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The Reel Problem with Digital: The Pixar Process of Preserving their Films from Today to Infinity and Beyond

Nicholas T. Sy
Loyola Marymount University, nsy@lion.lmu.edu

The Reel Problem with Digital:
The Challenges of Preserving Motion Pictures in Digital Formats

The Pixar Process of Preserving their Films from Today to Infinity and Beyond

by Nicholas Sy

Mentor: Professor Robert Simmons

Abstract: Film preservationists have been able to find methods to preserve traditional film stock for at least 100 years. However, with the rise of digital cameras and effects in films, preservationists have yet to find a practical and reliable way to preserve films long-term in the digital format. Hardware or obsolete software have forced archives to constantly migrate digital files to new tapes every few years, a process that is more than ten times more expensive than the traditional preservation practices on film stock. This study attempts to find a long-term solution in preserving digital files by exploring new technologies and procedures practiced by studios. Finding an affordable and efficient method of preserving digital files long-term would benefit not only the film industry, but also public archives, government agencies, scientific and medical organizations, as well as average consumers in their personal digital archives. This materials grant proposal pertains to a research trip to Pixar Animation Studios in order to learn how they archive their films, which are almost entirely computer-generated and rely on digital data and assets.

Introduction

Many disciplines need to preserve relevant materials, whether artifacts from earlier people or current work and findings. Archaeologists and historians may want to preserve ancient artifacts and manuscripts, scientists may want to save scientific instruments or experiment data, and art historians may want to protect works of art, such as paintings, sketches, and sculptures. These examples imply desires to preserve various forms of media—paper, parchment, wood, stone, metal, and cloth. As preservationists have been able to save and protect these artifacts that may be centuries or millennia old, they must also learn how to preserve new mediums developed by humankind. As motion pictures were introduced at the end of the nineteenth century and became a booming industry in the twentieth century, film preservationists spent time determining methods to preserve film elements for at least 100 years ("Digital Dilemma" 26). These procedures were developed, in spite of the tendency of film to fade, shrink, decompose, or, in some cases, be flammable (Slide 1).

During the latter half of the twentieth century, digital technology was introduced. Devices such as cameras, which traditionally shot on film stock, became digital by recording images with electronic sensors onto memory cards or hard drives (*Side by Side*). As a result of the rise of digital technology, such as computers, cell phones, and cameras, more data and information is saved digitally—and with that, a new method of archiving through the preservation of media in digital formats. This digital technology has also affected the film industry, with cameras, editing tools, audio equipment, visual effects, and projectors switching from analog to digital ("Digital Dilemma" vi-vii). Despite the enormous increase in digital files, preservationists have yet to find a long-term solution in preserving these files digitally, due to problems with hardware or obsolete file formats (Conrad 31).

Since the digital revolution in film has been developing in the past few decades, this problem of digital film preservation has only become a recent issue, which the film industry has only begun addressing in the past decade. The National Film Preservation Foundation's *The Film Preservation Guide*, published in 2004, calls digitization of film elements "not a practical film preservation solution", saying that digital preservation was still in the "testing stage" (44). In 2007, the Academy of Motion Picture Arts and Sciences (AMPAS) published the report *The Digital Dilemma: Strategic Issues in Archiving and Accessing Digital Motion Picture*, which summarizes the major problems of digital film preservation and includes several initiatives for further research and development of new technologies that can address the issue (2). Thus, my central research question focuses on what new or developing technologies, methods, and procedures can become potential solutions to this digital film preservation crisis.

Background Work

For traditional preservation on celluloid, archivists store the preservation masters and film elements in vaults with cool temperatures, low humidity, and fire suppression systems ("Digital Dilemma" 6). The film elements are regularly inspected for damage and aging, allowing films to be preserved for at least 100 years ("Digital Dilemma" 6, 26). For the preservation of films captured on digital cameras, the master copy of the film can be recorded on yellow-cyan-magenta (YCM) separations on black-and-white film and preserved like traditional celluloid elements ("Digital Dilemma" 1, 14).

Another option for preserving these digital files is to keep the files in their original digital formats. Currently, in the film industry, the most popular method of preserving these master digital files—typically, Digital Cinema Packages (DCP)—is Linear Tape-Open (LTO), a type of

open-format tape storage technology (“Digital Dilemma” 16, 32, Rosenthal 30-32). However, every few years, a new generation of LTO is released, with each expected to double its storage capacity and data transfer rate than the previous generation (“Digital Dilemma” 32-33). The most recent generation of LTO is the LTO7 generation, which was released in September 2015, boasting storage capacities of 15 TB (“LTO Program”). In addition, each LTO reader is backwards compatible by two generations (“Digital Dilemma” 32-33). For example, an LTO6 reader can read LTO4 and LTO5 tapes, but it cannot read LTO1, LTO2, or LTO3 tapes. As a result of the limitations of the backwards compatibilities of LTO readers, as well as the guaranteed lifespan of LTO tapes of three to five years, archivists must constantly migrate the data onto new tapes every few years (Rosenthal 32). Despite the fact that the cost per terabyte decreases as technology improves, the need to migrate files every few years adds up to tens of thousands of dollars for each film annually. In fact, AMPAS estimated that it costs about $1,000 to preserve a film’s traditional celluloid elements per year, while a digital master with 4K resolution would have an annual cost of about $12,500 (“Digital Dilemma” 1-2). One final drawback of LTO is the reports of the fragile nature of the tapes. According to Mark Quigley of the UCLA Film Archive and Dino Everett of the USC Film Archive, whom I had interviewed in my previous research on digital film preservation, all of the data on an LTO tape can be lost by simply dropping the tape from three feet off the ground. Thus, the master file for a film can be lost through any minor accident by an archivist or someone transporting the tape—let alone falling from shelves in earthquakes. In this way, LTO may be a temporary solution that film studios and archives can use now, but a much more reliable technology and procedure must be found.

Besides hardware, the other major problem with digital film preservation involves file format compatibility. File formats used today may quickly change every year, so that the files saved today may not be able to be opened decades from now. As part of my prior research on film preservation, I attended a film preservationist conference, The Reel Thing, where AMPAS presented a new file format system: Academy Color Encoding System (ACES) 1.0. This system is meant to standardize digital color systems as well as digital file formats, so that colors and file specifications can stay consistent (Forsythe). The standard set in ACES 1.0 is also meant to create a definitive standard so that files in this format can be opened for long-term use, providing an archival component for the system (Forsythe). As ACES 1.0 has only been in use since December 2014, it was still fairly new to the preservationists in attendance ("ACES"). Many of them asked the presenters about the specific ways the system would be able to have long-term archival use on digital files, but the presenters remained vague in describing a digital "wrapper" that would contain and protect the files, so that they could be opened decades from now (Forsythe). The presenters also claimed that the system would have few upgrades, in order to maintain the file format established and to ensure long-term archival use (Forsythe). When asked about the issue of data corruption, however, the presenters reiterated that this is still a worldwide problem that needs to be solved—the standardized file format from ACES 1.0 is merely a step towards long-term digital preservation (Forsythe). When I spoke with other archivists in attendance, many were still uncertain about the technology, since AMPAS was there to sell and promote their new system (Forsythe). When I tried to conduct further research on AMPAS's Science-Technology Council website, very little technical information was available, and the only official documentation I could find on ACES 1.0 was a copy of the slideshow that was presented at The Reel Thing ("ACES", Joblove).

Methods

I propose to visit a studio that is considered to have been at the forefront of the digital revolution in Hollywood: Pixar Animation Studios, located in the Bay Area. Pixar is known for producing the first feature-length computer animated film, *Toy Story*, in 1995. In addition to the increasing number of films shot digitally, more computer-generated animated films and digital effects in films have created a larger number of digital assets that must be archived. In having to develop the digital tools and technology in order to create these images, animation and visual effects studios, must also have developed or continue to develop a digital archival system for their own assets.

However, even Pixar has run into archival problems. In re-releasing its film *Finding Nemo* for Blu-ray 3D release in 2012, the studio had to render the film again to produce the 3D effect, using software similar to that used for the original film in 2003 (Fenlon). Unfortunately, the movement of some of the underwater plants in the film was originally controlled by a random number generator (Fenlon). Pixar did not have access to the numbers generated at the time of the original render, and as a result, animators had to replicate the movements manually from a frame-by-frame reference (Fenlon). Since the studio could not re-render its own film a decade after its original release, this example demonstrates that digital preservation is still a problem, even for a studio that has a great technical reputation in the digital world.

Thus, I would like to visit and interview archivists at Pixar in order to understand how they approach preserving their digital files. Since any computer models produced for these film projects are equivalent to props, sets, or costumes on a live-action film, these digital assets are also important in preserving the history of these films, in addition to their opportunities for

restoration in the future. Pixar's focus on digital assets and products makes the studio a good candidate in exploring the technologies and procedures behind preserving digital files.

I currently have arrangements to meet with Sue Kalache, a Project Manager of the Software team at Pixar. She, as well as members of the Software, Post-Production, and Image Mastering teams, will be able to show me how they archive digital assets at Pixar and answer any questions I have on digital film preservation and digital archives.

Expected Results

As a result of this visit at Pixar, I hope to be able to continue to further develop my research in digital film preservation. My previous research trips to the non-profit film archives at UCLA, USC, and AMPAS demonstrated that these archives were limited in resources and budgets. On the other hand, Pixar, as a major animation studio owned by Disney, may have more resources and funding to develop a procedure for preserving digital assets. Thus, a visit to Pixar can potentially offer a new perspective and solution to the issue of digital film preservation.

Future trips to other major film studios are also currently being planned and arranged. Such studios include Fox, Disney, Paramount, Warner Brothers, Universal, Sony, as well as visual effects studio Industrial Light & Magic (ILM), from Lucasfilm. In addition, I am also trying to arrange an interview with members of AMPAS's Science-Technology Council, specifically those who were part of the team responsible for developing ACES 1.0. Interviews with archivists at these studios and institutions would again further my studies in the problem of digital film preservation, much like interviewing Software and Image Mastering employees at Pixar.

Ultimately, from this research, I plan to produce a paper that summarizes and analyzes the current and developing technologies and methods in digital film preservation. With the rapid growth and development in technology today, there is a possibility that I can identify solutions or steps to find a reliable way to preserve films digitally. Per AMPAS's goals outlined in *The Digital Dilemma*, these solutions are intended to allow access to the film for at least 100 years—even if not accessed for extended periods of time; to allow duplicates to be made for future distribution, to maintain the quality of original camera negatives and sound recordings, and to not conflict technologically with the original archival masters (49-50).

Conclusion

While this research primarily focuses on digital preservation in the film industry, the work produced would ultimately benefit other businesses and fields. Film is one of the major industries that have a large amount of digital files that need to be preserved (such as digital masters) and the funds and resources to actually develop ways to effectively preserve these files, using new technologies and methods. However, AMPAS has mentioned other institutions and disciplines that also use a large amount of data and face these digital problems on a similar scale, such as public archives (Library of Congress, U.S. National Archives), government agencies (Department of Defense), medical institutions and clinics (Cleveland Clinic), large corporations, and scientific organizations (especially in geology and astronomy) ("Digital Dilemma" 20-30). Thus, finding an effective and reliable solution to digital preservation would be an enormously significant benefit to other fields, beyond film. In fact, AMPAS encourages the collaboration of these industries and institutions in order to find a digital solution that would benefit them all ("Digital Dilemma" 54).

On a more personal level, finding a practical and reliable way to preserve digital files would also benefit everyone individually. If solutions to digital preservation can be found, personal files on computers, cameras, and cell phones could be better preserved for the long-term. The idea that, in a few decades, it may be more likely that people will still have decades-old physical photographs than the digital photos on their computers today could also be a personal reason why such a digital solution should be found. Preserving one's own memories and family history may be just as important as preserving humans' knowledge and culture. Preservationists seem to have found a reliable way to preserve most forms of physical media; right now, they need to find an effective way to preserve data in digital formats.

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