionals and the public on regional culture, history, and preservation. It is located in the restored Alamo Theatre, thereby linking their collection to an important piece of local history.[95] NHF has a state-of-the-art storage space for both film and video. I had the pleasure of interviewing Joe Gardner,

[95] "About Us", *Northeast Historic Film,* 2014. www.oldfilm.org/

the Technical Services Manager at NHF about their 16mm film digitization and streaming initiatives.

NHF has 10 million feet of film and 8,000 hours of video, with most items being unique and irreplaceable. According to Gardner, their 16mm film is comprised of documentaries, experimental, and professional (news and corporate) content. Using a telecine, they have transferred and continue to transfer 16mm film to the analog video format Betacam SP (Superior Performance) for access. This transfer process is done to see what is on the films without needing to project them. If NHF needs to do a digital transfer, it does not digitize the Betacam SP materials, but retransfers the film to a digital file format. NHF has an MWA Flash Transfer Choice 2k+ digital scanner that uses a CCD chip and can transfer 16mm, 8mm, S8mm, and 9.5mm. This scanner transfers at 2K resolution and can output digital video standards as well. NHF also has a number of Elmo, modified projector telecines that output to digital and analog Standard Definition (SD) video. Sometimes the film elements degrade to the point where they are no longer usable, cannot be salvaged, or lost and the only copy that remains are the digital transfers. This means that the transfers are the only copies of the work that exist. Joe states this is rare, but is known to happen with their collection.

NHF scans either 10 bit uncompressed DPX for special projects or 1920 x 1080 HD Apple ProRes 422 (HQ) codec and MOV format for preservation quality. NHF also has sound pickup heads for both optical and magnetic sound for integration into the HD transfers and outputs them as a separate .WAV file for DPX files. These files are then transcoded to H.264 codec and MPEG-4 format for streaming files. NHF has been transferring films to digital formats for 5-6 years in a variety of different codecs and formats for both preservation and mezzanine formats. Not all of these files are designed to be placed online; they reflect different projects and

reasons for digitization. Files that are streamed are low-resolution and feature a watermark from NHF. Gardner feels that a true preservation digital surrogate for film would be an edge-to-edge scan with a high resolution (2K or higher).

NHF focuses primarily on non-theatrical releases that are mainly 16mm or smaller gauge (8mm, Super 8mm, 9.5mm, etc.). It rarely projects 16mm anymore and most access is digital in nature, either online or through DVDs. Gardner feels that there is still small-gauge expertise and equipment out there, and has seen small-gauge including 16mm projected at events like Home Movie Day, but he does not think NHF will project such materials much in the future. He also stated that while the skills to project are still there, although not necessarily the way people used to project, projector repair and maintenance is a serious concern.

NHF's digital storage currently consists of spinning disk hard drives arranged in a RAID array. These drives are in duplicate and configured as RAID 1 to prevent data loss. RAID 1 configurations are designed so that hard drives mirror each other by having exact duplicates of each item of data. NHF is also currently backing up its master files in-house to Linear Tape Open (LTO) version 6. LTO is magnetic tape designed for data storage. NHF is also in the process of determining the best digital asset management systems to integrate into their existing database and catalog.

Streaming files are cataloged separately (generally online in Google indexable and discoverable web pages) from the main catalog, whether it is online or offline. The film and video items are entered into a large catalog that notes when there have been transfers to video or digital only when detailing other instantiations. Data such as format and codecs are not part of the main catalog. While NHF puts much of its catalog online, Gardner recommended visiting them to view their whole catalog offline. Online is a way for people to discover what NHF has.

Once discovery occurs, more in-depth information is available by request or by consulting the offline catalog, which has such things as scene annotations. Gardner also stated that streaming files go hand-in-hand with catalog records by enhancing them. NHF is currently creating a new catalog that integrates their streaming and digital instantiations with their old catalog.

Most of the streaming initiatives at NHF are project-based. One such project is entitled "Moving Images of Work Life, 1916-1960." The Council on Library and Information Services, Cataloging Hidden Special Collections and Archives program funds this project, but it is administered by NHF.[96] This collection is meant to showcase forgotten and overlooked collections, as well as introduce people to using moving images as primary material for research. Excerpts from each of the highlighted collections appear as streaming video clips with a full cataloging record below. It is interesting that the collections page for NHF film discusses the limitations of streaming media. "An important shortcoming of online access is that the small screen diminishes the experience by skipping the clarity and thoughtfulness of discussion during research. This is a largely unrecognized downside to instant search/return/next."[97] This statement highlights the individual nature of streaming, contrasting it with the communal experience of film projection. Yet it is streaming and online access that makes these collections less hidden. This project thus uses the discovery features of digitization, streaming and the web to alert users to otherwise unknown collections (something repeatedly mentioned in the survey as well).

A full list of projects that NHF is pursuing, with many involving streaming video from their 16mm films, can be found at "Projects" www.oldfilm.org/content/projects. These include experiments in placing digitization of film and video holdings in social media settings such as the streaming website Vimeo, as well as promotion on Facebook and Twitter. By using such

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[96] "Moving Images of Work Life, 1916-1960", *Northeast Historic Film,* 2014. http://oldfilm.org/collection/index.php/Browse/HiddenCollectionsList
[97] Ibid.

outsourced platforms, NHF is trying to promote its holdings and interact with users in less scholarly settings than that to which it is accustomed.

The collaborative projects that feature NHF holdings and work are the Maine Memory Network, the Boston TV News Digital Library: 1960-2000, Finding and Using Moving Images in Context, Open Video Digital Library Toolkit, and Windows on Maine. Finding and Using Moving Images in Context is a National Endowment for the Humanities Digital Humanities Start-Up project in which a 16mm film collection, the Joan Branch Collection, along with a collection of 9.5mm film has been digitized, streamed, and presented online. Each clip and collection comes with detailed metadata, archival, and historical contexts along with avenues for future research for scholars. The University of Maine hosts the videos for this project, which tries to push the boundaries of research and possibilities for using historical moving images under the rubric of digital humanities. This project providing contextual information and the collaborative relationship with the University of Maine mitigates some of the issues respondents in the survey had with streaming, namely the losing of context and lack of infrastructure and expertise.

Windows on Maine, Maine Memory Network, and Open Video Digital Library Toolkit are other examples of NHF offering content revolving around certain themes in collaborative settings. Windows on Main is an educational portal for video-on-demand relating to Maine history. There are 7 different contributors to the project, which is funded by the Institute of Museum and Library services. NHF has 42 streaming and downloadable clips for educational purposes as part of Windows on Maine, facilitating reuse and classroom use. Maine Memory Network has over 200 different contributors, including NHF, to a database of 12,000 items. It is a collection of digital surrogates for paper, paintings, manuscripts, and moving images that link

between collections and formats through Library of Congress subject headings. This allows users to make connections using a variety of resources that otherwise would not have been made because they cross institutions. Open Video Digital Library Toolkit provided excerpts from NHF collections for a test project funded by the Institute of Museum and Library Services (IMLS) to help cultural heritage institutions develop tools to create digital video libraries on the Web.

One of the collaborative projects that Gardner mentioned in particular is the Boston TV News Digital Library: 1960-2000. This is an 8-year project that involves the Boston Public Library, Cambridge Community Television, and NHF, administered by WGBH Media Library and Archives. The funding body is the IMLS, which provided around $500,000. The website is the first to consolidate TV news from commercial, noncommercial, and community cable in the Boston area. It will feature 100-50 hours of streaming video from 16mm from NHF in particular. WGBH already has a successful and important website called Open Vault that put their archive online. Using this website for the Boston TV News Digital Library allows researchers and educators access to transcripts, video, audio, images as well as resource management tools in individual and classroom environments.[98]

Gardner stated that access and increased web presence are the main reasons that NHF digitizes and streams its collections. A large percentage of its 16mm films are amateur films, home movies, and newsfilm. There is much current interest in Boston concerning online news that has led to collaboration and increased awareness of NHF and its collections. Gardner also stated that since NHF put material online it has received more inquiries and requests for copies that it is used to. NHF has also placed a couple of its works on Amazon Instant Video for sale and rental. Unlike other services discussed in this thesis so far, Amazon allows users access to high-quality files without watermark, increasing certain risks of putting the content online. Using

[98] "About Us", *WGBH Open Vault,* 2014. http://openvault.wgbh.org/blog/about/

the Amazon interface, users can download and also stream videos. To do this, one has to download plug-ins (such as Microsoft Silverlight) for streaming and their specific players for download. As with a number of digital services, Amazon licenses material only for a limited time. This reduces the likelihood of theft and unauthorized reuse of the high-quality copies.

Indiana University Libraries Film Archive

Indiana University Libraries Film Archive (IULFA) is one of the largest academic film and moving image collections in this study, with over 71,700 items in its care.[99] Part of the overall library system of Indiana University (IU), IULFA has film-specific staff who catalog, preserve, and curate its collections. IULFA is home to one of the largest and most extensive collections of educational films in the world with 48,000 items. Most of these are on 16mm film and originally meant for non-theatrical classroom settings. IU was one of the largest distributors of educational film from the 1930s through the 1990s, and one of the few to retain and preserve its collection. IULFA is committed to preserving, providing access, and exhibiting thia collection as well as seeking partnerships with other institutions and funding bodies. IULFA and IU Libraries are also part of the IU Media Digitization and Preservation Initiative (MDPI) that seeks to preserve, digitize, and make available online IU's film (and other time based media) collections now and in the future.[100] This is also reflective of IU Libraries' goal of digitizing and putting online all of its holdings.

I interviewed Rachael Stoeltje, the Director of IULFA to learn what they are doing with respect to digitizing and streaming 16mm film. Stoeltje stated that IULFA plans to digitize all of its holdings, whether they are educational or theatrical releases. IULFA is creating both

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[99] "Indiana University Libraries Film Archive", *Indiana University Libraries,* 2014. www.libraries.iub.edu/index.php?pageId=1002886
[100] Ibid.

preservation and access level files in a massive undertaking that involves considerable financial and technical investment. Stoeltje also stated that IULFA still does film-to-film analog preservation and restoration. It is also, however, definitely participating in IU's overall digitization efforts. The film archive and cinema programs benefit from generous support from IU President Michael McRobbie who curates a cinema series each semester. McRobbie also established the MDPI to preserve the university's historical and cultural artifacts and make them accessible for future generations through large-scale digitization.[101] This initiative is for all time-based media, not just the film collections.

McRobbie's and the University's support for digital initiatives within the library community means that much of the digital infrastructure, storage needs, digital asset management systems, servers, and Internet access required for 16mm digitization are already part of the general IU library system. This infrastructure is housed and managed by the IU Information Technology Services unit in coordination with the IU digital library unit, which uses Fedora as the DAM. Despite this significant support on campus, IULFA also has partnerships with a number of external organizations. The MDPI involves a partnership with Memnon Archiving Services, which is performing digitization in its facilities and also setting up digitization stations at IU, in what they call shared services.[102] I am unsure who is storing and making accessible the resulting digital assets, but both IU and Memnon can provide such services. 45% of IULFA's collection is being selected for digitization through the MDPI project. Stoeltje sees the process of selecting which films to digitize as involving the same kinds of decisions as found in overall curation strategies. Some of its digitization workflow, however, comes from user requests rather than the larger initiatives.

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[101] "MDPI", *Indiana University,* 2014. http://mdpi.iu.edu/

[102] "Memnon Archiving Services", *Memnon Archiving Services,* 2014. www.memnon.be/Yourmediaarchivingsolutionspartner/tabid/82/language/en-US/Default.aspx

IULFA also has a partnership with Northwestern University to create the Avalon Media System, with funding through a National Leadership Grant from the IMLS. Avalon is an open source software system specifically designed for academic cultural heritage institutions to curate, distribute, and provide online access to video and audio collections.[103] This system is designed to provide access for teaching, learning, and research and to integrate with current digital libraries. Stoeltje mentioned that Avalon allows only one person to access the content rather than general dissemination through widely accessible webpages as well as those web pages. Rachael and I did not discuss Avalon's relationship with the Digital Library Fedora system. Avalon is currently funded through September 14, 2014, and it is not known if it will receive additional funds. In any event, what is happening at IU in general and IULFA in specific is an integration of digitized works within the university system and online. The University is creating the partnerships, infrastructure, software, tools, and funding necessary for large-scale digitization and online access. This represents a major commitment to keeping the cultural heritage represented by film alive and accessible in the face of technological and technical obsolescence.

IULFA also supports the media production units on-campus and collect born-digital works, or works created through digital technologies. In such cases, it works with the artists and departments involved to determine what level of access is necessary. This workflow also impacts the IULFA ability to preserve and provide access to digitized works. If there is infrastructure to store, preserve, and make accessible to born-digital works then it is also there for digital surrogates of analog works.

As part of the overall MDPI initiative,16mm film is scanned at 2K 10-bit DPX files for preservation and H.264 for access. Stoeltje was not certain about the technical specifications of the files since this work occurs elsewhere. IULFA does not have film scanners on-site and sends

[103] "Avalon Media System", *Indiana University,* 2013. www.avalonmediasystem.org/

materials out to film laboratories and post-production houses. Stoeltje hopes eventually to have vendors build a digitizing facility on-campus similar to what is occurring in the MDPI for other media resources. Once the preservation files are received back from the vendors, IULFA then delivers them to Information Technology Services that stores, makes derivatives, and places them online.

Online access occurs not only through the website of IULFA, but also through YouTube pages that link to IU catalog records and provide some bibliographic information along with the clip. Information about the work is more detailed on the IULFA website, but the YouTube pages contain enough to contextualize the clip as well as ways to discover more information if desired. YouTube allows users to "like," embed, and share in social media settings. For instance, if signed into YouTube, I could save the videos and "favorite" their channel so when new videos are uploaded I would get a notification. I can also share the clip with other people in my social network, allowing it to be viewed in new contexts. Such possibilities provide new avenues for discovery through Google searches, and also increase use and reuse while enhancing the IULFA web presence in general. Each YouTube video also connects to other social media in which IULFA is involved including Facebook, Twitter, and the IULFA blog. In sum, YouTube creates a new space to present IULFA's works and activities as well as publish material in non-academic settings. Many users discover and use the IULFA materials in the course of their normal web activities as opposed to specific research spaces, although dedicated researchers take advantage of these social media as well.

Stoeltje also discussed the convoluted nature of film rights, meaning copyright and clearances. Sometimes theatrical works are easier to deal with than other films. All the IULFA has to do in such cases is track down the rights holder to get permission to publish the work

online. Sometimes the cost can be prohibitive for such works, however, and unpublished works are easier to clear. For Stoeltje, ease of rights clearances depends on each individual work. Since IU was a major distributor of educational films, it retains rights to many. IULFA also digitize sand publishes a number of films online that come from IU activities to which it also retains the rights. If IULFA does end up violating copyright for a work, it receives a take down notice and complies immediately.

Whenever IULFA has the rights to digitize a 16mm film, it believes in streaming the work and making it available to the world. Stoeltje is not too concerned with theft of such materials placed online. IULFA does not watermark, but publishes low-resolution files. They also offer download options as well as streaming the content online for specific works. This allows users to reuse, remix, and also own a copy of the work in certain cases. IULFA currently does not license materials, but it may do so in the future. IULFA feels it is understaffed when it comes to cataloging and is looking into crowdsourcing online materials in the future. Stoeltje is unsure if all these efforts have resulted in an increase in users; IU is a diverse place was her response. Ultimately, however, she feels that the digitization and streaming initiatives are worth it because IULFA is able to provide greater access to its collections.

University of California, Berkeley Art Museum and Pacific Film Archive

The Berkeley Art Museum was originally founded in 1963 on the University of California – Berkeley campus by a donation of both art and funds from Hans Hofmann. The Pacific Film Archive (PFA) that is a separate part of the Berkeley Art Museum followed shortly after in 1966 through the efforts of underground film author Sheldon Renan with the help of the legendary film archivist from the Cinemathèque Française, Henri Langlois. The combined mission of these

two entities is educational in nature. According to the its website, Berkeley Art Museum and Pacific Film Archive (BAM/PFA) strives to "inspire the imagination and ignite critical dialogue through art and film."[104] BMA/PFA operates as a local fine arts institution with global influence and reach. It provides services for the Berkeley campus, community, and beyond. The PFA part of BAM has over 10,000 films and videos, as well as 100,000s of supporting materials. PFA exhibits 500 presentations to over 50,000 viewers each year. Known for its avant-garde, independent and Japanese film/cinema collections, PFA also prides itself locating and exhibiting the best possible prints in original formats with expert projectionists, along with critical films notes with each screening.[105]

I interviewed Assistant Film Archivist Jon Shibata about the PFA's 16mm digitization and streaming initiatives. He discussed their 16mm film collections in-depth. Shibata feels that the lowest priorities for digitization are reduction prints from 35mm films, even though a number suffer from color fading. Since PFA's 16mm strengths are its avant-garde, documentary, and animation collections, these receive the highest priority. A number of the films in each of these collections were expressly shot and exhibited on 16mm. In regards to 16mm versus 35mm, Shibata felt that both were being phased out, but especially 16mm in terms of exhibition. Although he sometimes sees 16mm projected at small venues and artist screenings, Shibata feels 16mm is hardly shown anymore. Despite this, preserving film on film still feels more secure to him than digital instantiations. The PFA preservation program does more than just preserve a print by striking a new one; they sometimes also add in medium integration, that is adding in other media including digital works to analog prints, to their preservation work. By way of

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[104] "BAM/PFA Mission and History", *BAM/PFA Berkeley,* 2014. http://www.bampfa.berkeley.edu/about/mission
[105] Amazonas, Lee. "Guerilla Cinematheque Comes of Age: A History of the Pacific Film Archive", *BAM/PFA Berkeley,* 2014. http://www.bampfa.berkeley.edu/about/aboutnotedetail.php?Nickname=TXT0010

example, Shibata highlighted that the PFA is thinking of preserving a “crazy psychedelic” 1960s 16mm film print in this way

In addition to feeling that film-to-film is more secure for long-term preservation, Shibata expressed other concerns about digitization. He sees copyright issues as a big barrier to online access, especially when upholding the standards and rules of the International Federation of Film Archives (FIAF). Putting work online while adhering to these standards often feels daunting. For the PFA and Shibata, copyright is the biggest stumbling block in providing online access to works, although he also mentioned issues of funding along with staff and time. One funding source PFA has already tapped is a digitization planning grant from the National Endowment of the Humanities.

Shibata also feels that digitization and streaming works feels like a difficult mental issue and PFA is more used to analog preservation and workflow. The mental issues require a shift in thinking about the role of copyright and access in networked and digital environments as opposed to analog forms of access and copyright. Shibata feels PFA is not fully prepared for digital assets: there are difficulties with naming conventions and locating works and integrating streaming into their existing web pages. Generally the naming conventions come from the vendors and vary for each project or work. In addition to its LTO tapes and hard drives, the PFA uses off-site storage with some of its partners, especially the California Audiovisual Preservation Project (CAVPP). If Shibata leaves the PFA, he wonders if anyone would be able to locate PFA’s digital files. In this light, he wants to upgrade the DAM for their spinning disk hard drives in proprietary RAID arrays called Drobo and LTO-5 tapes.

In spite of these barriers, Shibata feels putting works into the digital realm means the work is not forgotten and is able to persist. People see and use a work that would otherwise just

sit on shelves unused and unseen. Streaming and online publishing also help drive web traffic to the PFA website, especially since such formats are Google searchable as opposed to some of PFA's other records. Streaming capabilities have enhanced the PFA website significantly. Interested parties come to the website because of this and then stay connected to the institution (through the web). PFA is also now more likely to be discovered as potential users conduct web searches. This outreach and access is also part of PFA's mission to serve the UC campus and community as well as beyond. This is a major reason why Shibata wants to digitize and stream as much as possible, despite the difficulties he sees with the process. Other benefits to PFA from putting works online include an increase in licensing requests. In fact, PFA has received so many requests as a result of discovery through streaming and CAVPP (California Audiovisual Preservation Project) that they can barely handle them.

CAVPP is a partnership among 75 cultural heritage institutions to digitize and provide online access to historic audio and moving image materials concerning California.[106] Access is available through an online database and the Internet Archive. The Internet Archive was chosen as host due to the possibility it offers for folksonomic tagging. This allows people to comment, add metadata, and information about a work, thereby enhancing its metadata. Right now, PFA's only streaming works are through this project and were selected due to their value in understanding California history. Most of the items in the CAVPP collection are from the California Video Collection on ½" open reel and ¾" videotapes. Shibata characterized the 16mm films that were digitized and streaming as home movies with famous people and relatively few in number. Shibata outlined the workflow for getting works online for the CAVPP as illustrated below.

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[106] "California Audiovisual Preservation Program", *Calpreservation.org,* 2014. http://calpreservation.org/projects/audiovisual-preservation/

Selection ➔ Nomination to Funding Group ➔ Laboratory/Post House ➔ Quality Control and Adding Metadata ➔ Post Online

Shibata did not go into too much technical detail about the streaming files or what is created. 16mm films are digitized to 10 bit uncompressed video from which mezzanine and access files are created. One person does the quality control and adds metadata to the record for the work after digitization. Shibata feels that such collaborative projects are good, but somewhat worrisome. They can be hard to track, and it seems that the files go to many different places. The webpages that I visited connected to the PFA collection for CAVPP did not allow download, but only streaming accompanied by a copyright restriction notice. They also stated that PFA had screening rooms and flatbeds for 16mm films available at its facilities.

The only other file associated with PFA that is online is a documentary about the organization that they uploaded to YouTube. PFA seems to control how its content is disseminated and is concerned about copyright restrictions. Shibata feels that the PFA views itself as a guardian or steward, holding individual and highly valued property. Its assets make PFA special and interesting, and it is guarding them carefully. It may be time, however, to open up these assets a bit more. These assets can be preserved on film for 200 years, but what about matters of curation or access. The PFA's unique holdings may disappear from the public consciousness unless they are translated to the digital realm. Such are the issues with which PFA is now wrestling.

A 16mm Film is Digitized and Streamed

The following is a composite and fictionalized account of a cultural heritage institution digitizing and streaming a particular 16mm film derived from the survey results and case studies. A cultural heritage institution decides that they are going to launch a digital initiative for moving images as part of a collaborative project that already has funding. A 16mm film is part of a group of films featuring home movies and industrial films that have rights clearances through donor agreements that feature life and work in the 1940s. The work is a silent home movie made by a prominent family in the area using Kodachrome reversal stock using a 4:3 aspect ratio at 24 frames per second (fps) in 1943. The institution decides to use the film scanning method meaning the aspect ratio and frames per second are automatically adjusted for in the transfer. The 16mm film is examined on rewinds, repairing, replacing splices, and cleaning. All internal metadata is updated reflecting preservation actions and its pending shipment to the digitizing facility.

The cultural heritage institution does not have a telecine, so they send out to a third-party organization similar to AV Geeks, to transfer the work to preservation level files. Derivatives will be made in-house as the cultural heritage institution has the infrastructure to process preservation level files and transcode them. Storage will be held at an internal digital repository and at partner institution to create redundancy and geographic separation. After the work is repaired and examined, it is placed on archival level storage, plastic film containers and cores, and shipped. An agreement about cost, deliverables (what is received back from the organization), metadata captured, and general procedures for the digitization and shipped with the film.

The 16mm print is received by the digitizing organization that makes sure the film can run through its machines. If the film has not been properly prepared by the cultural heritage

institution then they clean and repair the film so they can digitize it. The 16mm home movie film is scanned at 2K resolution in 10-bit DPX Log RGB files with edge-to-edge information captured. The digitizing organization records all metadata requested from the organization, delivers the file with fixity and other technical information enabling quality control and authentication by the cultural heritage institution. The files are loaded onto a hard drive and sent through secure (encrypted) FTPS protocols to the requesting cultural heritage institutions using the Library of Congress application Bagit.[107] In order to facilitate network transfer Bagit creates standardized containers for transfers with metadata including fixity information. Bagit also helps with ingesting digital assets into digital repositories.

The cultural heritage institution receives the files from digitization through the network and hard drives. Their staff verifies the contents of the network transfer and hard drives by using the fixity information and metadata as well as basic quality control. This includes looking at the content of the video files to make sure the transfer is acceptable. If there are any problems, they contact the vendor and discuss a way to get what they stipulated. The institution ingests the content into the digital repository to ensure its safety and long-term use. After the files are sent to a computer so a staff member can do more quality control as well as create derivatives. The staff member uses the open source software FFMPEG to transcode the files to the mezzanine format DVC PRO HD (1080p) wrapped in MOV (QuickTime format) with pillar boxes (dark edges around the frame) to adjust for aspect ratio at 24 fps and the access files encoded with H.264 wrapped in MOV with pillar boxes at 24fps. This institution has decided to stream the access files with the edge-to-edge information. If they wanted to remove the edge-to-edge aspect, they

[107] "Bagit: Transferring Content for Digital Preservation", *Library of Congress,* 2014. www.digitalpreservation.gov/multimedia/videos/bagit0609.html

would use the mezzanine format[108] to create the changes and then create the access files. The staff member also creates additional metadata about content, technical aspects, and others.

The mezzanine files are then ingested into the digital repositories and serve as the editable files for the institution. The access files are also ingested into the digital repository and both become part of the DAM Fedora. The preservation, mezzanine, and access files and metadata are then shared and ingested with a partner institutions digital repository using BagIt. The website itself is developed and published offsite at a partner institution, so this cultural heritage institution does not have to worry about creating a website that allows video files to be streamed, webpages to be published, and a portal for discovery of the project.

The access files and metadata records are ingested by this partner organization to be published online. The resulting webpage, record, and streaming webpage gives full accreditation to the cultural heritage institution allows for comments, folskonomic tagging, and user cataloging down to the shot level. Videos are restricted per the cultural heritage institutions instructions to streaming and not download. What is published on the cultural heritage institutions website is a link to this portal and a webpage with content about the project. Actual streaming instances are limited to the portal and project website.

[108] Mallsen, Kara, "Digital Video Preservation and Oral History", *Oral History in the Digital Age,* 2014. http://ohda.matrix.msu.edu/2012/06/digital-video-preservation-and-oral-history/

PART FOUR: CONCLUSIONS, THE DIGITAL LEAP FOR 16MM FILM

The digital leap for 16mm film in U.S. cultural heritage institutions is clearly on its way. Not all institutions are participating to the same extent, but all (or nearly all) are thinking about the possibility of digitizing and providing online access to at least part of their collection. Through initiatives, both large and small, 16mm films are being turned into digital information that requires computers, digital projectors, and processors instead of film projectors, rewinds, and light to interpret and access their content and meaning.

For most of the institutions examined in this thesis, the benefits of digitization and online access have outweighed the costs. Only one remains unsure that it wants to take this leap any further than it already has, and it is one whose collection contains largely artistic films the content of which may or may not transfer well to digital instantiations and over which the institution wishes to exert fairly controlled access. Artistic works on 16mm films have a number of issues of archival practice including the FIAF code of ethics[109] that focuses in on the original viewing practices, do not violate copyright, accurate replication of the work, do not distort the nature of the work, and the intentions of its creator. This makes it more challenging for archives of artistic and avant-garde works on 16mm to migrate to the digital realm. For the other institutions, the value of increased access to their collections exceeds any issues or difficulties they have encountered. These organizations are taking the digital leap for reasons of access, much more than preservation.

This access has breathed new life into these 16mm film collections and carried institutional benefits, both expected and unexpected. As expected, the user audience for these collections has expanded and become more diverse, accompanied by increased awareness and

[109] "Code of Ethics", *FIAF,* 2002. http://www.fiafnet.org/uk/members/ethics.html

enhanced reputation for the institutions that hold them. Not so expected, however, are the new ways in which some of these users are engaging this 16mm film material. The content and nature of 16mm works is directly responsible for this. Individuals recognize themselves, their ancestors, and their communities in some of these films – and provide this information to the cultural heritage institutions. Source communities are finding historical ethnographic and documentary films, asking for copies, and providing yet further information. Each such discovery can spark still further discoveries. In some ways, these films are active players in contemporary cultural and community dynamics. They are not just records of the past, but also agents in the present. Digitization and online access carry clear benefits for users as well as institutions.

Another unexpected benefit from this process is the way that it has brought different cultural heritage institutions into contact and collaboration with each other. Collections that were once isolated and unknown are now being placed alongside similar collections that were also once isolated and unknown. The result gives added perspective to what each institution understands about its own collection, while building an increasingly more comprehensive picture of the various kinds of images, information, and perspectives presented by the different genres of 16mm film. The kind of comprehensive knowledge of the filmic corpus that has been developed for theatrical 35mm films may now be built for 16mm works.

This same connectivity is also sometimes felt by users, even those who are widely separated from each other. Streaming is different from traditional projection presentations for a group of people in a common location. It permits a more individualized engagement with formerly film content. It also, however, enables eventual connectivity with a larger set of fellow users than possible in any auditorium. This connectivity is more participatory in nature, between users and the cultural heritage institutions, creating a secondary community.

In short, the digital leap for 16mm film is placing these works into much greater discussion by scholars and the public alike. Their importance as ongoing and valuable elements of cultural heritage is being realized. This digital leap is also achieving the information threshold necessary for our understanding of these works to match our understanding of theatrical cinema. This is the basis for my comments on the importance of this leap for digital humanities with which I end this thesis. Before making these comments, however, I include a discussion of what has been learned about productive ways to make this leap and how to deal with the pitfalls along the way.

16mm digitization and online access are not without their issues. All of the risks of digital preservation are there: format obsolescence, copyright restrictions, illegal copying, and disconnect from various contexts and meanings of the film. Institutions need to make sure they have the appropriate understanding and infrastructure to begin digitization and digital preservation. As discussed earlier in this thesis, they face a myriad of decisions on what technological processes to use, whether to do things in-house or not, how to determine which films to digitize, how to make them available online, and how and under what circumstances they will partner with other institutions. All of these issues are made less stressful if institutions develop comprehensive digitization and online access plans for their 16mm collections. Given the sheer volume of this material it is unlikely that all will be digitized in the near future, so strategies for deciding which to do first are critical. Curation based on a variety of factors that will vary by institution, collection, and mission will guide the selection. In similar fashion, as these materials become fully networked, it will be increasingly important to coordinate records and metadata with other institutions. An understanding of this issues so that 16mm film works persist in a way that aids users, scholarship, heritage, and the institutions. This way institutions

can exert more control and care for their collection when it is migrated into digital and online realms upholding archive principles.

The 16mm films involved in this leap not only contain their encoded content meant for public display, but reference a series of conventions and industrial models that led to their production as well. These film objects reflect a general mode of production and distribution when they were created, change during their lifespans, and contain more information than just the images. There is a lot more information and process than immediately visible on the digitized version. Digital access to 16mm film changes and updates how the work is produced, distributed, and presented. Institutions should therefore migrate and represent the previous meanings and reception as much as possible. What can be lost are the cultural, social, historical, and economic mechanisms as well as technology that led to the creation and meaning of the film. Digitization requires great attention to metadata and the possibilities of the digital representations to provide historical understanding and meaning.

Digitization also requires an acceptance and explanation of the ways in which the digital instantiation is not the same as the analog one. Users need this information as well. This does not invalidate the digital version entirely, but rather interprets it. As stated in *Film Curatorship,* "… it would be perfectly arguable to say classroom films have always used 16mm film, and not for aesthetic purposes, but because it was the technology that was available for non-theatrical use, and nowadays digital technology has the same status. So isn't the proper presentation and also the proper preservation for something which has always been destined for non-theatrical access digital?"[110] This passage goes on to say that digital versions may need "seams", metadata and textual insertions that give more information than is immediately visible. Similar to the way a

[110] Cherchi Usai, Paolo, David Francis, Alexander Horwath, and Michael Loebenstein, *Film Curatorship: Archives, Museums, and the Digital Marketplace,* (Vienna: SYNEMA, 2008). Page 201.

goal of philologists to bring all versions of a written text together in one digital representation, film images can undergo the same type of treatment in the digital realm. There is in fact a certain value in going through and annotating various works, even unacceptable fragments of work in the analog realm, but acceptable and interesting in the digital. Embracing the possibilities of digital representation and computing technologies allows for new understanding and analysis that were previously unavailable. For a total understanding of an historical film system or work, a projector is necessary. Digital technologies do allow, however, for certain encoded information, like edge codes and perforation sizes to be widely accessible.

This said, digital surrogates for 16mm film are becoming increasingly high quality. As Jan-Christopher Horak pointed out a few years ago as the digital cinema conversion from celluloid was taking place,

> "Furthermore, improved scanner/telecine transfer techniques have meant that 2K digital masters (with a resolution of 2048 by 1080 pixels) can be generated from 16mm negatives, giving producers and distributors an added incentive use the cheaper 16mm, rather than 35mm, as their production medium. In other words, the high quality digital needed for a DVD transfer can be struck from a 16mm negative, and this reduces the incentive to shoot on 35mm."[111]

Put another way, motion picture film digitization technology in the 2000s reached a point where 16mm could produce digital surrogates that rivaled 35mm exhibition prints and the main form of access digital cinema. It, however, does not lose the same historicity as 35mm films in the digital realm.

Borrowing concepts from the archiving and preservation of computer games that are often dependent on obsolete or not readily available technology might provide the conceptual answer to what cultural heritage institutions should seek in producing their digital surrogates for

[111] Jan-Christopher Horak "Archiving, Preserving, Screening 16m" *Cinema Journal* Vol 45 Issue 3, 2006 p. 112

16mm film. In 2004 Henry Lowood envisioned the ideal archives and repositories for computer games in the following way.

> The first is we should be open to revision of institutional and curatorial roles for historical new media collections. The second is that we will need to create repositories that will be focused less on conserving physical objects than emulating the "look and feel' of interactive media, documenting and delivering computer-mediated performance, describing and reformatting media objects, and possibly even recreating the social and personal experiences made possible by historical media such as computer games. The third notion is simply that the lynchpin of all that follows will be to solve these problems in collaborative, multi-institutional projects.[112]

The conception of cultural heritage institutions as physical spaces filled with physical objects as their primary duty is changing. What is more important now to users and our cultural heritage particularly in relationship to 16mm film is creating something that captures the "look and feel" of the original objects and experience as well as forming new collaborations between various institutions. The digitization and streaming of 16mm film fulfills all of these needs for 21st Century cultural heritage institutions as well as user demands.

The Digital Leap and the Digital Humanities

As the recent MIT Press book on the topic succinctly suggests on its first page "Digital Humanities is born of the encounter between traditional humanities and computational methods.[113]" As the UCLA Center for Digital Humanities states in "The Digital Humanities Manifesto 2.0"

> Digital Humanities is not a unified field but an array of convergent practices that explore a universe in which: a) print is no longer the exclusive or the normative medium in which knowledge is produced and/or disseminated; instead print finds itself absorbed into new, multimedia configurations; and b) digital tools, techniques, and media have altered the production and dissemination of knowledge in the arts, human, and social sciences.[114]

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[112] Henry Lowood, "Playing History with Games: Steps towards Historical Archives of Computer Gaming" 2004.
[113] Burdick, Anne, Johanna Drucker, Peter Lunenfeld, Todd Presner, and Jeffrey Schnapp. *Digital_Humanities.* (Cambridge: The MIT Press, 2012). Page 1.
[114] "The Digital Humanities Manifesto 2.0" Presner, Todd and others. *Humanities Blast, UCLA,* 2009.

With the advent of the Internet age there has been a paradigmatic shift in media and information production, more relaxed views of intellectual property rights, and the resulting social expectations of information. Not only did information and cultural output become more decentralized and collaborative, but this shift to digital also resulted in the decline of 16mm production, distribution, and support. Economic production is now between old models of intellectual property rights that are too constrictive for the open and free information promised by the Internet. One of the major byproducts of this shift was the rise of digital humanities scholarship. Digital humanities examine the human or cultural record in a digitized and networked realm using new computational methods and tools for moving image materials and other parts of the larger cultural record.

The moving image world is now a highly networked one, with its commercial sector increasingly dominated by on-demand video and digital cinema packages. Digital cinema package and video on demand are generally for commercial marketplaces, but this shift in delivery has had an impact on non-commercial entities like cultural heritage institutions. Traditional forms of moving image and image representations have given way to digital representations of analog materials with an increased focus upon networked access. Information is now expected to be free or licensed as opposed to purchased out right and open to reuse and new social forms of expression (social media, sharing, posting). The shifts in commercial distribution for moving images have resulted in new expectations from scholars and users alike.

This shift in the economy and distribution models has affected the way that humanists and scholars interested in cultural records conduct and publish research. The objects and nature of research and discovery are now democratized and outside of specific locations represented by digital information. This includes works that are born-digital or made by and for digital

technologies as well as digitized analog (non-digital analogous) materials. The tools and methods of this inquiry now use and explore networked environments and the possibility of computing technologies to provide qualitative and critical analysis as well as preservation of the cultural record. For centuries humanities scholarship consisted of text-based research that was in done in isolation in specific research locations and viewed as separate from labor and craftsmanship. In the digital humanities scholars are not creating and generating projects and materials of the cultural record.

Digital humanities, however, changes this conception of humanities scholarship to one of collaboration and craftsman like production of new materials and products for the cultural record. Instead of individuals working alone, collaborative scholarship that looks at the way information is presented and disseminated as important as the information itself. One of the most consistent forms of output in the digital humanities is that of projects with a focus on their design, distribution, and technical requirements. Instead of a paper, one is likely to encounter a digital document or experience that includes more than text-based components including audio and visual components that are distributed over the network in digital humanities. An older, but valuable work by Schreibman, Siemens, and Unsworth *A Companion to Digital Humanities* published in 2004 tells us: "The field also places great importance on the means of disseminating the results of these activities and, as Pitti discusses, recognizes that project conception and management can be as important pragmatic concerns as others which are more traditionally associated with disciplinary pursuits."[115]

[115] Schreibman, Susan, Ray Siemens, and John Unsworth, A *Companion to Digital Humanities* (Oxford: Blackwell, 2004). Introduction.

The projects and digital humanities have some common features and approaches, curation, analysis, editing, and modeling.[116] Analysis in a digital humanities context means the processing of text or data. This can be close readings of works or analysis of large volumes of works and its metadata. Results from analysis are increasingly being shown by graphics rather than text. This is taking the form of geography and temporal visualizations on mapping platforms to analyze dynamics. Editing is generally the way that material is put together to form an argument. In this content editing is not just text-based, but involves compiling, removing, and constructing arguments using any available materials. This could be putting all evidence about a 16mm film (variations, different elements, production agreements, etc.) on one website or doing the same for books, a dream of philologists.

Modeling is the process of using content models to structure information and design an interface (not just a digital one, but a way to interact with the information). This is a concept that a model is made that shapes the cultural content. This can be the organization of files and databases and the actual interface that a users see which are often different in structure. The way people organize information and the way people interact with this organization calls into question what is included, why is it included, and what are the possibilities of this organization. This goes to the heart of digital humanities by challenging "Even basic questions about file formats, image resolution, metadata, and classification schemes to structure the digital materials are intimately bound to the argument made by what is referred to here as a 'content model'."[117]

One of the four activities, curation, is closely connection to cultural heritage institutions and their professionals. Definitions of curation in digital humanities reflect argumentation, the variety of materials in the process, as well as the new visual, spatial, and analytical relationships

[116] Burdick page 17. Remainder of description of activities is from this work, Presner *Digital Humanities Manifesto Version 2.0,* and Schreibman.
[117] Burdick, Page 19.

that can be revealed through curation in the digital realm. "Curation means making arguments through objects as well as words, images, and sounds. It implies a spatialization of the sort of critical and narrative tasks that, while not unfamiliar to historians, are fundamentally different when carried out in space-physical, virtual, or both-rather than in language alone."[118] "Curation is the selection and organization of materials in an interpretive framework, argument, or exhibit. The capacity with digital media to create enhanced forms of curation brings humanistic values into play in ways that were difficult to achieve in traditional museum or library settings."[119]

There are new ways to approach and construct information and meaning through the curation of cultural objects including 16mm film and moving image materials. How digital objects are presented in combination and order creates an argument and new meanings. "It means becoming engaged in collecting, assembling, sifting, structuring, and interpreting corpora. … It is a medium with its own distinctive language, skill sets, and complexities;"[120] Generally curation is associated with cultural heritage institutions and professionals outside of academia. Instead of leaving it to professionals in cultural heritage institutions, part of current humanities scholarship is creating argumentation through the selection, editing, and combination of digital objects. There is a lot of information that can be placed online and a lot that is still locked away in repositories, part of curation is discovery, selecting, and editing from these collections. Large-scale digital and digitization initiatives expand the available information as well as individual user requests. As information becomes more democratic and access more expected, curation and use of relatively undiscovered material becomes more important to understanding the full cultural record and human experience. From humanistic and cultural heritage perspectives digital collections of materials needs to come with the ability to be curated. Either humanists will help

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[118] Presner, Page 9.
[119] Burdick, Page 18.
[120] Presner, Page 9.

curate the collections from the beginning or digital collections should enable for curation from humanists and others.

The approaches and conceptions of digital humanities all stem from a change in information, people, and the cultural record, not just questions of humanities disciplines. The forms of epistemology and production are now transmedia (text, images, moving image, audio, etc.) and influenced by open source models that allow for a more lax view of intellectual property rights.[121] When one encounters information on the web, it contains digital representations of text, images, video, audio, and any number of components and interactions. Instead of copyright laws intended for physical objects and ownership, new copyright models such as licensing appear where no one actually owns anything, but only have access for a limited time. Our way of conceiving and producing both culture and information is changing rapidly in this environment. It takes any number of processes to create cultural production in multimedia and web-based content as well as technological constraints and possibilities that use materials under copyright. Unlike traditional texts, a lot of these resources are non-linear in nature and pull together a wide variety of content to synthesize an experience and knowledge.

These intellectual property rights are too restrictive for more scholarly pursuits that demand reuse, remixing, and curation to make arguments. Copyright stands at odds with the free culture and use of Internet that makes cultural objects that go against intellectual property rights. Both humanists and cultural heritage institutions need to have a more relaxed view of copyright and intellectual property to not hamper culture or scholarship. This quotation is from "The Digital Humanities Manifesto 2.0", "Digital humanists defend the rights of content makers, whether authors, musicians, coders, designers, or artists, to exert control over their creations and

[121] Burdick discusses intellectual property and the transmedial nature of culture in the first chapter of the book. Schreibman takes a more restrictive view on copyright in the section entitled "Developing Sustainable Projects and Publications" by Dennis V. Pitti. That section also describes how to get around copyright restrictions and fair use.

to avoid unauthorized exploitation; but this control mustn't compromise the freedom to rework, critique, and use for purposes of research and education."[122]

This transition in the Internet age also extends to scholarship and the nature of evidence and academic research. What is being demanded from cultural heritage institutions as well as their own imperatives to preserve and disseminate the cultural record are to provide moving image and other materials in a manner consistent with current scholarship and cultural practice. This goes against previous forms of institutional practice and scholarship for cultural heritage institutions and humanities scholarship that were rooted in texts, objects, and place. Most 16mm film digitization and streaming projects in cultural heritage institutions reflect this shift in responsibility and duty to the public as well as current shifts in culture and information.

We are now in a transitional period from traditional humanities to new approaches and research methods that fall under the umbrella term digital humanities. Production of knowledge, like media production in general now occur across multiple platforms and forms of media as well as influenced by open source models that allow for a more expansive view of intellectual property rights. The current transition to the Internet also extends to scholarship, research methods, and the nature of evidence. What is being demanded from cultural heritage institutions as well as their own imperatives to preserve and disseminate the cultural record are to provide moving image material in a manner consistent with current scholarship. This means that most 16mm film digitization and streaming projects reflect this shift in responsibility to users as well as thinking about culture and information.

Humanism itself is engaged with the study of what it means to be human and is formed by specific disciplines (literature, classics, philosophy, history, art, design, etc.). The various disciplines and thought that constitutes humanism are concerned with the cultural record and

[122] Presner, page 4.

output to understand the human experience. Humanities are in contrast to scientific empiricism where everything is weighed and tested, and value qualitative judgments. Thus converting analog content that is also data to digital representations or data comes with suspicions from some humanists who see it as a quantitatively generated analysis. What digital humanists want to stress, however, is that this conversion does not destroy humanistic inquiry. Rather if research and projects are carried out with a humanistic spirit and allows for qualitative judgments then they are part of the humanities. This means that humanities data and digital humanities projects provide new tools, mediations, and ways to think about the cultural record and does not destroy the associated disciplines. Digital humanities also call for an expanded role of a humanist scholar, namely becoming more of a technologist and to work with information specialists in organizations like cultural heritage institutions to create digital environments catered to humanistic inquiry.

As Johanna Drucker states in a 2009 article calling for more humanist involvement in information technology,

> Unless we scholars are involved in designing the working environments of our digital future, we will find ourselves in a future that doesn't work, without the methods and materials essential to our undertakings. … Technical experts and library professionals are not mind readers, even in the futuristic film worlds of sci-fi. Design must emerge from the context of use.[123]

The humanities still present ways to approach and understand the world dating back to the Renaissance era where a human-centered view of the world replaced a theological one. It is just the objects and methods of cultural record have changed along with its how they are created, preserved, organized, and disseminated. This necessitates the construction of new ways to analyze, organize, and access them for both cultural heritage institutions and scholars.

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[123] "Blind Spots: Humanists Must Plan Their Digital Future", Drucker, Johanna. *The Chronicle of Higher Education,* Volume 55, Issue 30, April 3, 2009. Page B9, http://chronicle.com/free/v55/i30/30b00601.htm

It was in the early parts of the 20th Century primarily focused in on textual readings or philology. Specific disciplines also became more standardized and codified as separate entities in general and in higher-education institutions. As Burdick et al. put in,

> By the mid-20th Century, the modern research university assumed its present form, with segmented humanities departments separated from the natural and social sciences as well as from vocational and professional schools.[124]

Digital humanities mean a move away from the segmented humanities disciplines and text-based approach, to a more collaborative, interdisciplinary, and data based model. Rather than specific books and holdings locked away in cultural heritage institutions, it demands that these are digitized and represented as data and the institution to provide them online.

Digital humanities is traditional humanities scholarship combined with new computer technologies, sources, and tools as well as networked environments. In these environments collaboration is essential not just between the technologists and archivists that make materials available, but between (and among) these humanities disciplines. Digital humanities also transitions scholarship away from books and other texts as the primary document of humanities studies to new realms including moving images. It is a transition from isolated humanists looking at physical works to one that is expressly collaborative, multidisciplinary, and generative (creates new objects for study and ways to study) using digital data – including video. Thus, scholarship itself is shaping the role of cultural heritage institutions.

The various methods of humanities scholarship and texts generated through digital humanities are different than traditional forms of humanistic inquiry and shift the role of cultural heritage institutions. As a *Companion to Digital Humanities* puts it:

> Ultimately, in computer-assisted analysis of large amounts of material that has been encoded and processed according to a rigorous, well thought-out system of knowledge

[124] Burdick, Anne, Johanna Drucker, Peter Lunenfeld, Todd Presner, and Jeffrey Schnapp. *Digital_Humanities.* (Cambridge: The MIT Press, 2012). Page 7.

> representation, one is afforded opportunities for perceiving and analyzing patterns, conjunctions, connections, and absences that a human being, unaided by the computer, would not be likely to find.[125]

As this transition happens it is important that 16mm film in cultural heritage institutions is not lost, but rather is part of this process. It is ironic that in older and original forms of presentation 16mm film was often overlooked for commercial and theatrical releases on 35mm. It is with mass-digitization and scholarship designed for digital and networked environment they may yet be discovered. A number of these streaming and digital initiatives for these works from the surveyed cultural heritage institutions fall under the rubric of digital humanities.

According to *Digital_Humanities* published by MIT Press in 2012, the necessary components for any digital humanities project are digitization, classification, description and metadata, and navigation.[126] The success of digital humanists and digital humanities projects are predicated on the knowledge of technology and networked environments as well as their possibilities. This means that an understanding of the process of digitization and digital representation of analog information along with the necessary infrastructural requirements and limitations including storage, servers, and software are significant to the success of a digital humanities project. An understanding of digitization of for moving image materials and 16mm film is important due to a variety of factors. As Schreibman et al. foresaw a decade ago,

> The conversion of three-dimensional objects and of time-based media is more problematic than that of text or still images. It draws upon newer technologies, the standards are not as well supported, and the file sizes produced are very large. The hardware and software to manipulate such materials is also generally more costly.[127]

Coupled with this understanding of digital technology and representation is also the conception of the project in digital humanities scholarship. This involves an understanding of the

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[125] Schreibman, Susan, Ray Siemens, and John Unsworth, A *Companion to Digital Humanities* (Oxford: Blackwell, 2004). Introduction.
[126] Burdick, Anne, Johanna Drucker, Peter Lunenfeld, Todd Presner, and Jeffrey Schnapp page 17.
[127] Schreibman, Susan, Ray Siemens, and John Unsworth, A *Companion to Digital Humanities* (Oxford: Blackwell, 2004). Page 32.

subject and forms necessary to create sustainable and usable outcomes. Burdick et al. view projects as the basic unit of digital humanities scholarship and the way to gauge scholarship. "A project is a kind of scholarship that requires design, management, negotiation, and collaboration. It is also scholarship that projects, in the sense of futurity, as something which is not yet."[128] Projects are generally collaborative with individuals who compliment one another to conceive of possible research questions and ways to answer them. Due to the technology involved in the process rather than just collaborative scholars or archivists, it will involve institutions, technologists, partnerships with other organizations (cultural heritage and corporate), and widespread community members (amateur historians, collectors, etc.). "Projects are usually faculty-, staff-, or student-initiated. They are often built around a research question and/or a university collection or archival repository."[129]

Once a project is conceptualized around its subject then the process of digitization occurs and the results information or data is made available online. There are generally two types of digital humanities projects in relation to data. For larger scale projects that involve a large amount of data also called big data, digital humanities are known as big humanities.[130] In general smaller projects that do not deal with big data are just referred to as digital humanities. The smaller the project does not necessarily mean that the data is better structured, just literally refers to the amount of data. A model proposed by Christof Schöch is to refer to two types of data in digital humanities, smart data and big data. Smart data is processed, marked up, and more processed information. Big data is a large and/or complex data sets that come from a variety of sources, is a combination of different types of data, and has little structure. These two terms and

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[128] Burdick, Anne, Johanna Drucker, Peter Lunenfeld, Todd Presner, and Jeffrey Schnapp page 124.
[129] Ibid.
[130] Referenced in Schreibman, Presner, Burdick, and "Big? Smart? Clean? Messy? Data in the Humanities", Schöch, Christof. *Journal of Digital Humanities,* Vol. 2, No. 3 Summer 2013.

types of data refer to different approaches and analysis. Smart data is most suited to close-readings of data, while big data is most suited for distant reading or macroanalysis.

A more detailed accounting of this type of data and its usefulness is necessary to understand some of the projects and institutions that appear in the survey. As Schöch states,

> Smart data is data that is structured or semi-structured; it is explicit and enriched, because in addition to the raw data, it contains markup, annotations and metadata. And smart data is 'clean', in the sense that imperfections of the process of capture or creation have been reduced as much as possible, within the limits of the specific aspect of the original being represented.[131]

This is best for very close textual readings and due to its time-intensive activities of cataloging and processing is associated with smaller projects and datasets. Most of what makes data is smart involves human involvement and input. The analysis this allows is very granular and specific as the data is structured and input that way. As a result smart data does not lend itself to be automated easily as terms and individual input is not something that computers can do right now.

Big data is the alternative form of data, one that is messy, complex, and large without human input. This has far-reaching implications on its potential use and analysis in the humanities. Very low-level features can be quantified and analyzed using statistics and probabilities and more data and types of information will be used in an answer to a research question. The types of resources that can be used goes far beyond the standard texts that are taught or viewed as canonical. There is also less focus on the quality of representation and contextual information for each work such as Google books.[132] Switching from smart data to big data is a shift from purely qualitative modes of thinking to quantitative analysis to fuel

[131] Schöch section 2.
[132] Drucker.

qualitative results. “Big data requires visualization to even start understanding its possible structure, whereas smart data makes its structures explicit.”[133]

Schöch in modeling these two types goes on to say that what digital humanities needs is to bridge the two types of data. He wants to make smart data bigger and big data smarter. He proposes doing this through computer automation and crowdsourcing. Computers can recognize inherent data structures and annotate digital representations accordingly and more people annotating through crowdsourcing allows for deeper analysis, tagging, and structure for large data sets. He realizes that the process of digitizing information (including analog works) comes with these problems.

> The first step leads from the study of creative works in the form of books, paintings, and movies to their study based on digital representations of these works; this is what digitization at its most basic level is about.[134]

What is important about this example is that digital humanities are contain a trial and error component. Where analysis and projects are created to see what happens from them, some are destined to fail or lead to poor analysis, which is viewed as a triumph and a source of knowledge. The approaches of big and small data as well as a mixture of the two allow for new analysis, experimentation, and reflect the project-based, failure-based learning, and evolution of the field.

The networked and multidisciplinary approach with multiple individuals who helped create humanities scholarship and the conditions necessary for scholarship. This creates issues of accreditation and authorship in the creation and dissemination of the projects as well as research that results from the projects. More and more groups of people are credited for work rather than singular authors. Two of the works that I reference as well as personal correspondence with working with all reference this shift. For instance the books *Digital_Humanities* and *A*

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[133] Schöch.
[134] Ibid. There are also discussion of the transition to digital representations and what it means in Burdick, Schreibman, Drucker, and Presner.

Companion to Digital Humanities all have at least three authors and many more collaborators accredited throughout the work. This is a far cry from traditional humanities work where people work in isolation and publish their work alone.

What all of this means is that scholars and parties interested in the cultural record understand technology and digital representations, while demanding networked access to materials and data to conduct new research that involves large group of people. To begin to analyze and understand this amount of data in meaningful ways a serious of practices and viewpoints have been consolidated in response. These include a more relaxed view of intellectual property rights, collaboration, a shift in traditional roles of both scholar and cultural heritage institutions, scholarship, and cultural output. Who is involved in research and the cultural record has taken a shift to much more democratic nature, a number of initiatives including crowdsourcing, amateurs providing meaningful contributions to academia, and a more generative form of scholarship designed to impact a much larger set of people through the Internet.

Digital humanities are judged by and produce individual projects that have a number of features, but involve computer tools, visualization, and for a far greater number of viewers as opposed to academics. The resources used are also much more far-reaching and expansive than before, allowing for analysis of the full range of texts, movies, paintings, etc. that extend far beyond the standard canon. Digital humanities are a response to this new form of human experience, interaction, cultural production, and possibilities for analysis and information that stems from computers and networked environments. As people adapt and try new forms of analysis using computer models and quantitative methods to reach qualitative conclusions, results will vary in success, but the field and methods will continue to evolve to reflect new standards and methodologies.

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Final Remarks

Currently 16mm film is among the hardest film gauges or formats to accurately project and find expertise for. A vital part of our moving image heritage stored in cultural heritage institutions is currently being lost or at best marginalized when those institutions could serve more users through digital avenues. Digitization and streaming initiatives provide a way to keep this past accessible, while pushing the technological forefront and creating new meanings and ways for users to interact with and analyze film content. Regardless of their uniqueness and screening history, most works on 16mm have been overlooked until recently. It thus falls to cultural heritage institutions that are committed to preserving all forms of heritage to present 16mm film in the digital realm.

Digitization and online access updates film objects and content into current modes of production and dissemination, allowing for new possibilities of scholarship and understanding including metadata and annotation. Digitization and streaming keeps certain works in the current mindset and conversation much more so than traditional film preservation and access. Digital surrogates for analog films fulfill the stewardship condition of long-term access and availability for materials in cultural heritage institutions. Non-theatrical works on 16mm whose creation and dissemination were dependent purely on technology of the time making them ideal for digitization and streaming. With the decline of 16mm film production, distribution, and projection, it may only be a matter of time before artistic works should be migrated. As cultural heritage institutions are digitizing previous collections, creating virtual spaces, responding to user demand for content online, it is important to create an experience that recreates and makes

available a digital surrogate that satisfies user needs as well as adequately represents the object following institutions responsibilities and mission.

What is resulting from this process is a new dominant form of moving images in cultural, social, and technological terms and resulting new interaction and analysis. This does not mean the loss of previous knowledge and understanding of 16mm film, but the development of deeper insights that combine historical understanding with that produced by the new digital era or moving images.

The current age of digital cinema and streaming media have their own methods of production, distribution and access that informs our current meaning and reception of moving images that is expressly digital. Netflix, Hulu, and iTunes are examples of this distribution model used expressly for commercially distributed film and video works. They are the commercial theaters of online access and influence the way that people understand and produce non-commercial moving images. This thesis focuses on works that Netflix and others do not touch, because they do not have economic incentive to do so. David Bordwell feels that the movie distribution industries are intact and have made the transition to digital while ensuring their market share and barriers to entry. Analog film will nevertheless remain a metaphor and image that will endure as a collective memory.

Cultural heritage institutions are taking up the charge to preserve, digitize and make accessible those works that lack such economic incentives – and significant benefits are coming from these efforts. In this light it seems appropriate to end this thesis with the thoughts of David Bordwell,

> Maybe I'm not such a purist after all. I can't mock the kid who watches *Melancholia* VOD, or *His Girl Friday* on an iPhone. Is it any more absurd than me watching *The Wizard of Oz* on a black-and-white TV in the 1950s, or *Potemkin* on 8mm in the 1960s, or *La Passion de Jeanne d'Arc* on a 16mm dupe in the 1970s. In these and many other

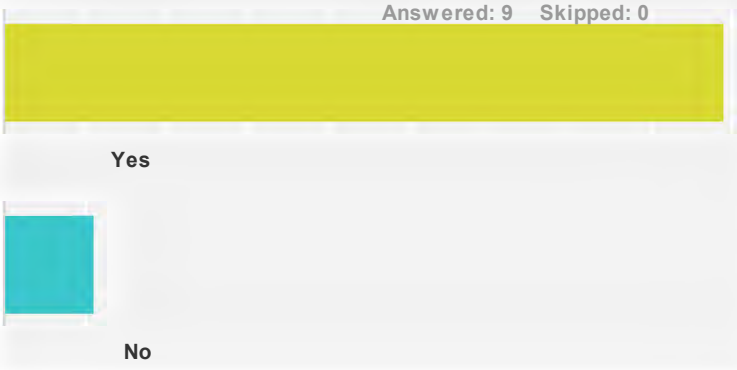
encounters, something powerful came through and led me forward, regardless of the faults of the format.[135]

Appendix I: Survey Results

16mm Film Digitization and Digital Video Online Access

Q1 Do you believe online access will become a major way that users access originally 16mm film content in the future?

Answered: 9 Skipped: 0



Answer Choices	Responses
Yes	88.89%
No	11.11%
Total Respondents: 9	

#	Explain	Date
1	It already has; the 16mm distribution, projection and lab infrastructure has collapsed, and there are many 16mm films unrestricted by copyright or other	2/19/2014 10:02 PM

[135] Bordwell, David. *Pandora's Digital Box: Films, Files, and the Future of Movies,* (Madison: Irvington Way Institute Press, 2012). Page 213.

2	At our regional archive, access to our 16mm film (and 8mm, Super 8mm, video) is mainly through DVD and online (our own website, Vimeo, YouTube, file sharing sites). I think DVD and Blu-ray access will stick around for a while, but online streaming or downloading (via public or private websites) often already feels much quicker than burning and mailing a DVD. Sadly, we barely project 16mm anymore.	2/14/2014 12:26 PM
3	inevitable	2/10/2014 9:26 AM
4	Archives will be digitizing more and more collections for which they cannot guarantee full preservation in order to make their content available at least a as a digital surrogate. This is likely to apply more to 16mm than 35mm	2/7/2014 4:03 PM
5	It's already happening (youtube, archive.org, ubuweb, etc.).	2/5/2014 2:53 PM
6	It is already becoming the primary way that patrons are requesting access from our 16mm collections.	2/5/2014 7:22 AM
7	I believe that online access will be an important way that users access content that was originally carried on 16mm, but given the quantity of 16mm films, doubt that the majority will be made available in the near future.	1/27/2014 9:54 AM
8	Because, when I've made 16mm films from my collection for streaming online – hundreds and sometimes thousand of folks have watched them.	1/26/2014 1:37 PM

Q2 Are there digitization and streaming issues specific to 16mm film objects in contrast to other film objects?

Answered: 9 Skipped: 0

#	Responses	Date
1	Not that I'm aware of.	2/19/2014 10:02 PM
2	None	2/19/2014 12:12 PM
3	Nothing that I can think of that specifically pertains to 16mm. The main thing I can think of is that it can never capture the original experiences of projecting a film, but that would apply to 8mm and Super 8mm as well.	2/14/2014 12:26 PM
4	I don't quite understand your question	2/10/2014 9:26 AM
5	Not specifically, the same issues can apply also to other film formats	2/7/2014 4:03 PM
6	Not really as far as i'm aware. I hate it when people stretch the 4:3 aspect ratio of (most) 16mm to 16:9!	2/5/2014 2:53 PM
7	If I understand the question, then yes a lot of issues specific to one over the other... copyright, derivative quality, choices and decisions of formats, codecs, wrappers, long term preservation of digital format vs physical damage of object	2/5/2014 7:22 AM
8	Not in our experience.	1/27/2014 9:54 AM
9	no.	1/26/2014 1:37 PM

Q3 What do you believe is gained or lost by streaming digitized 16mm film video files?

Answered: 9 Skipped: 0

#	Responses	Date
1	Streaming is imperfect, buggy and unstable. Downloading is omer reliable, especially in classroom situations, and also permits reuse.	2/19/2014 10:02 PM
2	Accessibility	2/19/2014 12:12 PM
3	It can allow for easy access to a film that would otherwise be very hard to see due to the scarcity or uniqueness of individual films. If the film was scanned at HD or better resolutions, cleaned up, color corrected, etc. it can be a very nice introduction for people who may think “old films" generally look terrible. There’s risk of a lack of context for the film, but that would depend on who is posting them and how much they care to write historical and filmographic information for whatever webpage contains the video.	2/14/2014 12:26 PM
4	Gained: access to the content Lost: the viewing experience	2/10/2014 9:26 AM
5	The number of individuals accessing those images can increase, especially over time. This can benefit researchers and the general audience. Increased access goes at the cost of image quality and overall experience. Also, researchers should strive for more than just access to video content: there are many object-specific important aspects that are lost in digitization and streaming. Ideally, accuracy of research could then also be at risk.	2/7/2014 4:03 PM
6	Communal film screening experience is lost as people watch stuff at home alone on their laptops. Image doesn't look as good. BUT people gain greater access so streaming is very important.	2/5/2014 2:53 PM
7	Gained: Accessibility to patrons around the world and making collections accessible in general. --Lost: Lower resolution required for streaming will be lower quality than beautiful film print.	2/5/2014 7:22 AM
8	The texture of the original image is lost. Things like color, sharpness, contrast and graininess are changed. But for most viewers most of the time, its access to the content that counts. That’s what makes web streaming so appealing.	1/27/2014 9:54 AM
9	Well, it’s not the same as watching 16mm projected but it does have other audiences and other experiences. Folks watching them at home, at work, on public transportation on their phones.	1/26/2014 1:37 PM

Q4 Is your institution handling its 16mm films differently from other films?

Answered: 9 Skipped: 0

#	Responses	Date
1	No.	2/19/2014 10:02 PM
2	No	2/19/2014 12:12 PM
3	We generally handle 16mm, 8mm and Super 8mm film the same (it is almost all reversal original home movies, newsfilm and industrial/promotional prints).	2/14/2014 12:26 PM
4	We have almost exclusively 16mm`	2/10/2014 9:26 AM
5	No	2/7/2014 4:03 PM
6	Not really.	2/5/2014 2:53 PM
7	We many have 16mm. Of the 80,000 or so item son campus, more than 95% is 16mm and that is all that we work with at the moment.	2/5/2014 7:22 AM
8	Not to my knowledge, though a grant from the NEH means that we are prioritizing 35mm at this time.	1/27/2014 9:54 AM
9	The vast amount of my collection is 16mm.	1/26/2014 1:37 PM

Q5 what would be the ideal collection or type of 16mm film content to digitize and stream online (both in general and at your institution)?

Answered: 8 Skipped: 1

#	Responses	Date
1	Unedited process footage; films of record; educational films; industrial films, sponsored films; home movies.	2/19/2014 10:02 PM
2	Content of interest to the scholarly community we serve in Byzantine, Pre-Columbian, and Garden and Landscape Studies	2/19/2014 12:12 PM
3	We have a lot of home movies and newsfilm (some edited, some not) that hopefully some day can all be posted and perhaps crowdsourced for identification purposes.	2/14/2014 12:26 PM
4	? Again I don't understand your question	2/10/2014 9:26 AM
5	Any material that otherwise would not be fully preserved or exhibited. In general, actuality footage tends to receive less attention than fiction for what concerns both preservation and exhibition. Same goes for shorts against features. Of course, copyright considerations play a central role in selecting materials to be streamed online. So the ideal target for digitization and streaming would be shorts, actuality footage, industrial films, orphan films, and everything is not covered by copyright.	2/7/2014 4:03 PM
6	I like to see content online that would be otherwise prohibitive for me to see (rare, obscure, unknown, forgotten stuff). Institutionally, we digitize primarily based on need (research or conservation).	2/5/2014 2:53 PM
7	Local television news	1/27/2014 9:54 AM
8	Prints with sound are the easiest. A/B roll materials with a separate soundtrack are much harder.	1/26/2014 1:37 PM

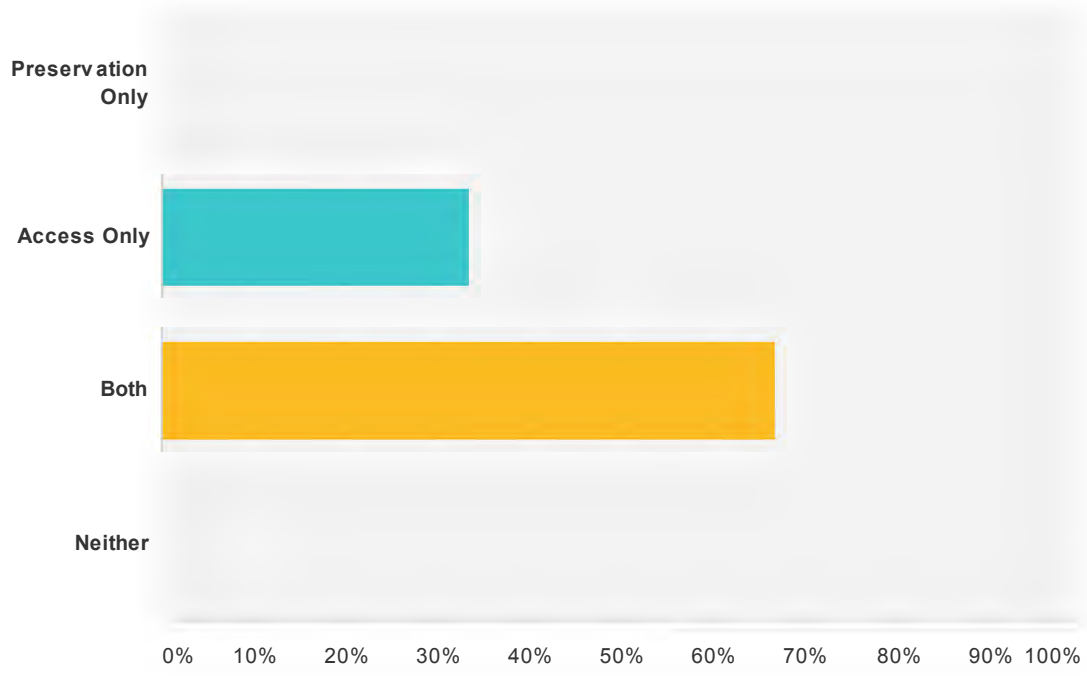
Q6 Please describe any digital initiatives your institution may have (digital libraries, digitization, digital repository, etc.) in terms of the whole collection in general and motion picture film in specific.

Answered: 8 Skipped: 1

#	Responses	Date
1	At Internet Archive and Preminger Archives we have digitized approx. 8,000 16mm film objects; at present about 7,000 are online (includes duplicates, but the 8,000 figure will represent unique titles)	2/19/2014 10:02 PM
2	Digitization of collection items books in library, documents and photographs in archives, and objects in museum. The only 16 mm digitization project that has occurred is in the archives (ICFA, Image Collections and Fieldwork Archives)	2/19/2014 12:12 PM
3	We originally telecined all film to Betacam SP tape, but we are now using a high definition film scanner for any film transfers we perform. New digital masters are being backed up on LTO tapes and compressed "access level" video swill be maintained on a server for quick access.	2/14/2014 12:26 PM
4	We have 85% or so of our collections streamed at archive.org	2/10/2014 9:26 AM
5	We are in the process of digitizing part of our moving image collection and our stills, paper sand photo collection. We also digitize on a request basis.	2/7/2014 4:03 PM
6	We've applied for NEH funding to plan for the digitization and streaming of a selection of collection works related to the humanities. We've digitized a large percentage of our Soviet Georgian 35mm films (for preview purposes) in preparation for a large touring exhibition. We participate in the California Audiovisual Preservation Project, for which we nominate film and video significant to California history to be digitized and streamed at the Internet Archive.	2/5/2014 2:53 PM
7	There are too many campus wide digital initiatives to name. The IU Libraries has many. Plus the It's Digital Preservation repository is built. And, now plans are in place for proposals for digitizing the most fragile and important 16mmm films.	2/5/2014 7:22 AM
8	We have a digital video repository that was designed specifically for moving images. We also share a ContentDM instance that "houses" diverse formats.	1/27/2014 9:54 AM

Q7 Does your institution use digitization of 16mm film for preservation, access, or both?

Answered: 9 Skipped: 0



Answer Choices	Responses	
Preservation Only	0.00%	0
Access Only	33.33%	3
Both	66.67%	6
Neither	0.00%	0
Total Respondents: 9		

#	Explain	Date
1	We scan 16mm film when we go the digital intermediate route for preservation. We also digitize 16mm film to create reference copies for partner institutions.	2/7/2014 4:03 PM
2	Primarily for access. For preservation of 16mm film, we still usually make a new 16mm nag and prints.	2/5/2014 2:53 PM
3	I digitize mostly for access (holding onto the original film), but occasionally I have a film that is too far-gone for screening and I digitize it and have to toss the film.	1/26/2014 1:37 PM

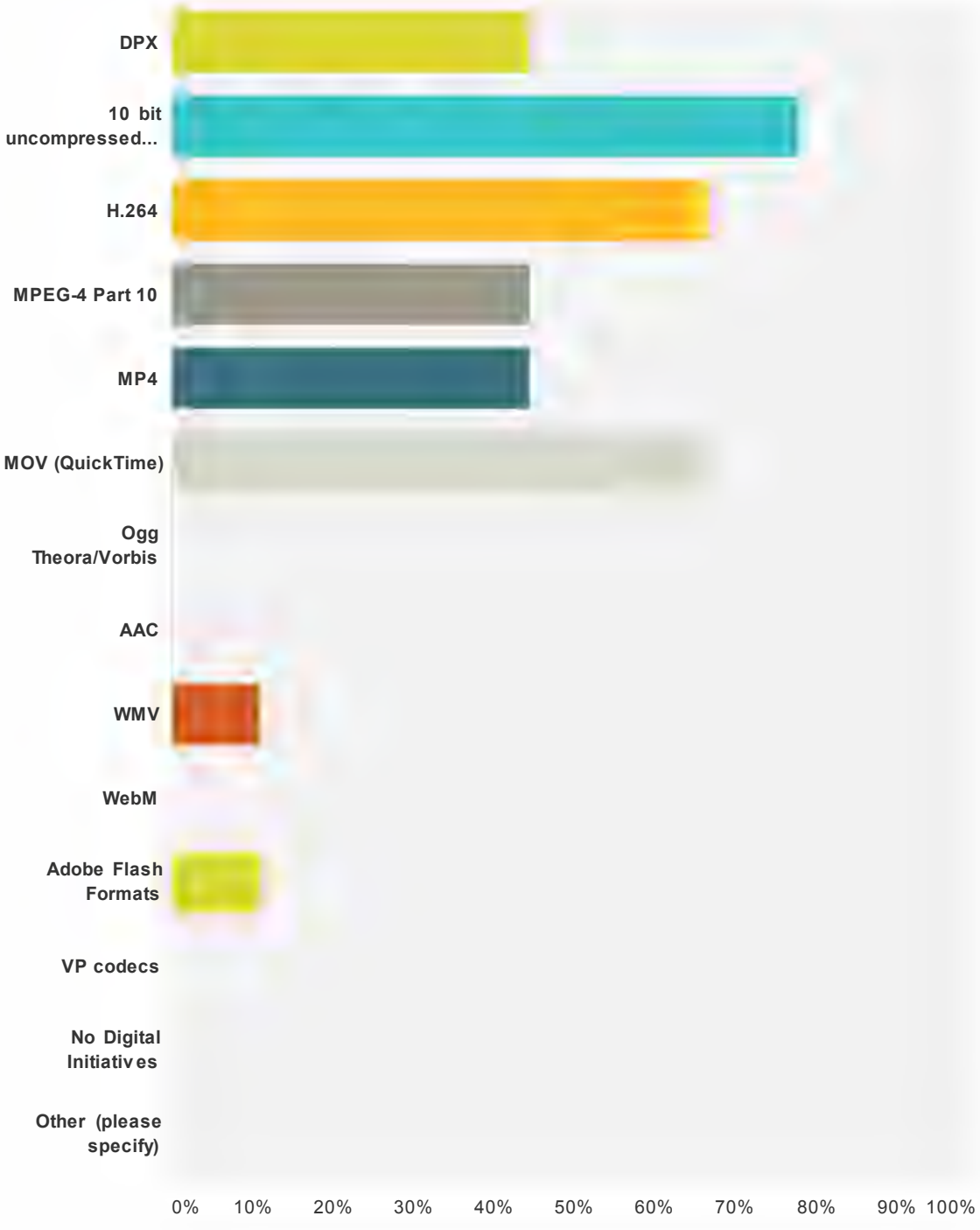
Q8 What do you believe constitutes a true digital surrogate for 16mm film?

Answered: 8 Skipped: 1

#	Responses	Date
1	In ideal terms, probably a 4K frame scan that's as uncompressed as possible.	2/19/2014 10:02 PM
2	A film-to-film copy would be a preservation surrogate, but very expensive. We opted for digital surrogates and also Betacam SP backup.	2/19/2014 12:12 PM
3	Whatever format can actually capture all of the information and layers from the film with the highest bitrate and resolution.	2/14/2014 12:26 PM
4	4k would be nice but who can afford the storage	2/10/2014 9:26 AM
5	2k 10-bit RGB 4:4:4 DPX log	2/7/2014 4:03 PM
6	I don't believe I've seen one, though high quality scans often look good enough.	2/5/2014 2:53 PM
7	Edge-to-edge scan at 2K or greater resolution	1/27/2014 9:54 AM
8	That's a hard question. I digitize my own collection and films for other folks/archives. Each of them has their own idea of what they want - 10bit uncompressed, DV, DVD, h264.	1/26/2014 1:37 PM

Q9 If your institution has digital initiatives, what file formats and codecs does it use? Check all that apply.

Answered: 9 Skipped: 0



Answer Choices	Responses	
DPX	44.44%	4

10 bit uncompressed video	**77.78%**	7
H.264	**66.67%**	6

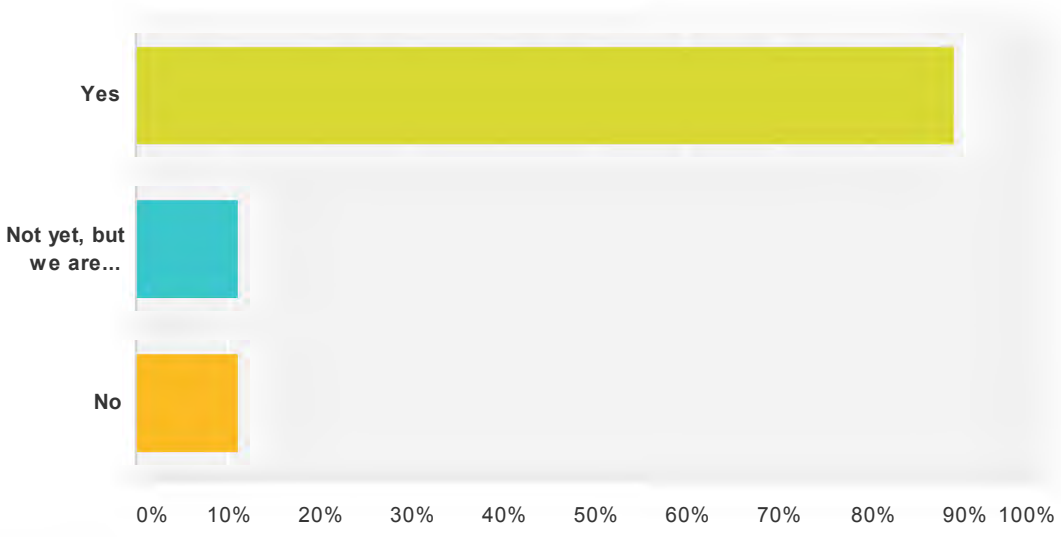
MPEG-4 Part 10	**44.44%**	4
MP4	**44.44%**	4
MOV (QuickTime)	**66.67%**	6
Ogg Theora/Vorbis	**0.00%**	0
AAC	**0.00%**	0
WMV	**11.11%**	1
WebM	**0.00%**	0
Adobe Flash Formats	**11.11%**	1
VP codecs	**0.00%**	0
No Digital Initiatives	**0.00%**	0
Other (please specify)	**0.00%**	0

Total Respondents: 9

#	Other (please specify)	Date
	There are no responses.	

Q10 Does your institution stream digitized 16mm film files online?

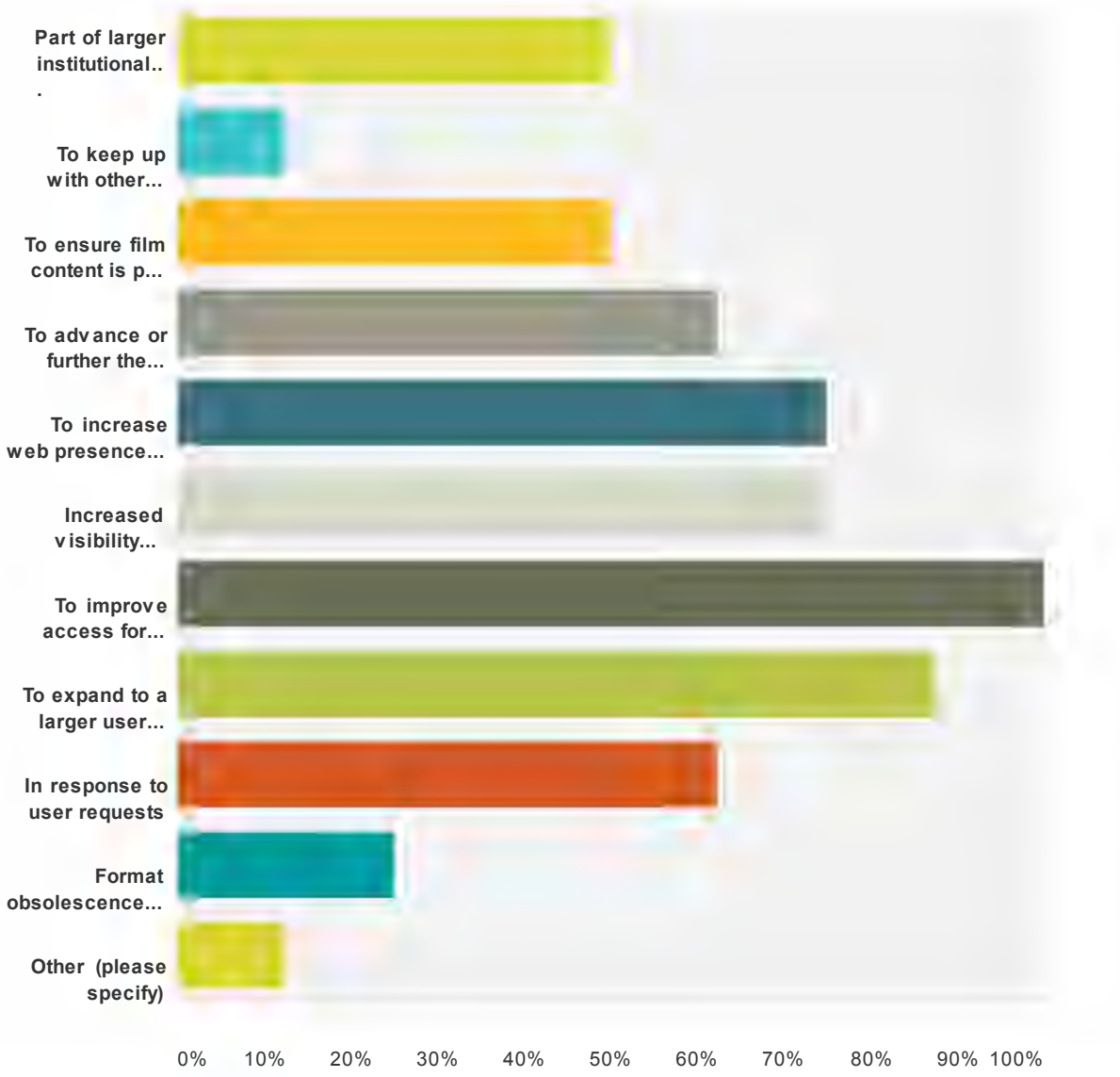
Answered: 9 Skipped: 0



Answer Choices	Responses	
Yes	88.89%	8
Not yet, but we are preparing to do so soon. (Answer following questions in terms of the plans you have already made)	11.11%	1
No	11.11%	1
Total Respondents: 9		

Q11 Why has your institution chosen to stream digitized video files from 16mm film objects? Check all that apply.

Answered: 8 Skipped: 1



Answer Choices	Responses	
Part of larger institutional digital preservation and access initiatives	50.00%	4
To keep up with other institutions	12.50%	1
To ensure film content is part of the broader digital environment	50.00%	4
To advance or further the digital humanities	62.50%	5
To increase web presence for institution	75.00%	6
Increased visibility, reputation, and use of institution	75.00%	6

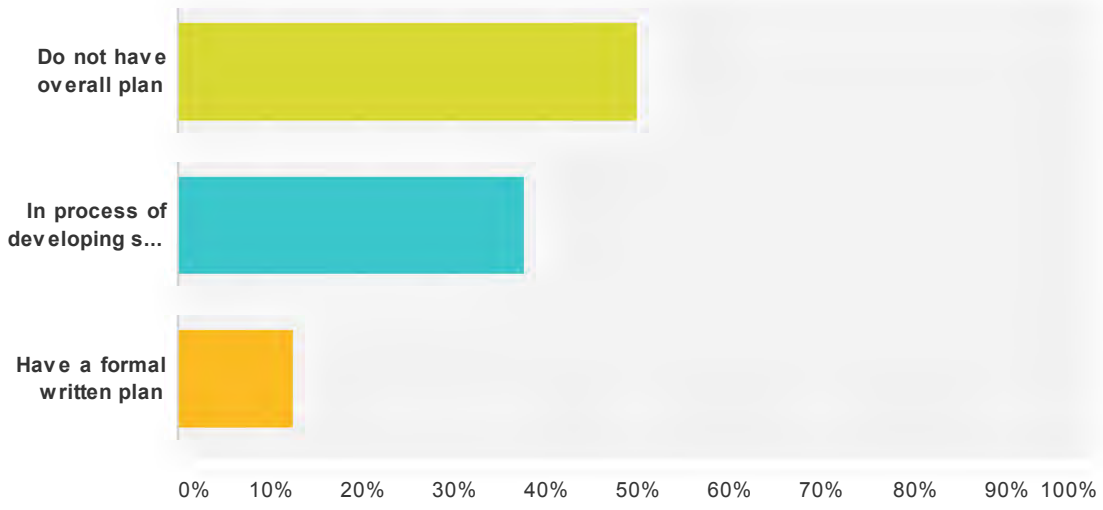
To improve access for users	**100.00%**	8
To expand to a larger user base	**87.50%**	7
In response to user requests	**62.50%**	5
Format obsolescence and no other means of presentation for 16mm films	**25.00%**	2
Other (please specify)	**12.50%**	1

Total Respondents: 8

#	Other (please specify)	Date

Q12 Does your institution have a formal plan for streaming its digital versions of 16mm film?

Answered: 8 Skipped: 1



Answer Choices	Responses	
Do not have overall plan	**50.00%**	4
In process or developing such a plan	**37.50%**	3
Have a formal written plan	**12.50%**	1
Total Respondents: 8		

Q13 If your institution has a plan for streaming 16mm film a collection, which of the following items does it cover? Check all that apply.

Answered: 7 Skipped: 2

Institutional goals for streaming digitized versions of 16mm films	**28.57%**	2
Criteria for selecting material	**0.00%**	0
Quality control and protocols for digitization of materials	**28.57%**	2
In-house streaming infrastructure or services	**0.00%**	0
Outsourcing streaming (Video, Wowza, Brightcove, YouTube) infrastructure or services	**28.57%**	2
Arrangements for long-term digital storage and access	**14.29%**	1
Archival digital preservation standards	**14.29%**	1
Partnerships and interoperability with other institutions and organizations	**14.29%**	1
Ongoing and timely expansion, rotation, and selection of formerly 16mm film content for streaming	**14.29%**	1
Long-term sustainability of streaming initiatives	**14.29%**	1
Staffing and organizational management	**0.00%**	0
Funding	**14.29%**	1
Specific metadata and online records for streaming digital video from 16mm films	**14.29%**	1
Promotion and advertising	**0.00%**	0
Copyright, legal, and piracy issues	**28.57%**	2
Donor agreement language relating to streaming	**14.29%**	1
Other (please specify)	**28.57%**	2
Total Respondents: 7		

#	Other (please specify)	Date
1	Actually our plan is not written down, but there was no other box to check off above	2/10/2014 9:37 AM
2	We do have documents addressing some of these issues, but we do not have a formal streaming plan.	1/27/2014 10:17 AM

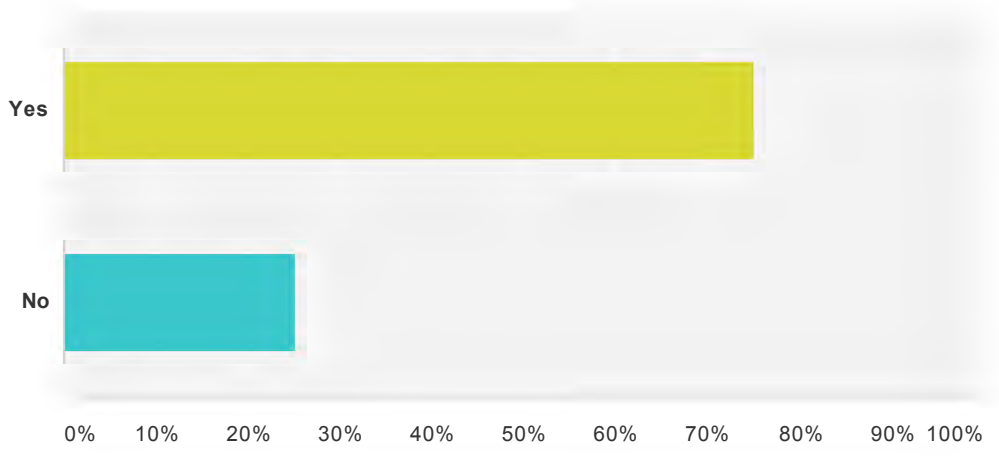
Q14 How have you made decisions on film materials to be digitized and streamed thus far?

Answered: 8 Skipped: 1

#	Responses	Date
1	Mass digitization with certain exceptions for sensitive content	2/19/2014 10:07 PM
2	On a departmental basis, not at institutional level.	2/19/2014 12:15 PM
3	Many of the selections have come from various grants that have allowed us to catalogue hundreds of collections over the years. Part of these grants had an online video component in which films (and videotapes) were chosen to go online.	2/14/2014 12:39 PM
4	?	2/10/2014 9:37 AM
5	In general, we've been digitizing based on research needs, conservation needs. We've been streaming through our portal at the Internet Archive (via California Light and Sound), and these works have been selected because 1) we are the copyright holder of the work or the copyright was simple enough for gu sto secure; 2) the films have potential importance to California history; and 3) the films are unique or not easily accessible elsewhere.	2/5/2014 3:27 PM
6	We hold the rights to the material.	2/5/2014 7:31 AM
7	A selection of 16mm films from across our collection were selected by curators to populate the repository when it was first built. Subsequently, items have been added as they have been requested by users.	1/27/2014 10:17 AM
8	Based on popularity, copyright status.	1/26/2014 1:48 PM

Q15 Does your institution outsource (or plan to outsource) some or all of your digitization and streaming for 16mm film collections?

Answered: 8 Skipped: 1



Answer Choices	Responses	
Yes	**75.00%**	6
No	**25.00%**	2
Total Respondents: 8		

#	Explain	Date
1	AV Geeks is doing digitization for us now. Internet Archives 16mm/8mm scanner was destroyed in a November 2013 fire.	2/19/2014 10:07 PM
2	AV Geeks did the work for the Internet Archive	2/10/2014 9:37 AM
3	We stream at the Internet Archive. Much of our digitization is done at outside labs.	2/5/2014 3:27 PM
4	We do not have in house digitization capabilities yet. Once we get the files back, we do all of the work with the digital material.	2/5/2014 7:31 AM
5	We do not plan to outsource 16mm digitization or streaming at this time. We have outsourced 35mm, however.	1/27/2014 10:17 AM
6	We do the digitizing and archive.org and YouTube host the files.	1/26/2014 1:48 PM

Q16 What are the advantages/disadvantages of outsourcing for digitizing and streaming for 16mm film collections?

Answered: 8 Skipped: 1

#	Responses	Date
1	High end services often available more easily, but at a higher price	2/19/2014 10:07 PM
2	Expertise	2/19/2014 12:15 PM
3	In the past, outsourcing for film scanning was necessary for very high quality scans, but now we are able to do a lot of it ourselves and have better control.	2/14/2014 12:39 PM
4	We do not have a telecine	2/10/2014 9:37 AM
5	Advantages: access to better quality equipment, don't have to purchase or maintain the equipment. Disadvantages: expensive, longer turnaround time.	2/5/2014 3:27 PM
6	We do not have scanners or telekines is house so it's not possible.	2/5/2014 7:31 AM
7	We chose to outsource 35mm content because the vendor was able to digitize a much larger quantity of film much faster that we can in-house. This was specifically for a grant project, however. Typically we do not need to grow that quickly, and indeed storage space constrains our growth.	1/27/2014 10:17 AM
8	Expensive to pay for digitizing.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q17 What are the advantages/disadvantages of in-house digitization and streaming for 16mm film collections?

Answered: 7 Skipped: 2

#	Responses	Date
1	Typically, cost and control	2/19/2014 10:07 PM
2	Cost	2/19/2014 12:15 PM
3	In house, we are able to control all aspects of the digital workflow, especially in regards to how the film is scanned in the first place. For streaming, where we are less knowledgeable, we must consult with outside help, which of course costs money.	2/14/2014 12:39 PM
4	See above	2/10/2014 9:37 AM
5	Advantages: can do it whenever we have the time, inexpensive. Disadvantage: not optimal quality (with our equipment).	2/5/2014 3:27 PM

6	In-house digitization means we have more control over the final product. It requires less paperwork, etc. However, we have limited resources in terms of time and equipment.	1/27/2014 10:17 AM
7	Expensive to acquire equipment, time-consuming to capture and process materials	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q18 From your perspective what would be an ideal digitization and streaming workflow for 16mm film at your institution and in general?

Answered: 7 Skipped: 2

#	Responses	Date
1	Too complex for this box, but happy to answer offline (rick@archive.org)	2/19/2014 10:07 PM
2	When we eventually have the digital infrastructure, files can seamlessly move from one workstation to the next (scanner, editing computer, compression computer, streaming server).	2/14/2014 12:39 PM
3	being the LoC in which you have lots of budget and staff and can watermark all of your own footage	2/10/2014 9:37 AM
4	Optimal digital scanner that could simultaneously output to multiple file formats (preservation, mezzanine, access).	2/5/2014 3:27 PM
5	All on site	2/5/2014 7:31 AM
6	In a perfect world, we would digitize everything before cataloging to make both the streaming video and the catalog record available simultaneously. This also allows for description without handling the original.	1/27/2014 10:17 AM
7	We have the equipment, we just don't have the manpower to pull, prep and digitize.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q19 How are your catalog records for streaming digitized 16mm film collections made available?

Answered: 8 Skipped: 1

#	Responses	Date
1	Some exposed through Internet Archive	2/19/2014 10:07 PM
2	Online	2/19/2014 12:15 PM

3	They are available on site in our catalog, where the original film records will note that a digital instantiation exists.	2/14/2014 12:39 PM
4	Together with the film son Archive.org I wouldn't call them actual catalog records though Sort of access points	2/10/2014 9:37 AM
5	The catalog records for the 16mm are available through our institutional website and the University library catalog site, but the fact that they have been digitized (and links to the digital stream) have not been integrated into the catalog records yet.	2/5/2014 3:27 PM
6	Next to the records	2/5/2014 7:31 AM
7	They are exposed in our digital video repository.	1/27/2014 10:17 AM
8	Wordpress site derived from Filmmaker Pro database.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q20 What content do the catalog records contain?

Answered: 8 Skipped: 1

#	Responses	Date
1	Basic filmographic data plus tags	2/19/2014 10:07 PM
2	Title, description, date	2/19/2014 12:15 PM
3	Pertaining to the digital instantiations, it should at least list resolution, codec and frame rate.	2/14/2014 12:39 PM
4	See above	2/10/2014 9:37 AM
5	n/a	2/5/2014 3:27 PM
6	Basic metadata, title, date, length, etc.	2/5/2014 7:31 AM
7	The records include both descriptive and technical metadata.	1/27/2014 10:17 AM
8	Basic metadata - title, creator, and year produced, brief description.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q21 Are there differences between records for the public and records exchanged between institutions?

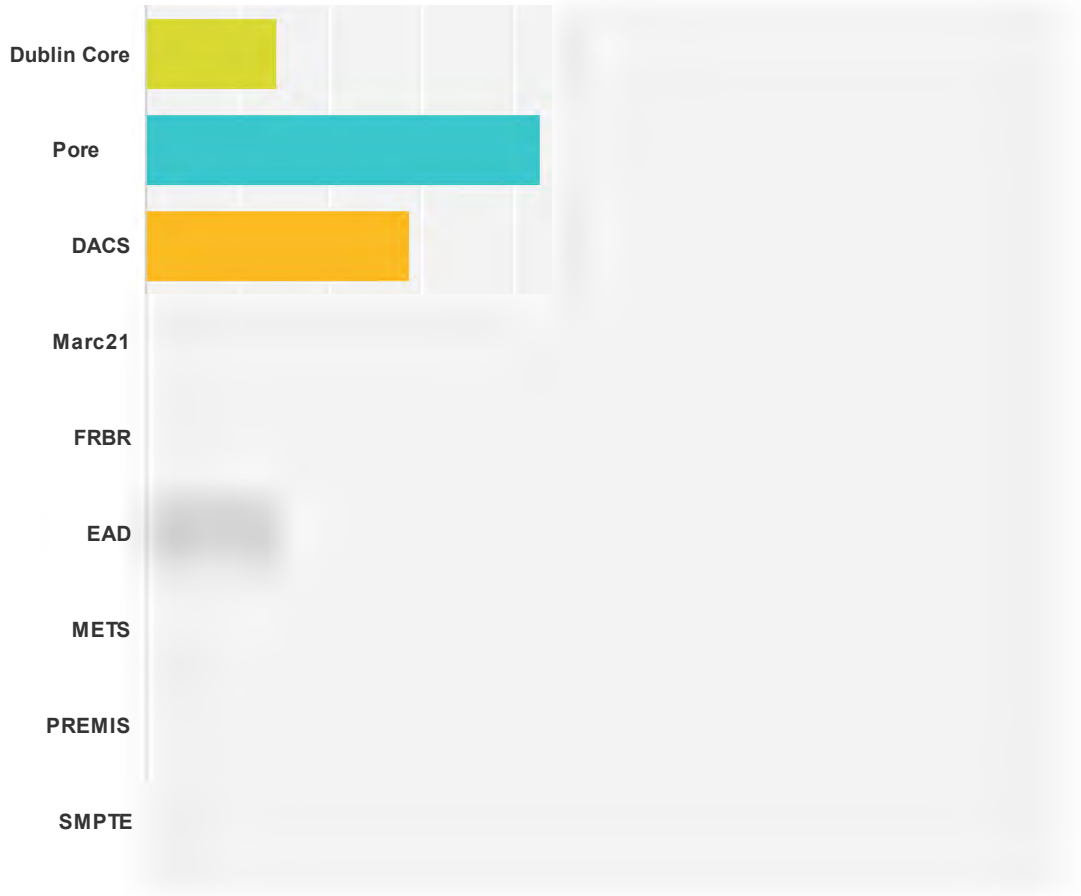
Answered: 8 Skipped: 1

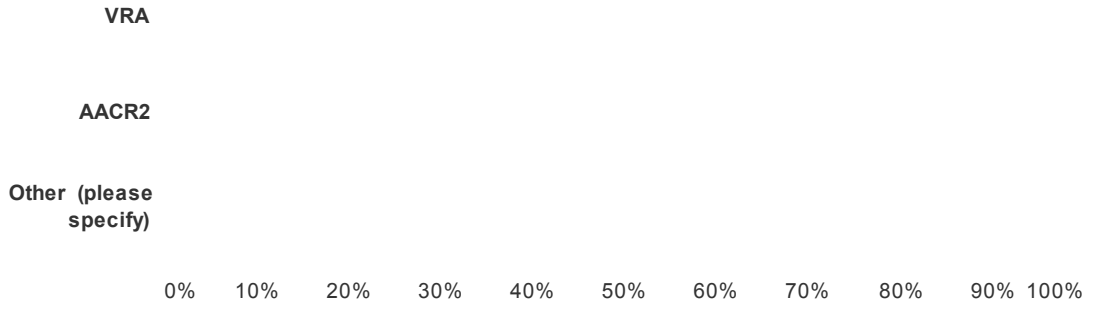
#	Responses	Date
1	No	2/19/2014 10:07 PM
2	Not sure	2/19/2014 12:15 PM
3	I'm not in the position to know.	2/14/2014 12:39 PM
4	? I don't believe so	2/10/2014 9:37 AM
5	no	2/5/2014 3:27 PM
6	I don't understand that question.	2/5/2014 7:31 AM
7	No	1/27/2014 10:17 AM
8	My records have more notes about the film's condition, source, shortlists, etc.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q22 What is your metadata scheme for the streaming digital video files for 16mm film collections? Check all that apply.

Answered: 7 Skipped: 2





Answer Choices	Responses	
Dublin Core	**14.29%**	1
PBCore	**42.86%**	3
DACS	**28.57%**	2
Marc21	**0.00%**	0
FRBR	**0.00%**	0
EAD	**14.29%**	1

METS	**0.00%**	0
PREMIS	**0.00%**	0
SMPTE	**0.00%**	0
VRA	**0.00%**	0
AACR2	**28.57%**	2
Other (please specify)	**57.14%**	4

Total Respondents: 7

#	Other (please specify)	Date
1	Idiosyncratic	2/19/2014 10:07 PM
2	This is not formally developed yet for the Museum. I would probably use PBCORE in an adapted framework and I created a little mini finding aid for each collection on archive.org main page as well	2/10/2014 9:37 AM
3	Contented	2/5/2014 3:27 PM
4	We use MODS and EAD (following DACS guidelines) for collection-level description and PBCore for item-level description.	1/27/2014 10:17 AM

16mm Film Digitization and Digital Video Online Access

Q23 What metadata does your institution add when describing the digital surrogate for a 16mm film?

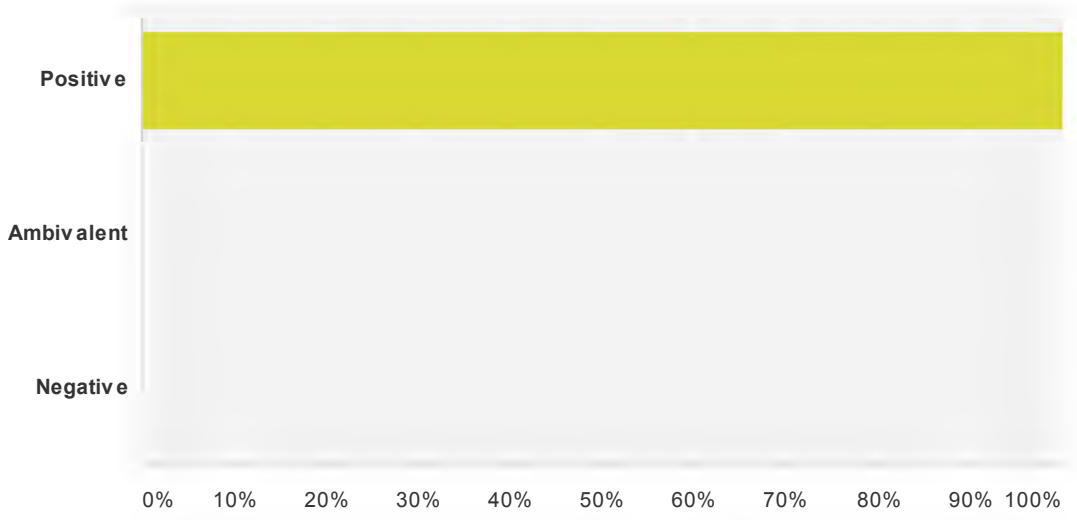
Answered: 7 Skipped: 2

#	Responses	Date
1	Location and disk number	2/19/2014 10:07 PM
2	Not applicable yet	2/19/2014 12:15 PM
3	See Q. 20.	2/14/2014 12:39 PM
4	None Some of that technical metadata is manifest in the A.O website but our own servers hold the higher resolution files	2/10/2014 9:37 AM
5	N/a	2/5/2014 3:27 PM
6	Catalogers would have to answer that one.	2/5/2014 7:31 AM
7	Technical metadata that is automatically extracted. We also note whether the digital asset is edge-to-edge or frame only; whether it represents the entire original, a part of the original (e.g., one reel of many), or a version that was edited by MIRC staff (usually for a curated program).	1/27/2014 10:17 AM

16mm Film Digitization and Digital Video Online Access

Q24 How have your users responded to digitized 16mm film streaming online?

Answered: 8 Skipped: 1



Answer Choices	Responses	
Positive	**100.00%**	8
Ambivalent	**0.00%**	0
Negative	**0.00%**	0
Total Respondents: 8		

#	Explain	Date
1	We get emotional responses from all over the world, also lots of use by filmmakers	2/10/2014 9:37 AM
2	Users have been appreciative of expanded access, but no one's commented on quality as far as I'm aware.	2/5/2014 3:27 PM
3	I've have people who've appeared in the films contact me.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q25 Have you noticed a change in the number, type, and location of users as you

digitize and stream your 16mm film collections?

Answered: 8 Skipped: 1

#	Responses	Date
1	Massive user increase; some 90 million views and downloads	2/19/2014 10:07 PM
2	Increased audience	2/19/2014 12:15 PM
3	Only that more videos have meant more viewers overall.	2/14/2014 12:39 PM
4	The collection was completely invisible before digitization	2/10/2014 9:37 AM
5	More requests to access archival footage from works that are streaming.	2/5/2014 3:27 PM
6	I have been able to provide access to requests to patrons on other continents for short films-- so that they do not have to travel to see a 30-minute film. -- So, yes, increased users and from lots of locations worldwide.	2/5/2014 7:31 AM
7	No.	1/27/2014 10:17 AM
8	It has increased.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q26 What legal questions have emerged from this process (copyright, other)?

Answered: 7 Skipped: 2

#	Responses	Date
1	Mass digitization requires some assessment for sensitive content (chiefly good taste and erotica)	2/19/2014 10:07 PM
2	None	2/19/2014 12:15 PM
3	Not much in copyright but a lot of stealing and misuse.	2/10/2014 9:37 AM
4	None so far, but we always clear rights when possible.	2/5/2014 3:27 PM
5	COPYRIGHT, COPYRIGHT, COPYRIGHT	2/5/2014 7:31 AM
6	None to date (we typically control copyright for our collections).	1/27/2014 10:17 AM
7	YouTube is very sensitive to music rights. Most of the films in our collection have background music which YouTube flags and forces advertising on those video seven though the portion of the film with music are tiny.	1/26/2014 1:48 PM

16mm Film Digitization and Digital Video Online Access

Q27 How have you accounted for potential theft of online content?

Answered: 8 Skipped: 1

#	Responses	Date
1	We do not think of reuse or access as theft	2/19/2014 10:07 PM
2	Not applicable	2/19/2014 12:15 PM
3	We watermark our videos with our logo or name.	2/14/2014 12:39 PM
4	Yes.	2/10/2014 9:37 AM
5	We do not allow downloading from our Internet Archive site (though we can't stop users from hacking the system). Also, we've limited the quality of the file so it's far from full res.	2/5/2014 3:27 PM
6	Low res. copies are available online only	2/5/2014 7:31 AM
7	We watermark and use low-resolution copies, and accept that the content will circulate.	1/27/2014 10:17 AM
8	Not a concern.	1/26/2014 1:48 PM

Q28 What major problems have you encountered in digitizing and streaming 16mm film? And how did you manage them?

Answered: 7 Skipped: 2

#	Responses	Date
1	Workflow is very difficult to administer, and it is difficult to train staff to think like managers and to keep QA at the front of their minds	2/19/2014 10:07 PM
2	A number of users have taken content uploaded to Vimeo and posted to other services like YouTube	2/19/2014 12:15 PM
3	Figuring out how to deinterlace films that were previously telecined to video. We have found new ways to do it, but the processing time is very, very long.	2/14/2014 12:39 PM
4	Some of the telecine work was done at the wrong frame rate. It can be adjusted digitally later.	2/10/2014 9:37 AM
5	No major problems so far.	2/5/2014 3:27 PM
6	Labor and storage space are the greatest problems, but these are not specific to 16mm.	1/27/2014 10:17 AM
7	Getting the momentum to do a big digitizing project shard sometimes.	1/26/2014 1:48 PM

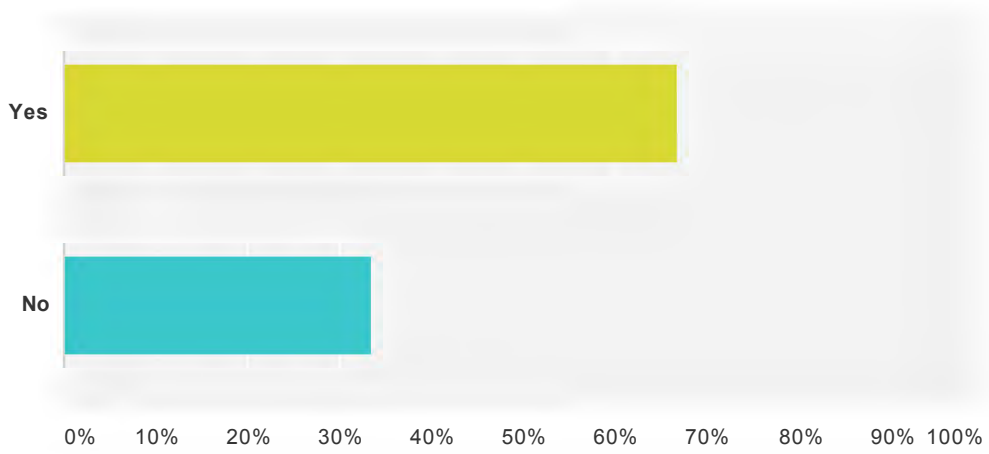
Q29 What unexpected benefits, exciting projects, unforeseen opportunities, etc. have emerged from your institution digitizing and streaming 16mm film content online?

Answered: 7 Skipped: 2

#	Responses	Date
1	Massive reuse; movement of ephemeral cultural materials from cultural periphery to center; increased stock footage sales; infuse Web with moving image materials not heretofore available	2/19/2014 10:07 PM
2	Contacted by documentary filmmakers with request to include film clips in their project.	2/19/2014 12:15 PM
3	People have been excited to discover something on our website or YouTube after doing a Google search, and then they call us for more information. This has been in tandem with us uploading much of our catalog to our website.	2/14/2014 12:39 PM
4	I could write about this for an hour. See our blog posts on the pen museum web page It's especially exciting when filmmakers from source communities ' use our footage; we have a series based on that called Live from the Archives!	2/10/2014 9:37 AM
5	More opportunities to license footage to documentary productions. One film got profiled on a significant blog, which increased the visibility of the film and our presence on archive.org.	2/5/2014 3:27 PM
6	I believe most, if not all, of the benefits were foreseen.	1/27/2014 10:17 AM
7	I've have people who've appeared in the films contact me. I've received more donations to our collection - money and more films.	1/26/2014 1:48 PM

Q30 How has streaming enhanced your cooperation or collaboration with other institutions? With other units within your own institution?

Answered: 6 Skipped: 3

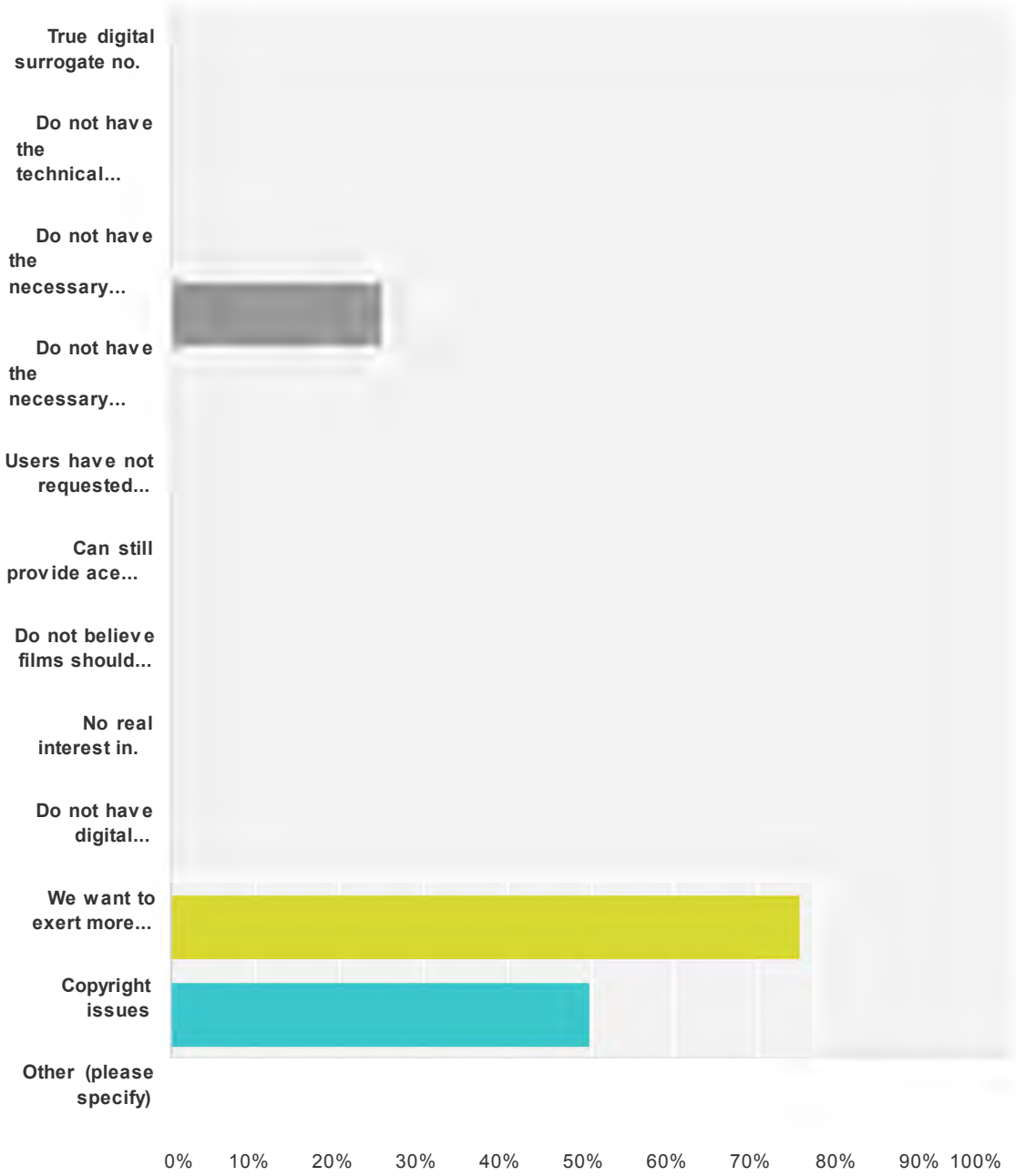


Answer Choices	Responses	
Yes	**66.67%**	4
No	**33.33%**	2
Total Respondents: 6		

#	Explain	Date
1	Many scholars and researchers have access to historical moving image for the first time	2/19/2014 10:07 PM
2	Collaborated with House Archives and Gardens to identify and date a historic film of the institution's archives. Also, effort to preserve the films allowed us to develop relationships with film archivists in the DC-area.	2/19/2014 12:15 PM
3	I think this has been minimal so far, but anticipate growth. I do give a lot of talks.	2/10/2014 9:37 AM
4	We've been able to share our workflow ideas with similar archives.	1/26/2014 1:48 PM

Q31 Why is your institution not digitizing and streaming 16mm films? Check all that apply.

Answered: 4 Skipped: 5



Answer Choices	Responses	
True digital surrogate not yet possible for 16mm film	0.00%	0
Do not have the technical capacity	0.00%	0
Do not have the necessary staff	0.00%	0

Do not have the necessary funds	**25.00%**	1
Users have not requested streaming	**0.00%**	0
Can still provide access to 16mm on-site	**0.00%**	0

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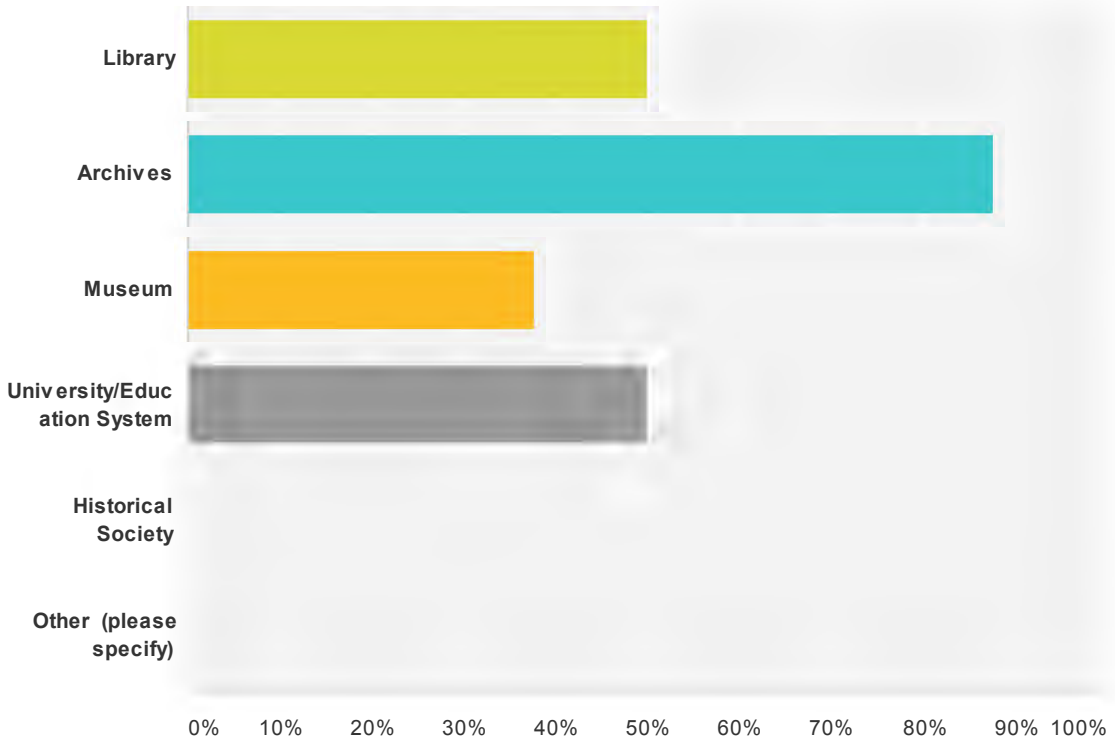
Do not believe films should be digitized	**0.00%**	0
No real interest in doing this	**0.00%**	0
Do not have digital preservation and access initiatives at the institution	**0.00%**	0
We want to exert more control over access to these materials	**0.00%**	0
Copyright issues	**75.00%**	3
Other (please specify)	**50.00%**	2

Total Respondents: 4

#	Other (please specify)	Date
1	There are a few that cannot be streamed for cultural reasons	2/10/2014 9:38 AM
2	Institutional website is currently being revamped. A lot of the core staff seems resistant to the idea of streaming, hung up over copyright and possibly the extra work involved with limited staffing.	2/5/2014 3:32 PM

Q32 What type of institution do you work for? Check all that apply.

Answered: 8 Skipped: 1



Answer Choices	Responses	
Library	50.00%	4
Archives	87.50%	7
Museum	37.50%	3
University/Education System	50.00%	4
Historical Society	0.00%	0
Other (please specify)	0.00%	0
Total Respondents: 8		

#	Other (please specify)	Date
	There are no responses.	

Q33 Roughly how many total items (audiovisual, books, art, maps, photographs, etc.) are held by your institution?

Answered: 7 Skipped: 2

#	Responses	Date
1	Prelinger Archives: 11,000 home movies; 2,000 ephemeral films; 5,000 digital files derived from videotape transfers	2/19/2014 10:09 PM
2	1 million	2/19/2014 12:17 PM
3	Ten million feet of film and more than 8,000 hours of video is the best I know, plus many periodicals, pieces of film equipment and books.	2/14/2014 12:42 PM
4	I cannot estimate. Millions.	2/10/2014 9:39 AM
5	Hundreds of thousands	2/5/2014 3:36 PM
6	We estimate that we have more than 100,000 items.	1/27/2014 10:35 AM
7	Over 24,000 films	1/26/2014 1:50 PM

Q34 Roughly what percentage of your institution's total and specific moving image collections are 16mm film?

Answered: 8 Skipped: 1

#	Responses	Date
1	70%	2/19/2014 10:09 PM
2	A tiny fraction. Less than 50	2/19/2014 12:17 PM
3	70%?	2/14/2014 12:42 PM
4	Less than 1%	2/10/2014 9:39 AM
5	<5% of total institutional holdings, but roughly 25-30% of moving image collections.	2/5/2014 3:36 PM
6	74,000	2/5/2014 7:35 AM
7	More than 50%.	1/27/2014 10:35 AM
8	98%	1/26/2014 1:50 PM

Q35 What communities or groups make up your standard user base? (Scholars, general public, artists, filmmakers, college students, etc.)

Answered: 8 Skipped: 1

#	Responses	Date
1	Scholars, general public, artists, filmmakers, college students, etc.	2/19/2014 10:09 PM
2	Scholars	2/19/2014 12:17 PM
3	General public, filmmakers, academic researchers	2/14/2014 12:42 PM
4	All of the above	2/10/2014 9:39 AM
5	All above	2/5/2014 3:36 PM
6	Scholars, family members of people who were in the films, filmmakers, general public	2/5/2014 7:35 AM
7	All of the above. Filmmakers, scholars and students probably make most frequent use of the collections.	1/27/2014 10:35 AM
8	All of the above.	1/26/2014 1:50 PM

Q36 What is the name of your institution? (Will not be used in final report unless permission is explicitly granted)

Answered: 8 Skipped: 1

#	Responses	Date
1	Internet Archive and Preminger Archives	2/19/2014 10:09 PM
2	Dumbarton Oaks Research Library and Collection	2/19/2014 12:17 PM
3	Northeast Historic Film	2/14/2014 12:42 PM
4	Penn Museum	2/10/2014 9:39 AM
5	University of California, Berkeley Art Museum and Pacific Film Archive	2/5/2014 3:36 PM
6	Indiana University Libraries Film Archive	2/5/2014 7:35 AM
7	Moving Image Research Collections	1/27/2014 10:35 AM
8	A/V Geeks	1/26/2014 1:50 PM

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Q37 What is your position within your institution?

Answered: 8 Skipped: 1

#	Responses	Date
1	Board member, Internet Archive; Founder and President, Preminger Archives	2/19/2014 10:09 P
2	Manager, Image Collections and Fieldwork Archives	2/19/2014 12:17 P
3	Technical Services Manager	2/14/2014 12:42 P
4	Film Archivist and curator of culture films programs	2/10/2014 9:39 AM
5	Assistant Film Archivist	2/5/2014 3:36 PM
6	Director	2/5/2014 7:35 AM
7	Director	1/27/2014 10:35 A
8	Founder	1/26/2014 1:50 PM

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