Title
Preservation Fever: A Cultural History of Celluloid Acetate Plastics and How They Shaped Film Preservation

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Publication Date
2015

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA,
IRVINE

Preservation Fever:
A Cultural History of Celluloid Acetate Plastics and How They Shaped Film Preservation

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Visual Studies

by

M.M. Chandler

Dissertation Committee:
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2015

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ACKNOWLEDGMENTS

Writing a dissertation can at times feel like a thankless job. But that doesn't mean there aren't many to thank for their support and assistance in getting the job done.

Many thanks to my advisor, Professor Lucas Hilderbrand, for his keen insights, thoughtful revisions, and shared taste in the weird. Thanks also to my committee members, Professors Cécile Whiting and Bliss Lim, for their buoying encouragements and generative challenges.

Thank you to the UCI School of Humanities, Humanities Collective, Society for the History of Technology, UC California Studies Consortium, and Pacific Film Archive for their generous funding of my research. Thanks also to the Visual Studies, Film & Media Studies, and Gender & Sexualities Studies departments at UCI for providing Teaching Assistantships and conference travel funding.

And finally, deepest thanks to my nearest and dearest: to my family forged by blood, Heather, Steven, and Christopher Chandler; by heart, Diana Anselmo-Sequeira; and by fur, Martita Nancy Cumberbatch. Specialist of all thanks are reserved for you, Diana, for keeping me well feed in mind, spirit, and stomach from day 1 with your praise and critiques, baking and coffees.
It will always have meant everything.

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ABSTRACT OF THE DISSERTATION

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M.M. Chandler

Doctor of Philosophy in Visual Studies

University of California, Irvine, 2015

Professor Lucas Hilderbrand, Chair

Contemporary practices in film and media preservation have largely taken the form of "restorations" and "reformatting" initiatives, whose overarching goal is to save endangered analog contents through digital interventions. On the surface, these practices seem supported by the promising advent of superior new technologies. However, today's preservation practices are ultimately rooted in a profoundly flawed, old logic first introduced by the same acetate materials that are now falling into ruin. This dissertation questions our foundational ideologies of preservation by showing how they reenact principles established by early twentieth-century applications of celluloid acetate plastics. By returning to the forgotten and at times bizarre cultural history of acetate and its use in taxidermic model-making; biomedical braces and prosthetic limbs; X-ray radiograms and histology slides; microcellular motion pictures; microfilm, home movies, domestic gas masks, and bomb shelters, this project not only expands our conceptions of media studies "objects" but also provides an expanded understanding of why we continue to "preserve" film and media objects in the ways we do. These historic case studies

are traced across 4 chapters, which reveal how different fields relied upon the material qualities of acetate plastics to provide a type of "preservation" shaped by notions of replacement and artificially; reproduction and access; futurity and heritage; and with an overarching emphasis on visuality and visual appearances. Even after the discovery of acetate's material decay, these core principles have nevertheless continued to influence how preservation is thought of in the twenty-first century and practiced through new digital tools — a problematic legacy that demands our critical reconsideration.

INTRODUCTION

If we were to play a word-association game with “celluloid acetate,” what would some of the expected responses be? “Plastic,” perhaps; or “old film stock,” if the player knew their film history. If we happened to be playing with a media archivist, maybe “the Vinegar Syndrome” would be their knee-jerk response. Indeed, nearly all of the current industrial discussions, academic literature, and common knowledge concerning celluloid acetate have tended to focus on this last association: the Vinegar Syndrome, the material failure and decay of acetate plastics, and the need to save these objects (especially motion pictures) from a vinegar-soaked death. And while it is true that celluloid acetate does inevitably decompose in a self-directed process where the plastic base warps, shrinks, blisters, becomes brittle, and loses its color over time, if we played this word-association game a few decades ago the responses would have been quite different.[1] Before the first evidence of acetate’s decay in the 1950s and long before Kodak scientists reluctantly gave it a stigmatizing name in 1991, celluloid acetate was heralded in American labs, stores, homes, schools, and popular magazines as a safer alternative to flammable nitrate stock; as a promising innovation in artificial material engineering; and as an indestructible preservation medium.[2]

This dissertation returns to the beginnings of acetate to unearth its past history as a preservation medium, and to reveal a new understanding of how acetate plastics joined forces with twentieth century cultural obsessions with safety and future survival to form a set of ideologies that turned into “preservation” as it exists today. I argue for a critical reconsideration

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[1] While the plastic base of acetate is susceptible to decay, its gelatin emulsion layer is not. Thus, it is specifically the the failure of acetate that instigates the stock’s decaying process.

[2] Wallace Cloud, “Science Newsfront” *Popular Science* (July 1964): 15-16;18.

and demystification of “preservation” as a neutral desire or a singularly defined endeavor. Rather, preservation efforts and the other names it has been refracted and reshaped into — restoration, reformatting, access — have been culturally and materially constructed to function in ways that often do not serve the objects they mean to save. As this dissertation will reveal, acetate plastics and their rhetoric of improving organic life in the early twentieth century shaped preservation into a concept and ideological imperative that continues to haunt how it is understood within current twenty-first century film and media contexts. In short, newly invented acetate plastics reshaped organic life in the twenty century, and shape a type of “preservation” that has lasted into the twenty-first century in the form of digital media “restorations,” “reformatting,” and other renamed branches (or poisoned fruit) that stem from an anchoring trunk of acetate ideologies.

While media scholars within the archival sector have offered critical perspectives on the state of contemporary preservation initiatives in regard to acetate film objects, their focus has been primarily on how new digital technologies are being used to “save” analog film.[3] Building upon this work yet offering an entirely new historical and critical perspecitve, I trace these current debates back to acetate’s past interdisciplinary uses, specifically in the making of taxidermic replica and medical prosthetics; in X-ray and histological imaging practices; in the

[3] Alicia Fletcher and Joshua Yumibe, “From Nitrate to Digital Archive: The Davide Turconi Project,” *The Moving Image* 13.1 (Spring 2014): 1-32; Paul C. Spehr, “The Education of an Archivist: Keeping Movies at the Library of Congress,” *TMI* 13.1 (Spring 2013): 151-178; Arianna Turci,“The Use of Digital Restoration within European Film Archives: A Case Study,” *TMI* 6.1 (Spring 2006): 11-124; Brian Real, “From Colorization to Orphans: The Evolution of American Public Policy on Film Preservation.” *TMI* 13.1 (Spring 2013): 132; David G. Horvath, *The Acetate Negative Survey: Final Report* (Louisville: University of Louisville, 1987); James M. Reilly, *New Approaches to Safety Film Preservation* (Rochester: Image Permanence Institute, Rochester Institute of Technology, 1994); Jean-Louis Bigourdan, “From the Nitrate Experience to New Film Preservation Strategies,” *This Film is Dangerous: A Celebration of Nitrate Film,* Roger B. N Smither and Catherine A. Surowiec, eds. (Bruxelles: Federation Internationale des Archives du Film (FIAF), 2002): 52-73; Emily Cohen, “Orphanista Manifesto: Orphan Films and the Politics of Reproduction,”*American Anthropologist* 106.4 (December 2004): 719-731; Thomas A. Bourke, “The Curse of Acetate; Or, a Base Conundrum Confronted,” *Microfilm Review* 23.1 (15 October 2009): 15-17.

creation and distribution of "streaming" images of blood circulation; and in the depositing of precious "cargo" into future-proofed containers. Each of these cases show how today's digital preservation rhetoric is in fact a continuation of the methods, motivations, and rhetoric behind "saving"organic matter through acetate materials. Through a resurrection and reexamination of acetate's inherently contradictory, often conflicting history as a preservation medium *cum* decaying object in a number of fields, I reveal how film preservation interventions today still echo the overarching ideologies that once made acetate so popular: namely, that synthetic materials are superior and should be used to remake and replace organic objects and their visual appearances, especially, in order to ensure future access and survival. Though acetate has been discredited as a flawed preservation medium (in large part due to the discovery of the Vinegar Syndrome) and public faith in plastics have withered, the preservation logic they introduced lives on a century later. It is a flawed logic, founded in the superiority of technology and supremacy of visuality, but it has nevertheless lingered on as the ideological fundament supporting many of today's digital practices and perspectives.

In its very etymology, "plastic" mean capable of being shaped or molded. Living up to its namesake, acetate plastics were not only shaped by public discourse into products promising preservation and solutions for organic destruction, but also shaped the aims, methods, and end goals of preservation. Essentially, newly invented acetate plastics invented a specific form and theory of preservation. These acetate inventions were introduced in a number of fields and applications across the twentieth century, ranging from the mundane to the bizarre. Giving new attention to the later category, the case studies populating this dissertation include archaic taxidermic model-making; biomedical apparatuses including medical braces and prosthetic limbs; scientific imaging mediums such as X-ray radiograms, histology microscope slides, and microcellular motion pictures; and wartime domestic safety equipment including bomb shelters and gas masks. These examples, unearthed from the forgotten material history of acetate, serve as new lenses through which to refocus our contemporary understanding of preservation. Acetate assumed many different forms and guises throughout the twentieth century, but consistent amongst all of its manifestations were material promises of greater durability, visibility, longevity, and safety. In each of these cases, acetate was pitched as an improved replacement for what came before: it was superior to organic flesh, glass, wood, and even earlier versions of cellulose plastic.

With the advent of chemical sciences in the nineteenth century, plastics began to be artificially created out of partially synthetic and eventually fully synthetics materials. The historical development of plastics, in fact, illustrates a larger scientific and cultural turn towards increasingly artificial, man-made materials marshaled to overcome the limits of the natural environment. Parkensine, the first-born in the semi-synthetic family of cellulose plastics, was patented in 1862 by British chemist, Alexander Parks. Celluloid nitrate and acetate debuted the in following years. Acetate plastic is produced by artificially fusing together organic cellulose, the major component of plant cell walls, with acetic acid in a process called esterfication (first discovered in 1865, by French chemist Paul Schützenberger). Unlike nitrate, acetate proved to be a more stable, less-flammable base for the efficient and cost-effective mass production of plastic goods. The first acetate products were introduced in the early 1900s by Swiss inventors, Camille and Henri Dreyfus; one of these early and pivotal applications was as a fire-resistant lacquer used to protect the wings of European and American fighter plaines during World War I.[4] From its very beginnings, acetate appeared to be a safe, protective material that was marketed as literally saving lives.

Over the next fifty years, acetate and plastics in general would become a world-wide phenomena, infiltrating nearly ever product and aspect of daily modern living — from clothes to tools, toys to food. In his historical and industrial study of plastics, Jeffery L. Meikle identified the early twentieth century as plastic's heyday, culminating into what has become termed "the plastic age." The temporal anchor for this new "age" varies from the 1930s according to Meikle, to the 1950s as recently selected by contemporary anthropologist who claim the emergence of plastics mark the beginning of geological age (the "anthropocene") characterized by mankind's ability to reshape their environment. Regardless of temporal marker, the ethos/epoch of "the plastic age" is uniformly defined by human attempts to transcend organic materials or to control/re-engineer the natural world through technological means.[5] Even though Lewis Mumford claimed this is the common purpose/promise of all new technologies, plastics armed human agents with an unprecedented ability to transform material conditions which had previously limited human civilization: it could replace limited resources with an abundance of new, artificial creations, could overcome finite lifespans with ageless surfaces, and provided certain permanence in the face of unavoidable loss.[6] This introduces an inherent contradiction, though,

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[4] Theodore Macfarlane Knappen, *Wings of War* (New York: G.P. Putnam's Sons, 1920).

[5] for more on the anthropocene, see: Revkin, Andrew C. "Researchers Propose Earth's 'Anthropocene' Age of Humans Began with Fallout and Plastics." *The New York Times* [15 January 2015]. Accessed 20 January 2015. <http://dotearth.blogs.nytimes.com/2015/01/15/researchers-propose-earths-anthropocene-age-of-humans-began-with-fallout-and-plastics/?_r=1>; Smith, Bruce, D. "The Onset of the *Anthropocene* 4 (2013): 8-13; Revkin, Andrew C. "Embracing the Anthropocene." *The New York Times* [20 May 2011]. Accessed 20 January 2015. <http://dotearth.blogs.nytimes.com/2011/05/20/embracing-the-anthropocene/>.

[6] Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Co, 1934).

would come to epitomizes the counterintuitive, problematic legacy of acetate: in order to improve the natural world and make ephemeral things capable of resisting time, death, or decay, the very object in question needs to be enhanced, remade, or destructively replaced by acetate. The very means and materials of preservation end up causing destruction and loss — a foundational aspect of acetate and its ideological legacy that this project brings to the fore as still influencing working assumptions and prevailing media practices in the twenty-first century.

Plastics, in general, and acetate in particular grew out of and fed into the belief that new technologies and artificial materials were preferable to organic matter and natural materials. In the case of taxidermic "preservation," for example, a specimen's skin could be discarded after an acetate copy was made. Even more than reducing biological life to surplus, as Melinda Cooper describes in her writing on bioengineering, plastic technologies and materials would be used in ways that indicated life, as it naturally existed, had little value.[7] With this, an ironic polemic emerged across a number of sectors (museums, labs, archives, stores domestic homes) that suggested life/organics could be made better if remade or replaced with plastic/synthetics. Microfilm, another well know preservationist use of acetate film, functioned in much the same way. As publicized in a late 1960s advertisement for Kodak's microfilm products, users were encouraged to throw away their paper documents once its information was recorded on acetate.[8] Such acts of violent replacement, however, would be packaged within public discourse and sold as highly attractive, desperately sought after "preservation" interventions which would save, protect, and keep safe the item it was displacing or in some cases even destroying. The mission

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[7] Melinda Copper, *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era* (Seattle: University of Washington Press: 2008).

[8] Eastman Kodak, "Save the Facts...and Throw Away the Paper" advertisement (ca. 1965).

of this dissertation is to show how this history actually continues today in the form of digital technologies and interventions that have been repackaged as "restoring" or "reformatting," but that fundamentally repeat the same type of destructive "preservation" acetate offered a century ago.

The 1950s would mark another chapter in the story of plastics and a departure from its early excitement and promising potential. As Meikle has argued, plastics began to take on decidedly negative connotations in the second half of the twentieth century, perhaps not coincidently coinciding with the first suspicion of acetate's susceptibility to material decay in the late 1950s. Despite all its previous life-saving hype, plastics were no longer seen as offering a brighter, shinier future; these previous beliefs were now the butt of mocking jokes, as epitomized by *The Graduate*'s famously sardonic line: "there's a great future in plastics."[9] Continuing in today's pop culture parlance, to be "plastic" has come to connote phoniness, superficiality, and cheapness — a far cry from the fanfare that once heralded it as a lifesaving, invaluable aid to improving and sustaining modern life.[10] Sociologist Laurie Essig, has also signaled the 1980s as another meaningful moment of shift within the history of plastics.[11] Focusing primarily on plastic surgery and credit cards, Essig claims that a "plastic ideological complex" emerged which offered these plastic tools as the means for perfecting fleshly bodies and ensuring fiscal security. My objects of analysis connect to Essig's through these overarching plastic ideologies: namely, that synthetic plastics could transcend limitations of the natural world/body through

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[9] *The Graduate* (dir. Mike Nichols, 1967, USA).

[10] In *Mean Girls* (dir. Mark Waters, 2004, USA), for example, the vapid cliche of popular girls are derogatorily referred to as "The Plastics."

[11] Laurie Essig, *American Plastic: Boob Jobs, Credit Cards, and the Question for Perfection* (Boston: Beacon Press, 2010).

augmentation and visually arresting temporal aging, as well as provide a sense (even if falsely imagined, as in the case of credit card debt) of future security through the plastic consumerism. Post-1980s discussions of plastics have shifted into a markedly different register, however, which now characterized them as harmful synthetic materials that cause over consumption, wanton waste, toxic pollution, and deadly illnesses.[12] In fact, part of reason why plastics have been singled-out as the harbinger of the anthropocene is for its collateral damage and fallout. Ironically, many of these negative-side effect are in fact caused by plastics making good on their original promise: plastic grocery bags, for example, are now posing environmental pollution and litter problems because they are not decaying quickly or safely enough. Despite its checkered and changing public image, plastics have certainly proven their staying power, and one of the most entrenched yet unexamined places where they have taken root are in our cultural ideologies surrounding technological innovations, artificial materials, and how to "preserve" what came before them.

Pillars of Acetate Preservation

Even though current understandings of acetate plastics position them as the enemy of long-lasting survival and as frail materials that *should* be preserved, there was a time when

[12] Ironically, the same year the band Aqua proclaimed in their song "Barbie Girl" that "life in plastic, it's fantastic," the first laboratory evidence emerged that pointed to certain plastics (specifically BPA) caused serious birth defects. Plastics have also become an important environmental concern within the last thirty years; with some of the most recent backlash focusing on the banning of plastic grocery bags as San Francisco first did in 2007. Still, plastics have remained a resilient chameleon, and has been reshaped and remarked, yet, again into non-toxic forms and reworked into recycled post-consumer good.

acetate was historically understood and utilized as a medium that *could* preserve.[13] Echoing the discourses surrounding most new technologies and idealistic ideologies of technological progress, acetate products were initially marketed as ways to extend the limits of the natural world, control time, overcome aging and decay, and circumvent loss. As I have been arguing thus far, acetate materials and their use in the early twentieth century helped to crystalize a set of principles under which preservation efforts continue to operate. These concepts were born from the material qualities of the plastic substrate and fueled a preservation fever that preferred reproducible copies over unique originals; artificiality over organic materials; circulation and public access over restricted storage; and investments in "the future" even more than the present. These elements consistently appeared in the discussions and advertisements around acetate materials as their distinguishing features and positive contributions. What resulted was a prevailing discourse around plastics and acetate in particular that bled into its applications, ranging from taxidermic skins to histology slides to family photo albums. While vast and diverse, all of these applications were united by the same ideologies stitched into the material fabric of plastics: namely, that things could be made better if remade with artificial materials.

Part of making these things better involved increasing their visibility and the longevity of their visual surface appearance. In the case of taxidermy skins, acetate replicas offered the appearance of increased vitality and longer lasting colors; histology slides made it possible to see

[13] Paolo Cherchi Usai, David N. Rodowick, Giovanna Fossati, and Caroline Frick have all focused on acetate film as a decaying object that needs to be saved. Similar to nitrate, acetate is largely presented as a problematic "fire" that needs to be put out and replaced by "better" digital archiving materials. See Paolo Cherchi Usai, T*he Death of Cinema: History, Cultural Memory, and the Digital Dark Age* (London: BFI Pub, 2001); David N. Rodowick, *The Virtual Life of Film* (Cambridge: Harvard University Press, 2007); Paolo Cherchi Usai, David Francis, Alexander Horwath, and Michael Loebenstein, *Film Curatorship: Archives, Museums, and the Digital Marketplace* (Vienna: Österreichisches Filmmuseum, 2008); Giovanna Fossati, *From Grain to Pixel: The Archival Life of Film in Transition* (Amsterdam: Amsterdam University Press, 2009); and Caroline Frick, *Saving Cinema: The Politics of Preservation* (New York: Oxford University Press, 2010).

cellular structures; and photo-cinematic images persist even after their indexes do not. As continues to be the case in many of the film "preservation" projects today, it is the image and ocularcentric issues of visuality, clarity, and color definition that hold great priority and sway over those who continue to prioritize other aspects of cinematic materials, including their materiality and all visible flaws. Every gain in visibility, also comes with a certain type loss: taxidermy skins appear real yet render the original specimen disposable; histological imaging killed its cellular samples in order to turn them into images; and aggressive restoration efforts within certain labs turn the film artifact into a historic visual monstrosity inline with Playstation-esque hyper-aesthetics.[14] In some crucial ways, the same logics and side effects found in early attempt to improve the visibility of organic materials with acetate mediations are echoed in today's efforts to improve acetate film objects with digital mediations.

Replacement and Artificially

Acetate skins, histology slides, home movies, and infant gas masks collectively offered a form of safety and preservation through replacement and artificiality. If an animal's skin could not be adequately maintained over time, the solution was to substitute a plastic copy of it. Need an unchanging, stable view of an organism snatched from the flows of time? Turn it into a fixed slide or photographic image, both rendered through celluloid acetate. Human lungs and lives cannot naturally survive chemical warfare, but they can with the use of protective gear like gas masks and bomb shelters, both of which were fitted with acetate safety glass windows. In each of these applications, acetate plastics offered something superior, something life saving, something

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[14] see Nick Wrigley, "Crimes Against the Grain," Sight and Sound 22.12 (December 2012): 72-3; and Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White" *Some Came Running: Enthusiasms and Expostulations* (March 12, 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

that was previously lacking. While some applications, like medical braces and casts, may have supplemented or sought to improve what was already in place, other applications such as prosthetic devises (both literally in the case of prothetic limbs, as well as more figuratively as in the case of prosthetic memory devises like home movies) completely take the place of what was missing or gone.

Taken collectively, these applications reveal an overarching cultural embrace of artificial and engineered materials as a way to improve and/or completely replace inferior natural and organic objects. Marita Sturken and Douglas Thomas have identified this as a "myth of progress" — a belief that new technologies are always better than what came before them. Playing into these mythical beliefs, desires for artificial preservation came to trump both authenticity and the sacredness of organic materials.[15] With this, acetate interventions ultimately introduced "preservation" practices that ended up destroying original/organic materials; it introduced a logic that saw their replacement by artificial products as the best way to save them and ensure future survival.

As its lingering legacy, acetate helped to usher in a cultural shift that lead away from organic materials and towards inorganic-ness — to "do nature one better" through manufactured replacements and synthetic reproductions that could last longer, wear slower, and resist the effects of time, aging, and death.[16] This shift would circle back around to acetate, however, in the form of even newer, more synthetic materials positioned to take its place. Within the context of film preservation, first polyester film emerged to displace acetate and now non-filmic digital

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[15] Marita Sturken and Douglas Thomas, "Introduction: Technological Visions and the Rhetoric of the New," *Technological Visions: The Hopes and Fears that Shape New Technologies*. Marita Sturken, Douglas Thomas, and Sandra J. Ball-Rokeach, eds. (Philadelphia: Temple University Press, 2004).

[16] Alden P. Armagnac, "New Feats of Chemical Wizards Remake The World We Live In" *Popular Science* 129.1 (July 1936): 9.

formats have take hold. Interestingly, the process of ensuring digital readability, future access, and successful preservation depends upon processes of "emulation." These processes are akin to a form of mimicry: the new technology/format attempts to reproduce the functions of the format it is replacing. Essentially, digital emulation mirrors acetate's previous processes of imitation. Some of the earliest praise for acetate, in fact, surrounded its ability to mimic and to emulate existent materials. Once able to emulate, these acetate products (and later digital ones) are able to displace their predecessors because it is seen as providing a newer and improved version. Emulation is described as many archivists as a key strategy in digital preservation today, yet this is the same practice acetate original employed to improve and preserve, but which also ultimately failed

Reproduction and Access

Making content readily accessible through mass duplication and reproduction is considered a fundamental feature of digital formats. We fill hard drives full of backup copies to prevent losing our data, and have even turned to "immaterial" network servers to store our information and have it readily available. The philosophy behind these processes, however, can again be traced back to acetate preservation strategies which crystalized the belief that ideas/ content could be safeguarded if turned into many, widely distributed copies. As the adage goes, "there's safety in numbers," and before digital formats it was acetate duplication, made possible by the material properties of plastic substrates, that provided this. As Meikle notes in his material/industrial history of acetate plastics, acetate provided a streamlined, cost-effective mode of production that made the mass-proliferation of plastics a reality. Replication was one of acetate's most profitable features, and this material calling card defined not only its manufacture but how it would be used to copy, save, and preserve through replication.

While this logic in copying in order to save seem sound, it is also problematic in that neither reproduction nor access ensure the actual survival of the original items or full content being duplicated. Microfilm reproductions offer an apt, well-known example of how element of the original document are compromised if not completely sacrificed in the duplication process: colors, textures, three-dimensionality, user interactivity, et cetera. Ultimately, a great deal is lost in this act of preservation via reproduction, even though this method was championed at the time of acetate and still continues to be promoted in preservation contexts today.

Multiplication and over-reproduction have also imposed another type of loss; as Alexander Stille notes in *The Future is the Past*, an excess of information, data, and copies of copies have exceeded our natural and even man-made abilities to save them.[17] An overabundance of images and information has exponentially exploded since the beginning of mass consumerism, which we are now forced to face and rethinking how to save, what to save, and how to negotiate space as it becomes an endangered resource itself. Reproduction, in these ways, does not lead to preservation or to gains in safety, but rather to loss — an irony underscored when copied objects lose tiny details and overall quality each time they are reproduced. Materialist filmmakers, as discussed in the final Coda section, make this perverse scenario hyper-visible when they turn the methods of preservation (optical printing, duplication, and rephotographing) against acetate film in order to bring about its spectacular destruction. Like a virus, bacteria, or cancer, when reproduction runs amok it leads to death.

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[17] Alexander Stille, *The Future is the Past* (New York: Farrar, Straus and Girous, 2002).

While notions of "access" are more often associated with electronic and digital technologies, desires for access were in fact already present in the discourses undergirding acetate plastics.[18] Microfilm catalogues from the 1940s, for example, were praised for distributing knowledge through a network model that privileged reproductions over originals, and multiple points of access rather than isolated safekeeping. In contrast to an archive model, in a network model copies are held and distributed by various branches rather kept in singular, restrictive archives. Traveling taxidermic displays, educational science films, and portable histology slides were all successful forms of acetate-base mediation, not only because the could be produced, copied, and reproduced fairly easily, but because they provided the public with unparalleled access to their contents. As shall be discussed in their respective chapters, these objects were portable and could be circulated through the public because they were made out of safe, non-flammable, and damage-resent acetate plastics. The safe access provided by acetate became one of its major selling points among producers and advertisers. As they moved through the public sphere and layman use, these products not only carried with them knowledge about nature and life, but almost ironically also carried with them a rhetoric that artificial plastics were invaluable products and superior to natural materials.

Futurity and Heritage

In his critique of the archive, Derrida highlighted futurity as one of its driving concepts. Archiving and preserving efforts are fueled by a high regard for the future; they elevate the future into a prized position, and hold it up as a beacon of a promise and potential that the present is indebted to protect. The goal of preservation is not about the present moment, but

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[18] Lucas Hilderbrand, ed. "Media Access: Preservation and Technologies, Editor's Introduction" Special Issue, *Spectator* 27:1 (Spring 2007): 5-8.

about the future. The present is but mere pretense, and all present efforts should put in service for the future. Or, this is at least the rhetoric of futurity that initially emerged around acetate products and that have continued to color the preservation discourses encountered today particularly within film, media, and cultural heritage contexts. Caroline Frick has noted that an emphasis on futurity and heritage protection have been employed quite effectively within film preservation contexts. Film archivists in the United States have increasingly tailored their preservation efforts to reflect this rhetoric of futurity through a careful articulation of terms like "heritage," and by referring to certain endangered, acetate-based non-theatrical films as "orphans" — vulnerable children that need protection and safekeeping. This current discourse did not spring forth from Zeus' head fully formed, however. Rather, it can be traced back to the rhetoric used in the early twentieth century around acetate materials and their use as tools to protect and ensure the survival of endangered American children — symbols that stand in for our national heritage and collective "future" as contemporary critical queer theorists, namely Lauren Berlant and Lee Edelman, have also noted as a driving force behind twenty-first century social politics.[19]

Importantly, these notions of protecting the future grew out of Progressive era ideals of safety and ensuring safe conditions within industrial, educational, and domestic settings. A major threat facing both industries and schools during the early twentieth century was the risk of fire. Film studios, theaters, hospitals, medical labs, and any place that projected or stored nitrate film faced a heightened fire safety risk since nitrate is prone to catching fire, uncontrollably burning, and even employing. In light of a number of institutional fires, such as the Thanhouser Film Company studio fire in 1913, nitrate film was deemed too dangerous, especially for amateur and

[19] Lauren Berlant, *The Queen of American Goes to Washington City: Essays on Sex and Citizenship* (Durham: Duke University Press, 1997); Lee Edelman, *No Future: Queer Theory and the Death Drive* (Durham: Duke University Press, 2005).

non-theatrical educational use. A call for safer materials came in response and acetate would soon debut as a safer, less-flammable solution. In a telling filmic recreation of the Thanhouser studio fire, director Lawrence Marston punctuated the horror of the incident with the harrowing rescue of a child from the deadly flames.[20] This addition confesses an obsession with safety and foretells how the figure of "the child," or the "priceless child" as Vivana Zeliger nominated it, and doing everything possible to keep the child safe would come to influence the development and marketing of acetate safety plastics, most notably in the case acetate safety film as it came to market for schoolroom education and domestic image-making.[21]

Not only would this discourse help to secure acetate's place within educational and public sphere use, but it would also resurface in calls to protect children during World War II. Numerous advertisements, article, and even governmental/military initiatives turned attention to children and the nuclear family as the emblem of American civilization. If their future was not secure, then neither was America's. The child thus became a national treasure — a heritage and legacy that had to be preserved, and acetate products were called upon for this task in both literal and figurative ways. Figuratively, acetate photo-cinematic imaging technologies were marketed to the public as ways to grant the ephemeral child's body an extended life as well as contribute toward successful family and domestic life. In a more literal sense, acetate materials were also advertised as new ocular components in infant gas masks and domestic bomb shelters in the form of safety glass windows and eye-screens, which promised to keep the nuclear family, children, and their vision safe during nuclear warfare and chemical attack. Essentially, this was the same

[20] *When the Studio Burned* (dir. Lawrence Marston, 1913, 35mm, USA).

[21] In *Pricing the Priceless Child: The Changing Social Value of Children* (Princeton: Princeton University Press, 1985), Viviana Zeliger offers an extended cultural analysis of how children went from "useless" in the late 1800s to "priceless" in the 1930s — the same time amateur photocinematic imaging making technologies entered into more everyday, domestic uses to record children's lives.

underpinning rhetoric behind taxidermic preservation: to create lasting visual renditions of fleeting life through acetate surfaces and coverings which would last into the future and survive even after the death of any individual organism. In each of these applications, acetate materials and preservation practices set the standard for how preservation was seen as an effective measure and sought after in order to ensure the future. Even after acetate failed in this task, its templates for preservation continue to influence initiatives and discourses today.

Returning to Acetate to Reconsider Preservation

The first layer of this project proposes a new historiography of early film technology and practices from the perspective of material culture and, specifically, celluloid acetate plastics. In *The Archaeology of Knowledge* (1972), Michel Foucault proposed an "archaeological" approach to history and historiography that interrogates how discursive meanings, understandings, and associations are historically constructed around objects.[22] Following this model, I analyze how early twentieth century uses of acetate and the positive discourses surrounding them in European and American culture all contributed towards shaping acetate into a medium of preservation. This initial understanding has since become buried under acetate's material failures, while the type of "preservation" it introduced has now taken on an independent, taken-for-granted life of its own. It is important to signal that my focus is on European (specially British) and American cultural contexts, since these were the major marketplaces where acetate plastics were first developed and distributed. George Eastman's American based Kodak company, for example, lead the way in developing imaging technologies and other manifestations of acetate-based films, whereas Fuji Film, its Japanese competitor, utilized polyester instead of acetate in their

[22] Michel Foucault, *Archaeology of Knowledge*, Trans. Alan Sheridan (New York: Pantheon Books, 1972).

products.[23] Equally probative, though not covered in this project, are examples of acetate audio recording technologies. Products like audio tape and even sound-on-film motion picture formats like Super8 (ca. 1973) utilize acetate substrates for recording and preservation purposes, but for the sake of argument, the case studies tackled here focus on *visual* mediations.

Through archival research into early twentieth century biomedical techniques including taxidermy and cellular imaging; archaic photo-cinematic imaging technologies; and consumer product oddities including infant gas masks, I develop a new material history for acetate — a history that complicates current narratives by revealing how it was initially embraced as a solution to natural decay and an invaluable material that could safely protect or superiorly supersede organic matter. Inspired by the emerging field of media archaeology, as modeled today by the work of Erkki Huhtamo and Jussi Parikka, my approach to acetate artifacts is simultaneously sensitive to theories of technological determinism along with the argument that technologies are not predetermined or set in stone, but instead are "plastic" in the sense that they are shaped by their social contexts and the needs, hopes, or fears of their users.[24] Balancing between both perspectives, my analysis of acetate shows that it was groomed into a preservation medium in service of social needs and cultural fears/desires, and that this grooming also shaped how "preservation" was thought of and practiced through acetate's unique material feature of reproducibility, accessibility, artificial verisimilitude, and futurity. With this, I aim to answer the

[23] Preservation also takes a different form in Japanese architecture: for example, the Ise Shrine, a highly revived Shinto Shrine established in the Mie Prefecture in 4 B.C.E., is ritually preserved out through periodic demolition and reconstruction using traditional tools and materials.

[24] Erkki Huhtamo and Jussi Parikka, "Introduction: An Archaeology of Media Archaeology" in *Media Archaeology: Approaches, Applications, and Implications*, Erkki Huhtamo and Jussi Parikka, Eds. (Berkeley: University of California Press, 2011, 1-25).

call of Carolyn de la Peña: to apply a cultural studies approach to histories of technology in order to critique technology as both object and ideology.[25]

Beyond simply looking at acetate objects, I also interrogate acetate as a method of preservation that developed into a set of ideologies. This perspective diverges from how acetate is typically though of today: as an object that needs to be saved and preserved and not as a tool that was once used to save other objects. Film preservation scholars including Anthony Slide, Penelope Houston, and Karen F. Gracy, have compiled compelling accounts of film object preservation activities throughout the twentieth century.[26] However, whereas they focus more so on the archive institutions and the history of film preservation, my project extends beyond the medium of film to also consider the broader, interdisciplinary contexts for acetate preservation. Specifically, I bring together examples drawn from taxidermic practices (acetate skin replicas), biomedical apparatus and imaging techniques (casts, prosthetics, X-rays, histology slides), and the domestic application of wartime safety devices (bomb shelters, gas masks) to create a new historiographic understanding of how acetate's multimodal applications combined to create a larger theory and "culture of preservation" rooted in the properties of plastics. This legacy is acetate's most important, and lasting, after-effect.

As a second main goal, this dissertation aims to challenge disciplinary boundaries and expand what are considered to be the objects of media studies and histories of technology. I lay claim a new set of unusual objects — the taxidermic mount and medical cast, the histology slide

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[25] Carolyn de la Peña, "'Slow and Low Progress,' or Why American Studies Should Do Technology," American Quarterly 58.3 (Sept 2006): 915-941.

[26] Anthony Slide, *Nitrate Won't Wait: A History of Film Preservation in the United States,* (Jefferson: McFarland, 1992); Penelope Houston, *Keepers of the Frame: The Film Archives* (London: British Film Institute, 1994); Karen F. Gracy, *Film Preservation: Competing Definitions of Value, Use, and Practice* (Chicago: Society of American Archivists, 2007).

and X-ray record, the bomb shelter and gas mask — and contend that these artifacts not only share a material/chemical basis, but share the same promises and ideologies of preservation offered by non-theatrical film and media objects (educational science films, family photo albums, and home movie collections). By looking at the ways in which all of these applications utilized and promoted acetate plastics, we gain greater understanding into what became an overarching cultural preoccupation with preservation as well as what preservation meant, what its value/function was, and what it was supposed to accomplish. Looking at these uses of acetate also reflects back upon the photo-cinematic medium to illuminate how it has been theorized as a preservation technology. André Bazin, Fatimah Tobing Rony, and Mark Avery have all considered how photography and cinema share metaphorical connections with taxidermic preservation. Donna Haraway has also theorized how new technologies are used to augment human/animal bodies and create hybrid-cyborg figures that transcend nature.[27] This dissertation extends such theoretical discussions in a new direction: interdisciplinary material history. My investigation across a number of sectors opens a deeper understanding into how cinematic mediation intersects, materially and practically, with "preservation" acts like taxidermy which literally augmented the biological world with the same acetate plastic materials as photo-cinematic mediations.

Also included among my objects of analysis are a number of commercial advertisements for consumer acetate products, including surplus army protection goggles, time capsules, and home movie equipment. My method for analyzing these consumer objects, new technologies,

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[27] André Bazin, "The Ontology of the Photographic Image." Trans. Hugh Gray. *Film Quarterly* 13.4 (1960): 4-9); Donna Haraway, "Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908-1936," *Social Text* 11 (Winter, 1984-1985): 20-64, and *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (New York: Routledge, 1989); Fatimah Tobing Rony, *The Third Eye: Race, Cinema, and Ethnographic Spectacle* (Durham: Duke University Press, 1996); and Mark Alvery, "The Cinema as Taxidermy: Carl Akeley and the Preservative Obsession," *Framework* 48.1 (2007): 23-45.

and the discourses surrounding them across the century draws from cultural historians such as David E. Nye, Lynn Spigel, and Jeffery L. Meikle. Following a similar methodology as Nye, I traverse several consumer markets and move between historical periods within each chapter (at times not chronologically) in order to tease out the larger narrative and cultural work of acetate objects.[28] In their respective work on television and plastics, Spigel and Meikle model how popular magazines are significant sources of insight and reveal how new technologies are introduced and literally sold into public opinion.[29] Following their methods, I look at *Popular Science, Popular Mechanics,* and *Life Magazine* amongst other print outlets as places where acetate plastics were tailored to appeal to consumer desires for safety and preservation while also steering the conversation towards plastic solutions. The rhetoric utilized by both the magazine reporters and product marketers tended to represent acetate innovations as trustworthy, welcomed additions that would vastly improve everyday life. This was done through a repeatedly emphasized set of characteristics: durability and longevity (often communicated through the language of lasting color), cheap reproducibility, and safety. While Meikel outlines a comprehensive and compelling history of plastics in American culture and industry, he does not consider the rhetoric of safety nor preservation, in general, that came to be popularly offered through plastics and acetate products.

Of course, it is important to remain appropriately skeptical of commercial advertisements — they are, after all, mixes of marketing and journalistic sensationalism that some readers may

[28] David E. Nye, *America as Second Creation: Technology and Narratives of New Beginnings* (Cambridge: MIT Press, 2003); *American Technological Sublime* (Cambridge: MIT Press, 1994); and *Electrifying America: Social Meanings of a New Technology, 1880–1940* (Cambridge: MIT Press, 1990).

[29] Lynn Spigel, *Make Room for TV: Television and the Family Ideal in Postwar America* (Chicago: University of Chicago Press, 1992); Jeffery L. Meikle, *American Plastic: A Cultural History* (New Brunswick: Rutgers University Press, 1995).

dismiss and disagree with — yet, they do reveal how acetate was talked about and put in conversation with larger cultural discourses. Whether or not the acetate products in question could actually make good on any of their advertisers' promises (which we ultimately know they could not) was a besides the point, as often is the case in advertising and especially in the marketing of new technologies which are too new and unproven to support any of their claims. In their introduction to *Technological Visions: The Hopes and Fears that Shape New Technologies*, Sturken and Thomas propose that new technologies emerge amidst various social contexts, concerns, and crises that shape the way they are used, marketed, and understood within everyday life.[30] David Nye has further argued that the technologies or products themselves are actually less important than how consuming and engaging with them makes users feel. In the case of acetate, scientists, preservation specialists, and layman alike engaged with its products in order to do everything possible to save and keep their precious items from irreversible loss.[31]

A historic investigation into the material life of acetate plastics ultimately reveals how its cross-disciplinary use to forestall organic decay and loss in the first half of the twentieth century set the tenor for a "preservation fever" that inevitably and at times ironically undermined the survival of that which it was trying to save. Drawing inspiration from the Derrida's critique of the archive in *Archive Fever*, I propose a similar critical reconsideration of preservation, as a febrile craze in early twentieth century culture.[32] Echoing Derrida's theorization that archiving is an act of violence that keeps and saves in an unnatural fashion, I claim that amidst the frenzy to save civilization and living existence from impending destruction, acetate plastic was latched

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[30] Marita Sturken and Douglas Thomas, "Introduction: Technological Visions and the Rhetoric of the New."

[31] see David Nye, *American Technological Sublime* (Cambridge: MIT Press, 1994).

[32] Jacques Derrida, *Archive fever: a Freudian Impression*, Eric Prenowitz, trans. (Chicago: University of Chicago Press, 1996).

onto as a life-saving solution whose material properties and qualities shaped preservation in practice and theory. Thomas A. Bourke, the chief of New York Public Library's Microforms Division, aptly encapsulated this ironic reality when he equated acetate microfilm reproductions as a "malady produced by a self-inflicted cure."[33] In the same way a biological fever imposes negative side effects while trying to cure an ailment, this preservation fever and these acetate interventions ended up causing more harm than good.

This leads, finally, into the third main contribution: a critical interrogation of "preservation" as a concept an set of ideologies that were crystalized with acetate. As the following chapters and case studies will show, the emergence of acetate plastics tapped into cultural anxieties about loss during moments of upheaval, and attempted to assuage these fears with attractive promises of improving the natural world through artificial materials and correcting the short comings of organic materials. In short, acetate producers developed and promoted their products under the claim that artificial plastics could provide the safety, assurance, and longevity so desired by the consuming public. Acetate was to be the solution, the cure, for the problems of aging, destruction, impermanence, and loss. Even more important, however, was the type of solution offered. While popular discourse presented these interventions as ideal preservation efforts, I argue they never offered preservation in the first place but rather something inherently different: their vision of "preservation" suggested that original artifacts and material forms should be replaced with seemingly invulnerable acetate mediations. These mediations, by in large, provided the *appearance* of preservation by focusing on preserving surface appearances. In other words, the preservation interventions I interrogate all privileged

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[33] Thomas A. Bourke, "The Curse of Acetate; Or, a Base Conundrum Confronted," *Microfilm Review* 23.1 (Winter 1994): 15.

visual appearances, sight, and visuality as that which should be preserved and as the way to create a sense of preserved newness, life-everlasting and insoluble permanence. What I unearth in these cases, and argue is still at the core of today's visual restoration efforts, is a form of preservation wrapped up with the visual and with artificially fixed, "lively" surfaces which ultimately do not conserve nor serve the material object. In keeping with its connotations, acetate plastic preservation is shallow, surface-y, and even less than skin-deep; it is not about actually saving or keeping the actual material state of objects intact or alive, but rather as sustainable visual effigies that simply "look" that way.

Ultimately, a completely different understanding and culture of preservation emerged around acetate that contradicted previously held values of authenticity, materiality, and uniqueness — values typically at the heart of conservation efforts. Instead, public discourse was redirected towards technological interventions, artificial replacements, and visual reproductions as the best methods for achieving protection and longevity, or at least an appearance of these. I locate the beginnings of this shift in the early twentieth century, namely with President Theodore Roosevelt's natural preservation initiatives and the Chicago Field Museum's morphing of wildlife conservation efforts into the replication and disposal of wildlife specimen (a forerunner of the film archive's "copy-and-destroy" method). This form of preservation, spearheaded by Leon L. Walters and his newly invented method of acetate skin casting in formalized in 1925, elevated copies and artificially engineered materials over the flesh of organic animals. Walters' invention reveals a foundational shift from conservation and the maintenance of existent resources/material into something different: "preservation" and the idea that in order to "save" them, they must be transformed into other material forms. Acetate plastics became a key tool used to replace the natural world and organic objects with artificial materials in order to make them last — a promise that would become a prevailing selling point within twentieth century public discourse, and has continued to shape the emergence of "restoration" practices as they have now been turned against acetate materials in twentieth-century film preservation. While this is not the first project to critique preservation — especially within the context of film object preservation, as shall be reviewed next — I take this questioning further to show how the introduction of acetate safety plastics and products across a number of fields and facets of modern living skewed the meaning of preservation away from conservation and its prioritized regard for original materials.

Mapping Preservation Discourses and Debates

Even though this project intervenes to look beyond the film archive, its history and shifting treatment of acetate film objects are nonetheless vital contexts where questions of materiality, technology, and preservation are currently under debate. In fact, the ways in which film archives have dealt with acetate film objects and new technologies echo other public uses, understandings, and discourses surrounding the nature of plastic materials and technological inventions. Many archivist insiders make a distinction between how preservation efforts were defined and carried out before and after the 1960s.[34] Before the 1960s, volatile, fire-prone nitrate films were readily transferred onto acetate safety film and then liquidated. As Alicia Fletcher, Joshua Yumibe, Arianna Turci, and Paul C. Spehr have discussed in articles for *The Moving Image* journal, archives frequently disposed of original nitrate prints in a process now

[34] Alicia Fletcher and Joshua Yumibe, "From Nitrate to Digital Archive: The Davide Turconi Project," *The Moving Image* 13.1 (Spring 2014): 1-32; Paul C. Spehr, "The Education of an Archivist: Keeping Movies at the Library of Congress," *TMI* 13.1 (Spring 2013): 151-178; Arianna Turci,"The Use of Digital Restoration within European Film Archives: A Case Study," *TMI* 6.1 (Spring 2006): 11-124.

colloquially called “copy-and-destroy.” The fear of nitrate fires and trust in acetate safety drove this form of preservation/destruction and disregard for potentially dangerous, outmoded nitrate materials. Spehr notes from his personal experience has a archivist at the Library of Congress that, “during the 1940s-1960s, the principal duty of the Motion Picture Section was destroying film”; this would change after the 1960s, when organizations like the American Film Institute (AFI) began to take an active role in supporting the “preservation” rather than the destruction of America’s film “heritage” (a rhetoric that shall also be interrogated later on).[35]

However, when newer film technologies emerged in the form of polyester (PET) plastics and eventually non-filmic digital formats, acetate was recast as a problem to fix and original nitrate prints became historically significant artifacts. This shift can be attributed to different motivations, including increased governmental funding for the institutional retention and storage of nitrate, but it also seems that recognition of the unique materiality of analog film only began in light of new digital technologies. As a manufactured product, acetate film stock has been rendered commercially obsolete by the closing of production and processing plants; as a result of its forced extinction, much of the “preservation” work conducted by film institutes focuses on turning their contents over to newer digital storage formats which offer the promise of being better though are in many ways even more vulnerable to technological obsolescence. Taking this into consideration, many archivists maintain a concern for medium specificity of the “sanctity” of analog film objects and have lobbied for them to be given the same conservation treatment

[35] Paul C. Spehr, “The Education of an Archivist: Keeping Movies at the Library of Congress,” *TMI* 13.1 (Spring 2013): 153.

[36]afforded to objects within museum and art historical contexts. This recognition has lead to a different regard for analog film objects, including acetate and especially nitrate, as possessing a certain fetishized quaintness and quality worthy of entombing in climate-controlled vaults. However, I also propose that a subtle, insidious undercutting and devaluing of analog materiality remains, even if masquerading under a new assumed name: "restoration." It may seem like "copy-and-destroy" methods ended in the 1960s with "restoration" and preservation now being the goal, but I argue that when new technologies are used to restore acetate holdings they are ultimately destroying them in a way quite similar to its nitrate predecessors.

As preservation practices have evolved and changed over time and across disciplinary contexts, so have their names. Conservation, preservation, reformatting, restoration — each are used sometimes distinctly and other times synonymously for the process of saving endangered film objects, contents, or both. However, there are vital distinctions between each. With this, a vital though critically overlooked distinction exists between preservation and conservation. Though these terms are often used interchangeably as if they meant the same, they have vastly divergent goals and methods. Conservation, as in wild life conservation and museological conservation, focuses on the care and maintenance of artifacts in their current form. Preservation, on the other hand, has come to entail the alteration of objects and materials in a way that privileges their content over form. In short, the content is extractable and the form is exchangeable; the content can be repackaged it into whatever form offers increased access, circulation, or whatever else can theoretically ensure in the content's future survival.

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[36] see, for example, Nick Wrigely, "Crimes Against the Grain," *Sight and Sound* 22.12 (December 2012): 72-3 and Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White." *Some Came Running: Enthusiasms and Expostulations* (12 March 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

Preservation, in this way, is not about maintenance or conservation, but about improvement and about making the object in question "better" in order to make it last. While perhaps offering longevity, preservation is not conservation and in fact actively undermines its attempts at maintaining an artifact's survival into the future. Archivists have largely been sensitive to the differences amongst these terms/acts, acknowledging that there is a fundamental difference between the type of object-orientated conservation practiced by fine arts museums, for example, and reformatting a old film content in order to make it available for commercial redistribution and public access. However, while these differences have been noted in the field, the subtle ways in which they actually continue to perpetuate the same "copy-and-destroy" mantra of the past — a mantra historically spearheaded by acetate and its replacement of nitrate along with other organically-based materials — has yet to be noted or questioned.

Contemporary restoration efforts, as seen in the controversial revamping, color-correction, and even re-editing of classics like Alfred Hitchcock's *Vertigo* (1958, USA), typically involve manipulating the film's visual elements of color, resolution, and overall aesthetic form to look "better" in the eye's of modern viewers. Within popular discourse and even within the language used by The Film Foundation — a nonprofit organization established in 1990 by Martin Scorsese to "protect and preserve motion picture history" through restoration projects — there is a blurring between the aims and motives preservation and restoration. Turner Entertainment president Roger Mayer has even defended his company's restoration interventions by claiming that colorization and other restorations aid in the physical preservation of motion pictures.[37] While this statement seems difficult to support, especially since digital formats are

[37] qtd. in Brian Real, "From Colorization to Orphans: The Evolution of American Public Policy on FIlm Preservation." *TMI* 13.1 (Spring 2013): 132.

even less stable due to obsolescence and interface incompatibilities leading them to not qualify as viable preservation mediums, it does reveal a slippage between restoration and preservation rhetoric.[38] Arguably, the real purpose of restorations are corporate profit since they are sold to new audiences and revenue is generated from their reissued distribution. However, restorations are ultimately pitched as in the best interests of "preserving" the film.

Acetate's efforts to "preserve" nitrate and other materials were similarly pitched as transformative interventions that were praised for improving and enhancing, just like digital restoration efforts today. Wrapped up with a term and process like restoration is the connotation that the original material is obsolete, no longer profitable, or has fallen into ruin and needs to be saved by modern interventions. Reiterated again is the same rhetoric of time and age posing problems that need to be remedied by new materials or improved technologies. Restoration is, ultimately, another staging of the man-made fight against time and an attempt to control its effects upon material forms. While lip-service is paid to keeping true the essence of the film alive and reviving the original or intended look, restoration essentially "cleans-up" or "corrects" old films by artificially removing any signs of aging, decay, or projection wear. In this way, to restore really means to change. Fundamentally, "restoration" puts forth a rhetoric and value system that celebrates using new technologies to correct, fix, and master the unruly, messy, flawed materials that come before it. Nearly word-for-word, this is the same discourse first put forth with acetate plastics: that they would improve upon and transcend the limitations of natural materials and offer something better through technological intervention. Sharing a certain

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[38] To play devil's advocate for Mayer though, in some ways acetate films were never never meant to reach this state to disrepair, fading, and decay that some find themselves in today. Acetate's admit promise, in fact, was to resist such forces of nature. Restoring acetate, then, can also be seen as restoring it to its ideal promise, although these claims were never really anchored in the material itself but rather the public's desire and desperate demand for new technological methods to control and overcome to the problems of the natural world.

sensitivity to this idea, Paolo Cherchi Usai has begun to tease out distinctions between preservation, conservation, and restoration. He clarifies in *The Death of Cinema: History, Cultural Memory, and the Digital Dark* Age that *restoration* is a misnomer and should not be applied to film preservation, but instead should be thought of an act of simulation that attempts to recreate and mimic — or "emulate," as it is referred to in the archival parlance — the source material while providing an improved version.

In the name of improvement, however, essential elements generated from upon the film's material composition are characterized as issues that need to be corrected and are thus replaced and lost. Patina colors, scratches from the projector, sprocket whole punched into the acetate strip, are all characterized as flaws, imperfections, and material excesses akin to decay that should be removed rather than artifacts that should be valued and maintained like distress marks on an antique piece furniture or brushstrokes in a fine painting. Underwriting this perspective is the belief that the film strip is not an important or "unique" item worth saving. This echos Walter Benjamin's argument that film objects are merely reproductions and do not warrant the same type of conservation practices that offered in museum and fine art contexts that prioritize "original," singular objects as a rare, invaluable "artifacts."[39] Benjamin's theorization also established a belief that reproduction is a natural element to the filmic medium, which has been taken for granted in "preservation" practices that employ reproduction and the generation of copies as an appropriate treatment of the medium. However, I would argue that this is not only a misnomer (certain small gauge films, for example, can not be easily replicated because they do not produce a negative) but a crucial moment were preservation fails and actually can work to

[39] Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction" (1936) in *Illuminations* (New York: Schocken, 1969), 217-252.

destroy what makes film a unique artifact: the ways in which its material form becomes "damaged" and decays.

During projection, the acetate substrate picks up nicks, scratch, burn marks, spots of color fading, and other surface marks. Over time and numerous runs, these marks college to form a tactile, unique assemblage that are technically refereed to as "artifacts." Projection scratches are primarily left on the back side of the film, in the acetate substrate that forms the film's base and not the emulsion which holds the film's image on the front. So, these marks and artifacts are truly a feature of and imbricated with the acetate material.[40] Each set of artifacts are also unique and "original" to that particular strip, yet instead of being valued and conserved as precious artifacts, as this name should suggest, they are instead defined as negative side-effects, damages, and flaws that should be corrected in the name of film restoration.

An important difference does arise when talking about commercial versus non non-commercial film, though, that should also be noted. Commercial film objects, as well as a number of consumer products made from celluloid acetate plastics, were not meant to be unique "art" objects. In fact, they were promoted as being mass-reproduced items, which established an aura around them as not individually valuable for their uniqueness but rather their function or content. The presence of scratches, therefore, would be considered a technical flaw in a *commercial* film or a plastic kitchen item, rendering it "defective" because plastic should not scratch, or so it was promised. Within the context of commercial film production and restoration practices, these material features are subject to correction and expungement in order to "preserve" the ability to access and market the film content as clean, legible, pleasurable images

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[40] See Dennis Couzin, "Contact and Optical Printing Sharpness, Some Ultimate Comparisons," *Image Technology* (August 1988): 282–284.

for viewers and any marks, irregularities, or spots of surface wear, aging, and decay are unacceptable and certainly not worthy of keeping for their own sake. However, these same features are what make Materialist film possible and, ironically, give it their value.

Reviving film through digital restoration ends up killing these elements of the analog format. In an act of twisted plastic cosmetic surgery, digital remastering and retouching technologies have removed these visceral signs of age, wear, and unique materiality that like wrinkles, freckles, scars and fingerprints attest to unique, individual life lived by the acetate film strip. Not long ago, though, these same attempts to fix and improve were helmed by acetate technology and enthusiastically deployed to control, clean-up, and improve the messiness of organic decay of skin, or enhance the colors of wear-prone materials like painted wood. New technologies and material inventions like plastics fight against these unpleasant realities of the natural world under a form of hagiography, where technological engineered intervention become liberating saviors rather than threats posed to the natural world even though they later found to be even less stable and trustworthy than their predecessors. At the core here and threading throughout the arguments and examples presented in this dissertation is an ideological difficultly and refusal to accept or respect organic aging, decomposing, and loss. Acetate began at the other side of these practices and this rhetoric, and though its position has now changed, the overall message has remain unchanged: a persistent belief that scientific progress and new technologies are always better than whatever came before, and that new technology will set us free from the limits of the natural world and organic forms of existence. In these ways, today's digital restoration is intrinsically, fundamentally, the same as yesterday's acetate preservation.

I contend that this prevailing network of ideologies are colloquially subsumed under the shorthand umbrella of "preservation" and are repeating the type of saving principles and techniques launched with acetate plastics. Carolyn Frick has contented that nineteenth and twentieth century Western conservation efforts were orientated towards retaining material compositions and original forms. This is typically thought of as the type of conservation practiced within art historical museum contexts, where the cultural significance of art objects as artifacts is much more secure and accepted than it is for cinema. This would suggest that in the twentieth century and before new digital or "immaterial" technologies that a conservationist model was in place. However, my historical tracing of how acetate was marketed as a preservation tools shows a different model that proscribed a method of transmogrification and remediation, or "reformatting" and "restoration."

From its debut, acetate plastics promised to provide access, durability, and safer distribution potential than paper, glass, or nitrate-based film. Even though acetate has now become the object of preservation efforts rather than the method, we still find the same framework in place, especially in the film archive: acetate formats are now replaced by alternative digital formats that are seen as capable of emulating and enhancing previous materials and providing more access and distribution potentiality.[41] In these types of contemporary initiatives, analog formats like acetate microfilm or home movie reels have been replaced with digital ones which are seen by some as solutions to the material and access problems of analog

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[41] see David G. Horvath *The Acetate Negative Survey: Final Report* (Louisville: University of Louisville, 1987); James M. Reilly, *New Approaches to Safety Film Preservation* (Rochester, N.Y.: Image Permanence Institute, Rochester Institute of Technology, 1994); Jean-Louis Bigourdan, "From the Nitrate Experience to New Film Preservation Strategies" in *This Film is Dangerous: A Celebration of Nitrate Film,* Roger B. N Smither and Catherine A. Surowiec, Eds. (Bruxelles: Federation Internationale des Archives du Film (FIAF), 2002, 52-73); Emily Cohen, "Orphanista Manifesto: Orphan Films and the Politics of Reproduction,"*American Anthropologist* 106.4 (December 2004): 719-731; Thomas A. Bourke, "The Curse of Acetate; Or, a Base Conundrum Confronted," *Microfilm Review* 23.1 (15 October 2009): 15-17.

objects. This does not actually mean new technologies *do* provide better, more assured access; in fact, many archivist bemoan the use of new digital formats as "preservation" mediums because they are unstable and constantly changing with the introduction of newer versions, updates, and forced obsolescence. This phenomena, often referred to as "planned obsolescence," reveals a disjuncture between technology as it is *seen* — a tool for preservation and a hopeful future improvement — versus what it actual *provides* — ever-changing, unstable impermanence that is often "less good" than what came before it. Driven by economic and market motives, rather than reflecting the actual need for new upgrades or renovations to the materials in question, manufactures plan for their products to have short shelf-lives and to be replaced by re-bought newer, "improved" models. Planned obsolesce, at its core, functions in opposition to preservation, permanence, and notions of longevity even though these are the very promises made by new technologies. Operating under the same motivations and rhetoric, acetate materials and new digital technologies today continue to promote practices of planned or forced obsolesce, while attempting to pass them off as necessary, positive preservation interventions.

Some archivists, as noted by Carl Fleischhauer, are equally critical of restoration processes, and will not refer to such digital interventions by the term "preservation."[42] Charlotte Crofts notes in her article "Digital Decay," that "the shift to digital acquisition in the face of the instability, rapid development, and built-in obsolescence of the various digital formats is worrying for the world of film preservation. Whilst digital is being heralded as a potential 'savior,' crucial issues in terms of format standardization, longevity, and back compatibility are

[42] Carl Fleischhauer, "Looking at Preservation from the Digital Library Perspective," *The Moving Image* 3.2 (Fall 2003): 96-100.

being overlooked."[43] Despite this skepticism, there is still a separate, oppositional line of discourse that places more value on content and making this assessable to future generations through new digital forms and the distribution of multiple digitalized copies as the goal of "preservation" despite these forms not being reliably preservable themselves.

Overall, the debate within film archives has focused on critiquing contemporary restoration efforts as not fulfilling the role/duty of preservation. Building upon the ground work begun by film archivist and theories concerned with how preservation functions today, I expand the temporal and locational scope of their work by looking further back in history and outside of the film medium. I also argue that "preservation" never offered the type of safekeeping that we have come to take for granted. While it is true that restoration (or reformatting, or digital emulation) is not preservation, neither is "preservation" as it has historically been historically shaped by and carried out with acetate plastics. This dissertation returns to the beginnings of acetate plastics and their masquerade as preservation materials to show how their use to copy, emulate, enhance, and replace organic matters lead to a perversion of conservation. The goal, then is to demystify preservation; to show that it was never in fact "preservation" but always something all together different.

Theoretical interests in preservation extend beyond the institutional setting of the archive, and over the last decade has become a significant topic within media studies, cultural histories of technology, and material studies. The same issues surrounding reformatting, as discussed above, have influenced Jay David Bolter and Richard Grusin theorization of what they term "remediation" within media studies and the historical transference of old media technologies into

[43] Charlotte Crofts, "Digital Decay," *The Moving Image* 8.2 (Fall 2008): xiii-35.

new forms. From its Latin roots, remediation means to heal or restore to health; similarly, its English denotative meaning is to remedy or fix a basic, core problem. Building upon these definitions is a closely related third meaning, drawn from remediation's recent use as an education euphemism: the act of bringing deficient or sub-par students up to an expected or acceptable level of performance. Remediation is thus typically conceived of as a rehabilitative, corrective process that intervenes in a negative or flawed situation to bring positive improvement and advancement. However, Bolter and Grusin have also suggested that media "remediation" is more about replacement than rehabilitation. As they argue in *Remediation: Understanding New Media*, older media are replaced with what is believed to be a newer and therefor better.[44] This process depends much more upon the time period's circumstances, needs, beliefs and assumptions, however, than the actual virtues of either the old or new medium. All of these perspectives and definitions of remediation come into focus with the acetate interventions interrogated in this dissertation. A common theme found running throughout each is that acetate was marketed a superior agent that would improve and "fix" the deficiencies of inferior materials/products that came before it; whether this was glass, wood, nitrate, or even flesh and bones, in comparison to acetate plastic they were characterized as fragile, fleeting, and vulnerable to the ravages of time, war, and loss.

Even though Bolter and Grusin use the term "remediation" and archivists use the term "restoration" to refer to media technologies, I extend the scope of these terms to encompass the far-reaching, trans-disciplinary work done with acetate to transform, reshape, and ultimately replace existent, "lesser" materials with newer, "better" plastic products. I also introduce a

[44] Jay David Bolter and Richard Grusin, *Remediation: Understanding New Media* (Cambridge: MIT Press, 1999).

different historical anchor: most contemporary discussions of preservation tend to focus on new technologies and, increasingly, digital technologies. However, I focus on how an old and now outmoded technology actually set the course followed by these new technologies. Similar to Charles R. Acland and many of the contributors in *Residual Media*, I make an argument for the residual afterlife and influence of acetate and its lingering legacy of preservation.[45] The materials, formats, and technologies may have changed, but the discourses and the pillars of "preservation" have remained the same.

Overview of Chapters

In the chapters that follow, I present a collection of case studies that extend beyond the traditional borders of cinema and media studies to consider unusual manifestations and uses of celluloid acetate. I draw from across the history of scientific imaging, consumer culture, and educational practices to piece together a new historiography of acetate plastics and their larger discourses of preservation. While attention is also paid to examples from non-theatrical film in the case of educational science film and home photo-cinematic imaging, the objects analyzed hail from the taxidermic sciences, bioengineering, medicine imaging, and wartime defense devices. Stitching all of these case studies together is their common material denominator (acetate plastic), and their purpose of use (preservation and/or safety measures). Each chapter focuses on two or three closely associated uses of acetate that share a thematic relationship. For example, Chapter 1 interrogates how acetate was used within taxidermy and medical casting to manipulate time and movement, make fleeting colors permanent, and perfect material shortcomings. While concentrating on the primary periodization of the 1920s-1950s, bracketed

[45] *Residual Media,* Charles R. Acland, Ed. (Minneapolis: University Of Minnesota Press, 2007).

by acetate's height of popularity and usage, each chapter fluidly transverses decades to account for the larger cultural tapestry acetate was a part of and the social discourses surrounding it.[46]

Chapter 1 discusses acetate's curious use within the biomedical sciences to create artificial armatures — taxidermic skins, prosthetic limbs, corrective braces, internal organs — all of which replaced organic biomatter with what were then deemed to be better acetate-based alternatives. These case studies all point to the formation of a cultural embrace of artificiality and synthetic materials; a climate that, as Alden P. Armagnac's described in his 1936 article for *Popular Science,* saw the re-fabrication and replacement of organic materials with technologically engineered substitutes as positive.[47] In this chapter, I reveal how issues of natural scarcity and the destruction of organic bodies by new technologies (especially during the first World War) fed into to this move towards clean, controllable "inorganic-ness" and artificiality as preferable forms of existence and survival. Color is also introduced in this chapter as an ephemeral, problematic element associated with notions of "life" and progress, one that finds itself at the center of many preservation initiatives, controversies, and debates today. In the pursuit of fixing or making color last, much is lost: taxidermists replace and discard fading organic flesh to make their mounts look "alive"; histologists kill cell bodies with colorful dyes and fixatives in order to make them visible; and contemporary film "restorers" artificially inject color into old films in the name of revitalizing (rather than adulterating) them.

Chapter 2 interrogates how X-ray and histology used acetate films and slides to visually reveal the foundations of life through fixed, unmoving images of internal phenomena. X-ray

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[46] Though acetate would not completely fall out of usage by the end of the 1950s, polyester did emerge in the 1960s as the latest, improved flexible plastic material; unlike acetate, and nitrate before it, polyester was not made from celluloid.

[47] Alden P. Armagnac, "New Feats of Chemical Wizards Remake The World We Live In," *Popular Science* 129.1 (July 1936): 9.

utilized acetate's properties of transparency to penetrate skin surfaces and peer inside living bodies to uncover their internal foundations and represent them black-and-white, static images. Histology also capitalized on acetate's visual properties to create unbreakable, color-rich slides made out of cellular cultures embedded within layers of protective, clear plastic. These imaging methods led to important epistemological and ocularcentric shifts within the medical sciences, especially concerning how laboratories could use the latest in imaging technology to produce previously inaccessible images of internal life. Through a mapping of these medical imaging practices and their overarching privileging of visuality and interior contents, I argue that this set the course for what have become recent trends in film restoration today: namely, using digital tools (instead of acetate ones) to peel off the plastic "skin" layers of old film bodies to extract and reformat what is considered to be the more valuable and essential core treasure — the image content.

Chapter 3 turns to the medical imaging technique of microcinematography — or, the process of shooting motion pictures through a microscope — and how scientists as well as film production companies used this technique in conjunction with acetate safety film to publicly circulate moving pictures of literally circulating cell bodies. Unlike X-ray or histology which understood life through static images, microcinematography focused on living cells and moving processes, with a large focus on the spectacular movements of the blood stream. Importantly, acetate safety film brought these new perspectives on the essence of life to visual life through motion picture projection, as well as brought them to the public's attention through mass-distribution. The argument here is that the safe, non-flammable projection and distribution properties of acetate film allowed for these images of circulation to circulate throughout the public sphere and provide lay viewers with unprecedented access to these types of images. Scholars including Jonathan Crary, Lisa Cartwright, and Hannah Landecker have laid important groundwork for this chapter with their theorizations of cinema vis-à-vis historical and technological developments in the sciences.[48] While adopting a similar perspective, this chapter pushes these connections further to show how acetate fostered early fascinations with "streaming" on a visual and thematic level as well as introduced new methods in distributions that carry on into contemporary interests in public access, circulation, and streaming content as a method of "preservation." Acetate plastics not only played a significant historical role in allowing medical images to safely circulate within the public sphere, but in doing so they ultimately emphasized distribution and access as prized, important elements in the promotion and preservation of knowledge — elements that continue to influence how preservation is thought of and carried out into the twenty-first century.

Chapter 4 turns to the most-well known manifestation of acetate plastics within media contexts — microfilm, domestic photography, and home movie recordings — but places them into conversation with lesser-known applications — bomb shelters, gas masks, and time capsules. The argument teased out from this juxtaposition is that these applications promoted the use of acetate products through a shared discourse of keeping the children safe and future assured. During the Great Depression, throughout World War II, and into the Cold War, home safety and ensuring future survival became primary concerns for the National Government,

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[48] Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century* (Cambridge: MIT Press, 1992); Lisa Cartwright, *Screening the Body: Tracing Medicine's Visual Culture.* Minneapolis: University of Minnesota Press, 1995; Hannah Landecker, "Microcinematography and the History of Science and Film." *Isis* 97.0 (March 2006): 121-132; —, "Cellular Features: Microcinematography and Film Theory." *Critical Inquiry* 31.4 (Summer 2005): 903-37; —, "Seeing Things: From Microcinematography to Live Cell Imaging." *Nature Methods* 6.10 (October 2009): 707-09; —, "Creeping, Drinking, Dying: The Cinematic Portal and the Microscopic World of the Twentieth-Century Cell." *Science in Context* 24.3 (2011): 381-416; —, "The Life of Movement: From Microcinematography to Live-Cell Imaging." *Journal of Visual Culture* 11.3 (2012): 378-399.

which stepped in with social reform acts as well as safety directives for American families. Acetate materials were featured in the later, which included orders for how families should institute protective safety measures in their homes including the construction of acetate-fortified backyard bomb shelters and having gas masks for every member of the family. In all of these efforts, certain narratives were put into place that continue to drive the preservation efforts carried out by Nationally supported institutions: namely, that it is a moral and civic imperative to protect both “The Child” and “The Future” which were often personified in the form of the endangered children — a script that not only carried great significance during World War II, but also within contemporary efforts to save “orphan” films and cinematic heritage. In short, “preservation” was established as a necessary act vital to the future existence of civilization. This rhetoric would be adopted and mapped onto cinematic “heritage” and our culture’s film patrimony as the objects of twenty-first century preservation fever.

By way of conclusion, a brief “Coda” follows Chapter 4. Though most histories of acetate declare its death with the emergence of the Vinegar Syndrome, the story does not simply end there. Rather, like the musical coda, acetate has expended past this dead-end failure to find new life as a brilliant spectacle of decay. A new wave of twenty-first century Materialist filmmakers, including Luther Price, celebrate the Vinegar Syndrome symptoms and acetate’s blistering, fever sores as an aesthetic with artistic merit. Rather than publicizing acetate as a paragon of preservation, it is now publicly portrayed in these artworks as a visceral display fitting of the recently popularized “ruin porn” fetishization of decay.

Additionally, this Coda section offers a foretelling of what might continue to develop into significant cultural shifts as we creep into the second quarter of the twenty-first century. First, a certain embracing of decay as a feature to celebrate rather than a defect to fix. In the case of materialists filmmakers, acetate's decay is what makes their work possible and unique and I argue that it is through this type of spectacular decay, which is unique unto acetate plastic, becomes a new standard by which to measure and maintain material specificity. Second, there seems to be a revaluing of permanence and preservation, and even a reverse desire for impermanence present within the work of contemporary Materialist filmmakers as well as social media culture, at larger. New media programs and platforms such as "SnapChat" are, in fact, growing in popularity because they offer *impermanence*. Photos and information posted on these sights are systematically erased (though, one can still take lasting photographs or screenshots to save them). The promise of platforms like SnapChat is that users do not have to worry about their more sensitive content having too much of an after-life beyond their control or intended short-term purpose. Perhaps we are witnessing a slow segue into a post-preservation moment that, on the one hand celebrates the hipster who wears eco-conscious vintage, fetishizes outmoded things, and ironically repurposes old rubbish, while one the other hand seems to prefer that some things (mostly image/information content) be ephemeral, transient, and not permanent. The same sentiment can be traced through consumer culture, as well, where plastics have now become a problem. Plastic bags, for example, are demonized today because they last too long and do not decompose quickly enough or decay in a safe, eco-friendly way. Permanence, I would argue, has become a pariah if not a problem in many aspects of our current culture milieu and consumer society. Perhaps the preservation fever has cooled, giving way to an icy desire for disposability and a new age of impermanence.

CHAPTER 1

Too Tough a Morsel for Time to Swallow: Taxidermy Skins and Medical Appendages

On August 15, 1930, an orphaned infant gorilla arrived at Chicago's Lincoln Park Zoo from Cameroon, West Africa. Named "Bushman," he quickly became a staple attraction at the Zoo, drawing the loving adoration of his Chicago neighbors as well as the national and international community. *Time* magazine would even dub him "[t]he best known and most popular civic figure in Chicago," earning Bushman his fame was a temperamental, diva persona.[1] When not lounging in his cage or eating grapes off the vine, he hurled food and excrement at photographers with a deadeye accuracy that led some to suggest he pitch for the Cubs or White Sox. After attracting millions of visitors during his twenty years at Lincoln Park, Bushman died of a heart attack on New Year's morning, January 1, 1951. Mourners flooded the Zoo to hold vigil at Bushman's vacant cage while his remains were sent to the Chicago Field Museum of Natural History for taxidermic preservation. As recounted in the Field Museum's annual bulletin, preeminent taxidermist Leon L. Walters and sculptor Frank C. Wonder were called upon to "immortalize" the infamous icon in a "lifelike restoration."[2] Walters' groundbreaking preservation technique, first developed for reptile taxidermy and now perfected for use on mammals, promised to bring about Bushman's rebirth through acetate replication. "No technique other than Walters' own cellulose acetate," the bulletin proclaims, "could have made the hairless face, with its translucent fleshy skin, so lifelike; the gorilla's arresting expression of repose and

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[1] "The Jovial Gorilla," *Time* (26 June 1950): 19-20.

[2] David M. Walsten, "The Legacy of Carl Akeley," *Field Museum of Natural History Bulletin* 57.1 (January 1986): 15.

almost arrogant indifference to his multitude of viewers has been brilliantly captured."[3] Though Bushman was adored in life for his lively, one-of-a-kind personality, he would ultimately be immortalized and remembered in death as an acetate replica [Fig. 1.1].[4] His embalmed doppelgänger still remains on display at the Field Museum today, where it not only stands-in for the original Bushman, but represents a historical impetus to capture, preserve, and even replace ephemeral life with cellulose acetate.

[Fig. 1.1] Walsten, David M. "The Legacy of Carl Akeley." *Field Museum of Natural History Bulletin*. 57.1 (January 1986): 15.

Beginning in the 1920s, amidst the aftermath of World War I (1914-1918), and extending throughout the American Great Depression (1929 to late-1930s), World War II (1939-1945), and into the Cold War (1945-1991), science and the public at large increasingly turned their interests towards plastic technologies. Through new technologies and materials like plastics, the hope has been to gain control over the natural world and reshape it into a better future. Exemplifying Lewis Mumford's claim that all technological advancement is rooted in an "unwillingness to

[3] *ibid,* 15.

[4] Michael Arndt, "Bushman Still Looms Large in Memories of Chicagoans," *Chicago Tribune* [Chicago, IL] 2 January 1986, page A3.

accept the natural environment as a fixed and final condition of man's existence," plastic technologies have been fueled by a desire to transcend the limitations of nature including the depletion of natural resources, the cessation of life, and organic entropy through process of artificial reproduction and replacement.[5] Cellulose acetate plastics emerged as a new material phenomenon made possible by modern chemistry during the twentieth century. It was marketed as being be able to improve natural existence by providing an alternative form of life — "better living through chemistry," as it were, and as the infamous 1935 DuPont jingle would phrased it.[6] This form of "living," however, would be marked by artificiality, artifice, and a changing attitude towards nature; within the taxidermic sciences especially, a new form of "living" would be introduced that took nature elements out of natural life and replaced them with a dead, artificial stand-ins that were nevertheless praised as better because they could provide a longer lasting visual experience.

Throughout the 1920s-1980s, acetate plastics made a number of groundbreaking innovations possible, including revolutionary new techniques in artificial taxidermic replication, medical casting, and orthotic prosthetics. While hailing from different scientific disciplines, each of these early applications shared the overarching goal of "fixing" and improving life as it currently existed by mimicking and then usurping it with "superior" plastic formats. Each of these fields called upon the unique qualities of acetate to perfect what were deemed to be inherent failures of previously used materials, including the aging and decay of organic biomatter. Established here, with the first uses of acetate plastics and under an erected umbrella of "preservation," were foundational ideologies that not only directed how these materials were

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[5] Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Co, 1934), 52.

[6] DuPont's "Better Things for Better Living Through Chemistry" slogan ran from 1935 until 1982.

used at the time, but that have continued to influence the underlying logics of "preservation" within film and media contexts today. While this field is ripe with debates and opposing camps on the topic of how to best preserve failing or outmoded cinematic objects (which shall be addressed in the pages that follow), the central points of contention trace back to core beliefs galvanized through the early adoption of acetate plastics.[7] Within the contexts of taxidermic replication and medical appendage augmentation, as this chapter shall argue, acetate plastics were introduced as new ways to clean-up, fix, and correct the shortcoming of animal and human flesh. Included within the category of perceived "shortcomings" were natural process of aging, color fading, and surface decay as well as imposed damages such as broken or amputated limbs. This first category — natural aging and decay — became a battleground within taxidermy, fraught with ambivalent perspectives on nature, visuality, and representations of life. The same controversies struggled with here, in 1920s taxidermic practice, have continued in the film archives of today: namely, a tension between wanting to create lasting, preservable images and having this be fundamentally at odds with the natural processes and resultant visual appearances of material aging and decay. In order to achieve the former, early taxidermists as well as those who support digital media restoration efforts today, eschew the later; in both applications, the natural basis and associated look of things that decay (skin, grain, color fading, age spots) are removed and replaced with artificial "improvements," leading to cyborg-like post-organic animal and human bodies or re-fabricated digital stand-ins for analog film "bodies."

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[7] see, for example, Steven Puglia, "Overview: Analog vs. Digital for Preservation Reformatting," *Preservation Reformatting: Digital Technology vs. Analog Technology* (27 March 2003) Accessed 4 July 2015 < http://www.archives.gov/preservation/conferences/papers-2003/puglia.html>; Nick Wrigley, "Crimes Against the Grain," *Sight and Sound* 22.12 (December 2012): 72-3; and Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White," *Some Came Running: Enthusiasms and Expostulations* (12 March 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

It is important to clarify here how I use “natural” and “original” to describe acetate film objects and materials. While, of course, these have been artificially created through technological apparatus and a host of organic, semi- and fully-synthetic materials, the affects that time and decay have upon them are natural phenomena. I refer to these aspects of the medium as “natural” or “organic,” meaning that they arise from the interaction of acetate materiality and the effects of nature. While acetate plastics were initially used to mimic purely natural materials like precious stone and ivory, they soon came to replace them as preferable, technologically-engineered alternatives. As such, replacement become etched into the very meaning of acetate plastics, as well as the type of “preservative” acts committed with them. Acetate’s apparent durability, visual transparency, and reproducibility positioned it as a superior replacement for natural materials including skin surface and skeletal structures. Consequently, previous notions of biological “life” and the inherent value of original, organic materials were re-conceptualized; emphasis was shifted away from the natural world, and reinvested in the promises of new biotechnologies and artificial materials. In medical and scientific practices — including taxidermic preservation and orthotic medicine — this resulted in attempts to restore dead, injured, or disfigured subjects through plastic “skins,” corrective braces, and restorative prosthetics made out of acetate. While most commonly understood as a photo-cinematic material used within twentieth century analog film production, the medical sciences have also historically utilized acetate plastics products. Contributing, thus, to current histories of acetate as well as discourses of preservation within photo-cinematic contexts, this chapter reveals how the medical sciences used acetate materials to achieve “preservation” through re-engineering the natural wold; this ultimately solidified what has continued to be the prevailing logic today: that replication and replacement will provide safe, assured preservation.

This chapter will also reveal how an overarching cultural discourse emerged around such notions of replacing organic matter in order to "fix" (both in the sense of "to improve" as well as make "to make permanent") it. Within taxidermic and medical applications, acetate was championed for its abilities to manipulate ephemerality, mimic and improve biology, and ensure the successful longevity of modern civilization. Building upon Kathy Woodward's supposition that "[t]echnology serves fundamentally as a prosthesis of the human body, one that ultimately displaces the material body," this chapter argues that acetate plastics emerged as attractive prosthetic alternatives, presented by its manufactures and retailers as beneficial replacements for frail and failing substances, including bodily matter.[8] In her recent work on neoliberal politics within the life sciences, Melinda Cooper has also suggested that one of the goals of biomedical research is to reshape human life and transverse its organic frailties and limitations. Indeed, the early history of acetate plastics reveals this to be true within the medical and scientific contexts, and the continued treatment of acetate film objects within archival contexts is also informed by this base motivation. By beginning a larger interrogation of preservation logics, practices, and ideologies with the archaic bioscientific uses of acetate technology, this chapter provides a historical foundation and starting point for understanding contemporary desire to push beyond natural material limits and to use new technological innovations as a way to achieve an improved future existence.

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[8] Kathleen Woodward, "From Virtual Cyborgs to Biological Time Bombs: Technocriticism and the Material Body." *Culture on the Brink: Ideologies of Technology*, Gretchen Bender and Timothy Druckery, eds. (Seattle: Bay Press, 1994): 50.

This chapter also argues for an alternative historiography and understanding of celluloid acetate plastic — one that rescripts how it has been subsumed within larger histories of wayward media technology and made all but synonymous with decay, impermanence, and contemporary preservation practices within the film archive. Cultural historians of plastics, including Jeffrey L. Meikle, have claimed that while plastics were largely well-received before World War II, their reception shifted during the 1940-50s into a climate of mixed reception and into outright distain after the 1960s. However, acetate's integration within taxidermic, scientific, and medical practices reveals a more nuanced understanding of how acetate, as a particular type of plastic, emerged at a particular cultural moment with promises of safety and survival. Instead of instigating fear or rejection, acetate was embraced as a superior, saving innovation within taxidermy, medical casting, and prosthetic medicine. Most importantly, however, are the inchoate ideologies of "preservation" that were seeded with these early applications, including the belief that conservation of organic forms or retaining these materials was less imperative and successful than transforming them into "superior" new plastic forms which promised to last through time.

Taxidermic Skins:
To Preserve, Protect, Beautify

Taxidermy is at once a well-known and misunderstood practice. A cross between science and art form, it is generally thought of as the tanning, curing, and stuffing of chemically preserved skins. At its core, taxidermy is an exercise in resurrection: taxidermists strive to make the dead live again and forever, even if only in surface appearance. Essentially, taxidermists turn their specimen into frozen images which, like photographs, can be artificially preserved as surfaces through time. In this section, taxidermy and its integration of acetate plastics will thus be interrogated in relation to photography. Not only do taxidermy and photography intersect through shared desires to realistically render and permanently preserve images of arrested life, but they also intersect through similar utilizations of acetate as a way in which to achieve these desires.

The processes and techniques employed by taxidermists have evolved from basic tanning and stuffing to technology-driven methods. Various technological, scientific, and aesthetic innovations — including the use of acetate in the 1920s, fiberglass and polyester in the 1970s, and the contemporary use of polyurethane — have provided different means for achieving the same final goal: creating realistic "snapshots" of biological life preserved in statuesque poses of suspended animation. The introduction of plastic technologies revolutionized the taxidermic field; unlike past techniques, which continued to rely upon original bodily matter, plastic castings utilized alternative, artificial materials. These alternative plastics achieved a previously unobtainable level of realism and longevity. By 1925, a new era in taxidermy thus emerged where plastic technologies created "realer-than-real" replicas of animal mounts. Celluloid acetate, especially, was used to cast skins that retained their surface appearance longer than the original hides themselves. The desire for immortal representation through enduring materials thus seemed to be met by new plastic materials like acetate, which commercial producers labeled "too tough a morsel for time to swallow."[9]

Importantly, in the same decade Walters debuted his new taxidermic coverings, Du Pont, Pfizer, and several other chemical companies joined forced to form a "Paint & Varnish" consortium and instigated a widespread marketing campaign that called upon American consumers to "save the surface" of their goods and belongs by protecting them with applied

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[9] Robert Kennedy Duncan, "The Wonders of Cellulose," *Harper's Monthly Magazine* 113 (September 1906): 573.

vanishes and refinishing lacquers.[10] By doing so, the slogan ended promisingly, "you save all" and uphold the American imperatives and pillars of the nation: "to preserve, protect, beautify."[11] While some of these surface treatments were still organic in composition, synthetic products including acetate-infused sealants and plastic surfaces would increasing in popularity throughout the campaigns run from the 1920s into the 1940s. Fitting into this "save the surface" rhetoric, acetate plastics seemed ideal in that they were already easier to "save" and their material composition would last well into the future. Ironically, one early 1923 ad from the "Save the Surface" campaign even seemed to foretell Walters forthcoming attempts to save the surface of his specimen: in this ad, layers of protective materials were applied to the surface of a U.S. naval ship. The ship was named the "Leviathan," after the biblical sea monster, and its small-scale cousin, the gila monster, would be one of Walters first successful acetate skin creations.[12]

How Jealously They Are Preserved

Leon L. Walters, lead taxidermist and head of the Reptile Division at the Chicago Field Museum of Natural History, led the discipline's turn towards plastics through his "celluloid method" of casting and model-making. As Walters detailed in his influential treatise on taxidermic philosophy and practice, cellulose acetate emerged after the first World War as a promising material that could be used to construct realistic part-synthetic, part-organic skin replicas for reptiles and non-hairy specimen.[13] To make these replacement skins, Walters first

[10] see for example: Paint & Varnish, "Why the Circus Never Wears Out," advertisement (ca. 1924); "The Safety of Structures on Which Human Life Depends is Vital..." advertisement, *The Saturday Evening Post* (126): 187; Pfizer, "Save the Surface and You Save All" advertisement (10 April 1944).

[11] Paint & Varnish, "What Toil and Persistence Have Won, Let Paint and Varnish Preserve," advertisement. *The Saturday Evening Post* (3 Oct 1925): 104.

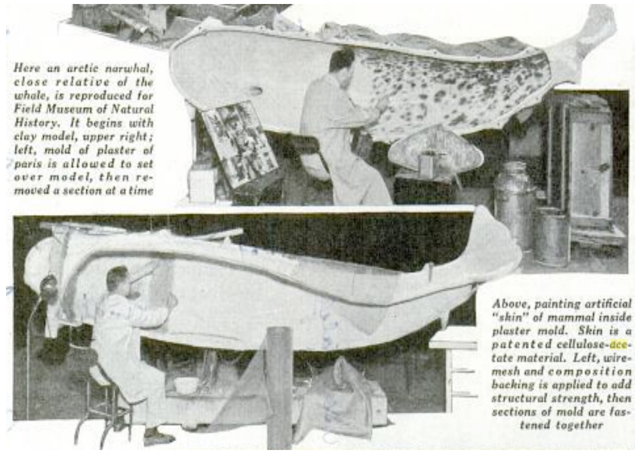
[12] —-, "Saving the Leviathan" advertisement, *The Saturday Evening Post* (1923): 138.

[13] see Leon L. Walters, *New Uses of Celluloid and Similar Material in Taxidermy* (Chicago: Field Museum of Natural History, 1925).

made a negative plastic mold of the dead specimen. Next, he would apply a series of liquid acetate players layers to the inside of a plaster model [Fig. 1.2]. Embedded within these layers were the transferred surface contours of the original skin, as well as an applied color pigments that could be carefully mixed and suspended between the thin, transparent layers. Acetate was uniquely effective in Walters' application thanks to its optical properties of transparency, its compositional stability, and its ability to invisibly mimic other visual appearance itself. Its success as a material dually hinged as on its ability to make embedded colors vibrant and visible, while remaining unobtrusive and invisible itself -- qualities that are reversed when acetate begins to decay.[14] As illustrated in a 1939 *Popular Mechanics* feature, these applied layers solidified into a sold film "skin" or pellicular surface not only matched and mimicked the original, but even surpassed in postmortem fidelity, vibrancy, and longevity. Walters' layers effectively mimicked skin through two forms of suspension: the acetate emulsion was able to support and permanently suspend color pigments, and the skins formed by these layers were able to realistically represent life and maintain an unchanging, suspended appearance of animated life.[15]

[14] Acetate becomes truly visible as a material, itself, through the visible symptoms associated with its failure and decomposition — a theme returned to in the Coda.

[15] Acetate also functions as a medium of "suspension" in its media applications: it is utilized for its ability to invisibly store, contain, and preserve other elements (whether it be color pigments, sound, or other information recording) and render them transparently accessible to users.



[Fig. 1.2] "Creatures Modeled to Appear Natural as Life." *Popular Mechanics* 71.2 (February 1939): 174.

While nitrate was first used in Walters' celluloid method, he replaced it in 1925 with acetate in order to decrease flammability and perfect the overall translucence and durability of the final model. Walters' celluloid models were visually and textually identical to the original specimen, yet were superior in their ability to stay fixed and free from natural signs of aging or decay. Unlike other synthetic or organic materials, and even chemically-treated hides, acetate replicas were perceived as better able to resist surface decomposition. Acetate, thus, appeared to fulfill one of the greatest goals of biotechnological intervention: the possibility of an invulnerable and immortal existence freed from the inevitable processes of aging, death, and decay. A faith in acetate was thus forged within the taxidermic sciences, which hung upon an overarching belief in the "newness" and "improving" potential of technology and plastics, in particular. Echoing larger ideologies and rhetorics surrounding new technologies — which offer lofty claims of superiority and endurance, even though such claims are inherently "too new" to be substantiated — acetate technology was positioned as the antithesis and antidote to aging bio-matter.

Acetate not only promised to improve the inadequacies of natural materials like skin, but also older taxidermic technologies and preservation methods. In the 1932 *Popular Science* article, "New Art Saves Strange Beasts," acetate was billed as a new taxidermic "art" capable of successfully fighting and even winning the "never-ending battle against the ravages of time and other agencies that would quickly destroy rare specimens and irreplaceable exhibits."[16] Traditional taxidermic techniques were no longer trusted to preserve life and keep time at bay. Instead, acetate was turned to as a hopeful intervener within the eternal fight against death and decay. Through acetate baths and sprayed-on lacquers, taxidermists hoped to accomplish the "near-miracle" of protecting old mounts and keeping them safe for decades.[17] As confessed by the article's writer, this state of assured safekeeping was not only desired but envied. "Looking at this finished [taxidermy] group," he wistfully wrote, "it is hard to realize how jealously it is preserved."[18] A later article, appearing in the October 1935 issue of *Popular Science*, reaffirmed acetate's praised status as a preservation agent capable of making organisms from the past last long into the future. "The skeletons of dinosaurs and other prehistoric monsters," the article notes, "are being coated with these [acetate] liquids (...) [which] have proved themselves best for protecting the remains of creatures representing life on earth hundreds of thousands of years ago."[19] Lurking within descriptions like these, as well as a number of other articles dedicated to

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[16] "New Art Saves Strange Beasts," *Popular Science* 120.1 (January 1932): 52-53.

[17] It should also be noted that Russian taxidermists significantly contributed to the science and practice of taxidermy, though not specifically through the use of acetate technology. Since the 1924 death of Soviet Leader, Valdimir Lenin, Russian taxidermists have managed to keep his embalmed corpse preserved and on public display thanks to yearly formaldehyde, methanol, and ethanol baths. While the components are different, the process is essentially similar to the acetate baths described in the 1932 *Popular Science* article, "New Art Saves Strange Beasts."

[18] *ibid* 52.

[19] John E. Lodge, "Chemistry Give Us Amazing New Substance for Art and Industry," *Popular Science* 127.4 (October 1935): 112.

this strange new preservation practice described acetate mediation as “monstrous.”[20] In a Frankenstein-like narrative, chemical science innovations were beginning to test and alter the boundaries of life — first on the level of appearances, but soon in applied bioengineering as well. Yet, the postmortem preservation and engineered livelihood offered by new acetate materials were still positioned within popular discourse as enviable conditions, and this privileging of the artificial and even “monstrous” would evolve over subsequent decades into the further replacement of human bio-matter with acetate medical apparatuses and prosthetic appendages.

Ironically, Walters’ desire to realistically preserve his specimens led him to replace their real skins with artificial replicas. While all organic bodies decompose and skin, especially, loses its supple, translucent sheen shortly after death, clear and durable acetate offered an alternative surface that realistically mimicked and indefinitely retained the colors and textures of life. Skin, the largest organ and most externally visible component of the body, was thus deemed inferior to acetate “skins” and was rendered disposable and replaceable in large part because it could be adequately mimicked by what was touted then as a more than adequate alternative material. In “Consumption, Duration, and History,” Arjun Appadurai claims that whenever processes of mimicry or imitation are happening, repetition is also likely at play.[21] To this list I would also add preservation — that preservation is also at play and was the end goal of mimicry and imitation. Such is indeed the case with taxidermic imitations: plastic materials were being used to replicate and replace biomatter, which was seen as a way to finally allow the visual appearance and “essence” of life to be retained over time and thus preserved. However, what proved to be the

[20] see “Model Monsters,” *Mechanix Illustrated* (Aug 1945): 67-71; 146.

[21] Arjun Appadurai, “Consumption, Duration and History,” *Stanford Literary Review* 10 (1-2, Spring-Fall 1993): 11-23.

case both here in Walter's early experimentation is that reproduction actually jeopardized the survival of the material *ante* by turning it into a redundant and thus disposable repetition. Acetate skins became the thing to keep and treasure in museum displays, while it was recommended that the vulnerable body and its impermanent skin should be thrown away. As stated rather prosaically in the 1936 edition of the *Field Museum News*, Walters' acetate replacements presented "an instance where synthetic goods [were] superior to genuine"; "whereas the skins deteriorate with age," these "reproductions may be expected to last for hundreds of years — probably long after the [species themselves] will have become extinct."[22] These grand hopes for a future freed from natural aging, death, and extinction were all predicated, however, on the widespread and ultimately erroneous belief that acetate (and new technologies, in general) are better and preferable to whatever preceded them.

Importantly, the type of mimicry and preservation offered through these material substitutions was not a complete one: rather, it was selective picking-and-choosing of what to render and save based on prevalent tastes and ideologies of aesthetics. Left out of both taxidermic and media reproductions are elements like wrinkles, spots, grain, and surface characteristics that come with age and that have been deemed problems fix rather than features to retain. In his critique of contemporary film restoration and preservation efforts, especially those featuring digital reformatting and replacement, Nick Wrigley contends in an article for *Sight and Sound* that:

> the natural appearance of filmed images - at the cinema and in the home - is often being detrimentally altered by digital processes (...) something gets left behind - and it's usually natural film grain. Perceived by those unfamiliar with viewing or handling film as something akin to 'noise' or even 'dirt,' film grain is considered by some to be the

[22] "Hippopotamus and Rhinoceros Placed in Akeley Hall," *Field Museum News* 7.8 (August 1936): 3.

> undesirable detritus of a dated technology, something to be 'improved' by digital tools. This often involves the significant reduction or outright removal of film grain, replacing it with something smoother, gauzier, more 'clean' (...) out of ignorance or some misguided attempt to make older films more relevant to the 'PlayStation generation'[23]

Missing from these sterilized reproductions as well as from equalize sterilized taxidermic replicas is the natural grain and hide -- the very elements that were once prized. Historically, it was the skin and hide of the animal that often netted the hunter their highest reward, and it was the introduction of suspended halide crystals within the film strip that allowed images (especially color images) to be captured in the first place. To recast the presence of these grains within the image as a flaw and something that should be removed is to remove the very essence, the bones and blood, of the analog cinematic image. And yet, this is what is frequently done in digital reformatting in an act akin to the way acetate skins were initially used to replace the foundational and once valuable matter of taxidermic specimen. Ironically, the tables have now turned and acetate is now the part being replaced in order to preserve a lasting image.

Operating under the same logic as Walter and likeminded taxidermists, proponents of digital media reformatting claim that analog materials and associated features like grain hinder preservation — which really translates into distribution and access, the primary goals and methods of "preservation" today. Film grain, as Wrigley also observes, would require a substantial, unsupportable amount of memory space to save in a digital format as well as bandwidth to distribute via electronic broadcast or internet streaming. Removing the grain, however, drastically decreases the amount of space needed to store and share the image, which has lead to stripping many analog films of their grain so that they are easier to saved and

[23] Nick Wrigley, "Crimes Against the Grain," 72-3.

accessed as digital clones.[24] Analog film objects are not being simply “thrown away” today, although “copy-and-destroy” was the lead method used to transfer the first nitrate film prints into safer acetate archival copies. However, perhaps an essential component of the film text is being discarded through a flawed process that is being implemented under guises of saving it by striking digital copies that can continue to “live” and be seen within public circulation, though as an incomplete, “neutered” and sanitized image, while the master original is relegated to long-term storage and film-based images become an extinct species. And as Wrigley aptly put it, “The fact that all things photochemical are experiencing their final death rattle is all the more reason to make sure we don’t forget what film is supposed to look like,” which includes its grain and textures, “flaws” or otherwise and all.[25]

Replacing the Real

Instead of causing dogmatic resistance, as might be expected, many in that taxidermic field praised acetate replacements for ushering in a “better than real” alternative version of reality. The general public also accepted and even embraced the fact that natural, organic materials were disposable. In fact, numerous articles in the popular press displayed an excited, enthusiastic response to acetate substitutions. In the May 1940 issue of *Popular Mechanics*, for example, Julia P. Leggett sung acetate’s praises and heralded it as part of a new “Era of Plastics” in which the average person would not even notice that bone, horn, semi-precious stones, wood, metal, and even one’s own teeth had been replaced by plastics. Acetate plastic, in particular, was presented as a miraculous material that was at once fantastical and practical: an improvement

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[24] In 2008, Warner Bros. realized a highly “cleaned-up” de-grained version of *Casablanca,* only to realize their hubris and re-release a new Blu-ray version in 2012 with healthy grain in tact. For more on this case and other crimes agains the grain, see *ibid.*

[25] *ibid.*

upon the natural world that could uncannily mimic existing materials, as well as create a new and better version of the natural world. Alden P. Armagnac's article, "New Feats of Chemical Wizards Remake the World We Live In," printed in a slightly earlier 1936 edition of *Popular Science*, encapsulated this positive attitude towards re-fabricating and even replacing natural products with technologically engineered substitutes. "[L]aboratory workers have gone the silkworm one better," Armagnac wrote, and their natural silk making abilities have been outdone by chemists who could now spin their own improved version of plastic silk.[26] Other engineered alternatives invaded nearly every corner of consumer culture and daily life: "your home, your clothing, your car, and the whole world about you," Armagnac concluded, "are benefiting from the wizardry of [the chemists'] touch," and their handiwork will ultimately make "the world a better place to live in."[27] Flanking Armagnac's article in this edition of *Popular Science* were two equally revealing and provocative advertisements [Fig. 1.3]. Even though these ads were specifically selling career development programs, they nonetheless echo an overarching cultural sentiment of wanting to control one's future and the natural world through extraordinary, even super-human means. The ad to the left of Armagnac's column optimistically promised that "You can! Control Your Fate." In contrast, a second ad to the right played upon the fear of not being able to control the inevitable march of time; its headline, "You Can't Hold Back the Hands of Time," was juxtaposed against a human figure struggling to hold back the oversized hands of a clock. Even though the figure's efforts seem hopeless, the ad's following text provided a hopeful solution: a forward-moving man of action could indeed fight back and retake his own destiny.

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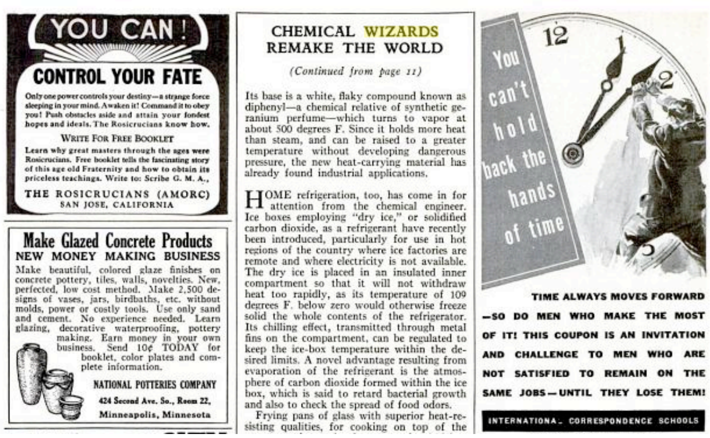
[26] Alden P. Armagnac, "New Feats of Chemical Wizards Remake The World We Live In," *Popular Science* 129.1 (July 1936): 9.

[27] *ibid.*

Through active intervention and embracing progress, this type of man could improve and reshape his life. Playing upon the same ethos of Armagnac's article, as well as emerging trends in bioscientific intervention and taxidermic preservation, these ads underscored overarching preoccupations with controlling the laws of nature and overcoming the effects of time. An advertisement run by the research and development division of Shell further revealed this positive attitude towards altering the natural world through artificial products and technologies. Printed in the March 8, 1943 edition of *Life* magazine, the ad admitted that even though the reality of "the future" and its promises of a better tomorrow may seem overly fatuous, "in America we do have rich, shimmering fabrics of cellulose acetate — with qualities beyond those which ever came from a silkworm." As popular articles and advertisement campaigns like these illustrate encapsulate, acetate was championed as a desirable alternative for organic life; this sentiment reverberated throughout popular culture and public discourse, and echoed a larger cultural desire to control, advance, and reshape the world through technological manipulation.


YOU CAN!
CONTROL YOUR FATE
Only one power controls your destiny—a strange force sleeping in your mind. Awaken it! Command it to obey you! Push obstacles aside and attain your fondest hopes and ideals. The Rosicrucians know how.
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Learn why great masters through the ages were Rosicrucians. Free booklet tells the fascinating story of this age old Fraternity and how to obtain its priceless teachings. Write to: Scribe G. M. A.,
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Make beautiful, colored glaze finishes on concrete pottery, tiles, walls, novelties. New, perfected, low cost method. Make 2,500 designs of vases, jars, birdbaths, etc. without molds, power or costly tools. Use only sand and cement. No experience needed. Learn glazing, decorative waterproofing, pottery making. Earn money in your own business. Send 10¢ TODAY for booklet, color plates and complete information.
NATIONAL POTTERIES COMPANY
424 Second Ave. So., Room 22,
Minneapolis, Minnesota

CHEMICAL WIZARDS REMAKE THE WORLD
(Continued from page 11)

Its base is a white, flaky compound known as diphenyl—a chemical relative of synthetic geranium perfume—which turns to vapor at about 500 degrees F. Since it holds more heat than steam, and can be raised to a greater temperature without developing dangerous pressure, the new heat-carrying material has already found industrial applications.

HOME refrigeration, too, has come in for attention from the chemical engineer. Ice boxes employing "dry ice," or solidified carbon dioxide, as a refrigerant have recently been introduced, particularly for use in hot regions of the country where ice factories are remote and where electricity is not available. The dry ice is placed in an insulated inner compartment so that it will not withdraw heat too rapidly, as its temperature of 109 degrees F. below zero would otherwise freeze solid the whole contents of the refrigerator. Its chilling effect, transmitted through metal fins on the compartment, can be regulated to keep the ice-box temperature within the desired limits. A novel advantage resulting from evaporation of the refrigerant is the atmosphere of carbon dioxide formed within the ice box, which is said to retard bacterial growth and also to check the spread of food odors.

Frying pans of glass with superior heat-resisting qualities, for cooking on top of the

You can't hold back the hands of time

TIME ALWAYS MOVES FORWARD —SO DO MEN WHO MAKE THE MOST OF IT! THIS COUPON IS AN INVITATION AND CHALLENGE TO MEN WHO ARE NOT SATISFIED TO REMAIN ON THE SAME JOBS—UNTIL THEY LOSE THEM!
INTERNATIONAL CORRESPONDENCE SCHOOLS

[Fig. 1.3] *Popular Science* 129.1 (July 1936): 109.

Rather than leveling the obvious criticism against technological manipulations of nature and replacing of earlier material forms of existence, there is another way in which to read these interventions as both historical practical within the early twentieth century wildlife conservation as well as the current state of film conservation initiatives. As argued in the preceding section, the idea of replacing anything that seems different to save with a "new technological" alternative seems to betray the very goal of keeping, maintaining, and saving the first object. Preserving an animal's likeness in the form of a lifelike taxidermic replica, in other words, is not the same as actually preserving the life of the animal, nor is preserving film content in the form of new formats and packets the same as actually ensuring the survival of the film object. This said, when plastic taxidermic casting is read within the historical context of the early 1920s and against larger cultural concerns over endangered natural resources and calls, perhaps the best way in which to conserve and to protect is to use reproductions and replicas instead. Why kill two elephants for taxidermic mounting when you can kill one, make a cast from it, and reproduce as many plastic replicas from it as you could conceivably want? The same could, perhaps also be said within film conservation contexts. While duplicating an reel of decaying 16mm acetate film onto a digital drive is not preserving the film reel, it can perhaps provide a form of conservation in that the digital replica can now bear the brunt of use and public display (things which damage and hasten its death) while the "original" can be stored away. Of course, this recuperative conservation hinges on the saving of the reel after it has been duplicated, which historical has neither been then the case in history of film preservation (particular the "copy-and-destroy" methodology used with nitrate) nor in the first uses of acetate plastics within taxidermic museum displays to replicate animal flesh.

As Good As Real and Even Better

The cellulose family of plastics were originally invented at the turn of the twentieth century by John Wesley Hyatt in America and Alexander Parks in England as a way to imitate natural materials. Hyatt especially envisioned nitrate as the solution to America's ivory shortage, and as a way to control diminishing natural supply levels. In the U.S. and Europe, high-end grooming products — such as combs, brushes, and hairpins — were fashioned out of rare animal materials like ivory. In theory and application, these devices became symbols of mastery and control: their refined production signified human mastery over the animal bodies that supplied the raw materials, and their use in personal grooming signified a civilized control over the human body. As Herbert Marcuse and Jürgen Habermas have respectively theorized, one of the ideological pillars undergirding all technological devices is that they are used to dominate the natural world and construct a civilized version of human existence.[28] This same foundational desire to control the natural world fueled the development of celluloid plastics and underwrote their initial use to mimic naturally-occurring animal materials. What began as imitation, however, would escalate into total replacement as plastics proved to not only be "as good as" natural materials, but were deemed "even better" in terms of durability and cheap reproducibility. By 1910, cellulose acetate products not only successfully mimicked expensive, natural materials — including tortoiseshell, leather, ivory, amber, and silk — they began to supplant them. Eighty years later, new digital technologies would emerge to continue the same promise: essentially that they could provide a preservative function by being able to emulate older media formats and provide replicated stand-ins for them. The same discourse established with acetate — that

[28] see Herbert Marcuse's *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society* (1964), and Jürgen Habermas' chapter, "Technology and Science as 'Ideology,' in *Towards a Rational Society: Student Protest, Science, and Politics* (1968).

rarifying things could be saved through emulating and replacing them with new technologies — lives on today in a reincarnated digital form.

Acetate replicas and substitutions were similarly, and rather ironically, presented as ways to control the extinction of endangered species. Essentially, they were equated with other conservation efforts that sought to protect fragile species and save them from forgotten oblivion.[29] A cultural openness towards alternative materials as well as an understanding that natural supplies needed to be artificially supplemented were initially primed by the American Conservation Movement at the turn-of-the-century. Even before later wartime shortages and cutbacks intensified the need for material replacements, the Conservation Movement (initially spearheaded by Theodore Roosevelt and later continued through the Great Depression by Franklin D. Roosevelt) brought public awareness to the growing scarcity of natural resources and necessity for alternative interventions. Ironically, one of the ways in which to conserve natural resources and wildlife was through increasingly artificial means and mediations — which began with the introduction of semi-synthetic alternatives like acetate, evolved into fully-synthetic materials like polyester, and has "ended" in contemporary alternatives like digital technology and "non-material" virtual reality.

In his essay on Theodore Roosevelt and the Conservation Movement, Finis Dunaway argued that photographic technology (which was celluloid-based roll film during this period) was positioned as an alternative to game hunting and as a way to preserve dwindling wildlife populations. Photography was, in short, presented as a means to ensure the continuation of the natural world, which was threatened by increases in modernization and urban expansion during

[29] In an ironic turn, by the end of the twentieth century plastics were differently scrutinized as a source of environmental destruction and pollution rather seen as a conservation solution.

the early 1900s. Anxieties over the death of nature and complete ruin of the natural world at the hands of hunters formed the base of the Conservation Movement. These anxieties were intensified by increases in modernization and the fears generated by World War I: that modern, industrialized warfare would succeed in destroying life and natural existence. In response to these fears, preservation-orientated uses of acetate technology, including Walters' taxidermic replication method, followed in the aftermath of WWI. Encapsulating the tenor of this historical moment, Carl Akeley, a pioneer in early taxidermy as well as field cinematography, wrote that "[t]here is just one relieving circumstance in this doleful perspective: what man seems bent upon destroying with his gun can at least be rescued from complete oblivion and given the illusion of reality through the camera."[30]

Photography and/as Taxidermy

On July 30th, 1928, George Eastman staged a lavish garden party at his estate in Rochester, NY, to introduce his Kodak company's latest innovation in amateur film technology: Kodacolor motion picture stock. Eastman heralded Kodacolor as the first color process capable of reproducing 16mm acetate movies in living color and handed Cine-Kodak cameras loaded with Kodacolor to his party guests. Also curiously circulating hand-in-hand was a taxidermic gazelle head. As many biographies note, Eastman was an avid game hunter, as were a number of his close friends including motion picture camera inventor, Carl Akeley, who shot and skinned game (both with guns and cameras) with Eastman in Africa. While this taxidermic gazelle may

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[30] Mark Alvey, "The Cinema as Taxidermy: Carl Akeley and the Preservation Obsession," *Framework: The Journal of Cinema and Media* 48.1 (Spring 2007). 285.

seem an odd party favor at first, it actually confesses Eastman's own affiliation with both film and taxidermy as well as their own material intersections.[31]

Within the context of game hunting, rifles were eventually traded in for cameras, and hunters began "shooting" their prey on acetate film stocks rather than with metal bullets. In this regard, photography functioned as a technological alternative, like taxidermic reproduction, that could conserve and protect endangered life. Taxidermy and snapshot photography are thus joined in their theoretical underpinnings and desires for lasting permanence, as well as fundamentally conjoined on a technological, chemical level. When influential media theorist André Bazin claimed that, "Photography does not create eternity (...) it embalms time, rescuing it simply from its proper corruption" he was speaking quite literally, even if unknowing.[32]

The invention of instantaneous, snapshot photography at the turn-of-the-century depended upon the invention of celluloid roll film and the same compounds Walters later used in his taxidermic casting methods. Developed by George Eastman (who was, in fact, also an avid hunter and friend of Carl Akeley) and his Kodak company, celluloid roll film replaced fragile paper prints (and glass plates before them) with a flexible, transparent plastic base.[33] While roll film initially utilized nitrate as its celluloid base, acetate replaced it as a stronger, more transparent alternative by the early 1920s — the same decade Walters' switched to acetate in his

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[31] Other photography and cinema scholars have also theorized connections between taxidermy and photo-cinematic imaging, including: Fatimah Tobin Rony, *The Third Eye: Race, Cinema, and Ethnographic Spectacle.* Durham: Duke University Press, 1996 and Finis Dunaway, "Hunting with the Camera: Nature Photography, Manliness, and Modern Memory," *Journal of American Studies* 34.2 (August 2000): 207-30. However, the material intersections between these practices have yet to be considered.

[32] see André Bazin, "The Ontology of the Photographic Image," *Film Quarterly* 13.4 (Summer, 1960): 8.

[33] see Brian Coe and Paul Gates, *The Snapshot Photograph: The Rise of Popular Photography, 1888-1939.* London: Ash & Grant, 1977; Colin Ford and Karl Steinorth, *You Press the Button We Do the Rest: The Birth of Snapshot Photography.* London: Nishen in association with the National Museum of Photography Film and Television, 1988; Kenneth P. Czech, *Snapshot: America Discovers the Camera.* Minneapolis: Lerner Publications, 1996.

taxidermic practice. Cellulose technology and acetate, especially, influentially advanced both the photographic and taxidermic fields; it enabled photographers and taxidermists alike to snatch figures from the flows of time and permanently render them as lasting, immobilized images.

In his writing, Walters confessed a full awareness of acetate's use within field photography as well as within the motion picture industry. He knew acetate was being used within these disciplines to capture and render lasting images of life.[34] Similarly, Walters turned to acetate in his development of an improved process to render lasting taxidermic representations. The requirements for photographic film were essentially the same as the requirements for taxidermic skins (as well as for medical casts and prosthetic surfaces). As J.M. Calhoun described in his article, "Technology of New Film Bases," photographic film had to be "transparent, free from haze and optical defect, chemically stable and photographically inert, moisture resistant, strong, tough, stiff yet flexible, dimensionally stable, high melting, and slow burning."[35] Acetate emerged as a promising support material capable of fulfilling each of these requirements; consequently, it was adapted as a base material within photographic image-making as well as taxidermic image-making. Further establishing a parallel between photographic technology and taxidermy, a 1939 *Popular Mechanics* feature on Walters described his new taxidermic method as rooted in the same material as photographic film.[36] "Strange synthetic creatures," the article details, now have "skins of cellulose acetate — the material of which photographic film is made."[37] Once again, acetate technology was publicly presented as strange

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[34] In *New Uses of Celluloid and Similar Material in Taxidermy*, Walter's acknowledges acetate's current use as an non-inflammable motion picture stock — "in which it has the greatest field of use" (18).

[35] J.M. Calhoun, "Technology of New Film Bases," *Perspective* 2.3 (1960): 250-256.

[36] "Creatures Modeled to Appear Natural as Life," *Popular Mechanics* 71.2 (February 1939): 174.

[37] *ibid.*

and fantastical, while also prosaic and as familiar as photographic technology, which by the late 1930s was domestically commonplace. A connection was thus confirmed between taxidermic skins and photographs, and the two fields were united through public presentations of acetate that explained its new usage within taxidermy through the language of photography.

Like taxidermy, photography also sought to capture and preserve life as still images and fixed surfaces. As cultural studies scholar Richard Dyer has noted in his discussion of photography and light technology, the photographic arts are driven by a desire to render colorful reproductions of life through a film-based medium that is inherently transparent.[38] The advent of color photography introduced a particular preoccupation with reproducing "pleasing flesh tones" in photographs. It was soon discovered, however, that in order to obtain such pleasing flesh tones and reproduce the appearance of natural skin, artificial means and materials (including elaborate lighting, lenses, and filters) had to be used. Similar difficulties also emerged in taxidermic practices and artificial manipulations were also turned to within taxidermic representation. Walters and other taxidermists discovered that artificial surfaces, particularly those produced in acetate, generated colorful, life-like surfaces. By the 1930s, color film stocks including Eastman Kodak's Kodachrome fully incorporated the same properties of color suspension and artificial color replication as taxidermic skins.

Kodachrome and a New Culture of Color

[38] Dyer writes argues that, "Print, the magic lantern, watercoulouring [sic], photography and film were all media which represented people through translucence" (112) and that cinema reworked photography's play on translucence by letting light through without becoming wholly transparent itself. See Richard Dyer, *White (*London: Routledge, 1997).

Kodachrome's most important and revolutionizing contribution to small-gauge, amateur photography and filmmaking was the introduction of color.[39] Attempts to produce color photo-cinematic images date back to the invention of photography itself; Nicéphore Niépce, one of the early innovators of photography, wrote to his brother in 1816, that "I must succeed in fixing the colors; this is what occupies me at the moment, and it is the most difficult."[40] Hand painting, tinted lenses, organic and chemical dies were all used to infuse color into black-and-white images, though with much effort and mixed results.[41]

Kodak's first motion picture color system, Kodacolor, attempted to produce color moving images using a 16mm color additive format with color lenses and filters.[42] However, this system was not ideal for everyday, amateur use: it was expensive, the color images were difficulty to achieve, and they were often poor in clarity and quality. Adding to these detractors was the fact that, as an additive format, the images could only be temporary projected and not permanently printed in color. As such, color prints could not be reproduced and kept in color, only visually projected and experienced that way in the moment.[43] Kodachrome would became the first commercially successful, mass-marketed color film starting with 16mm movie film in 1935; it

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[39] The inventors behind Kodachrome were actually two amateur photographers, Leopold Mannes and Leopold Godowsky Jr., who were conscripted to develop a color subtractive film format for Kodak. For more, see Stephen A. Booth, "Kodachrome at 50," *Popular Mechanics* 163.1 (Jan 1986): 46; 50.

[40] qtd. in Henry Wihelm, "A History of Permanence in Traditional and Digital Photography: The Role of Nash Editions," *Nash Editions: Photography and the Art of Digital Printing,* Garrett White, ed. (Berkeley: Nash Editions, 2007): 101.

[41] The earliest commercially successful method of producing colored photography after their development was the Autochrome, introduced by the Lumière brothers in 1907. In this process dies made from potato starch grains were added to the photograph to give it color. Autochromes were discontinued in the 1930s, upon the introduction of sheet and roll film formats. For an accessible, populist account of the Autochrome process, see: Robert E. Martin, "Secrets of *New* Color Movies," *Popular Science* (Oct 1928): 17-18; 153.

[42] Edison unveiled the new Kodacolor system at a lavish garden party hosted at his Rochester, NY estate., which was in fact captured on Kodacolor film and remains in existence as a home movie entitled *Kodacolor Party* (1928).

[43] Stephen A. Booth, "Kodachrome at 50," 46; 50.

would subsequently be adapted into still slides and prints and photographic transparencies known as "Minicolors"; 8mm and Super 8 amateur movie film; a even a 35mm professional version for Technicolor movies.[44] With its new capabilities, acetate-based Kodachrome emerged as an idealized color imaging medium capable of producing unmatched color vibrancy and enlivened representations of life. Thanks to acetate's stable, supportive, and transparent properties silver halide crystals (the same crystals that produce image grain, as discussed earlier) and other color-producing chemicals could now be suspended in emulsion layers on top of the underlying plastic film base.[45] A single strip of Kodachrome film contained three suspended layers of the photo-sensitive pigments which combined to reproduce an array of vibrant colors without the needing external lenses, filters, or special projectors. Gelatin, which is produced from the collagen found in animal bone and skin, was also used to stabilize and bind color emulsion to the film base. Thus, like taxidermic mounts, the photograph is also a part-organic, part-synthetic product formed by the technological manipulation of animal bio-matter.

Essentially, Kodachrome film suspended color emulsions and produced life-like color reproductions in the same way that taxidermic skins suspended color pigments within their acetate skin layers. Once developed, color prints could also be further treated and conserved with acetate: for example, it was recommended that home users protect the color quality and longevity of their photographs by sealing them within the acetate pages of photo albums. As Stephen A. Booth noted in his *Popular Mechanics* write-up on color photography, this method of acetate

[44] Professional photographers like Steve McCurry, used Kodachrome for a number of artistic and news images, such as the famous 1984 portrait of Sharbat Gula, better known as the "Afghan Girl," for the cover of *National Geographic* magazine.

[45] As previously detailed, additive color systems use black-and-white film and the final projected image appears in color by means of special filters or through the addition of dye stains applied to each frame. Subtractive systems, on the other hand, use "color film," which contains emulsion layers made up of embedded and suspended color dyes.

lamination and containment would keep color images from fading and, in theory at least, turn them into immutable records made immortal through acetate coverings.[46]

In a larger cultural sense, early twentieth century developments in colored imaging also intersected with resurgent popular aesthetics and interests in color. By the 1930s, color become an important and valued aesthetic within American culture, in large part because it was associated with progressive modern living and served as an antidote to the dark overtones of the Depression. Color was also becoming more and more accessible to everyday consumers and part of their daily domestic lives in the form of new, brightly colored and cheap plastic products — from cars to clothes to kitchen containers to color capable film.[47] Plastic materials, and acetate plastic especially, were uniquely and materially able to cheaply produce all of these domestic products in a spectrum of vibrant, imbedded color pigments.[48] With this, a "color revolution," as *Fortune Magazine* termed it in 1930, swept across America infusing a multitude of brightly colored consumer products made of new plastics.[49] Photography historian Sally Stein has further noted that popular interests in color grew in American visual culture throughout the 1930s; by the end the Great Depression, these aesthetic interests developed into what she terms a "rhetoric of the colorful": a discursive trend that positioned color as "as an all-purpose positive sign of

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[46] Stephen A. Booth, "Fading Memories: Careful Storage and Display Can Keep Your Precious Images from Disappearing," *Popular Mechanics* 164.7 (July 1988): 103.

[47] A number of commercial companies also literally made color their business: DuPont launch a "Save the Surface" campaign characterized by advertisements and products that offered permanently color-locked surfaces; the Rogers paint company unveiled their own line of acetate-based lacquer paint products and promised to give surface a new "lease on life" with permanent color; and Celanese debuted an array of brightly colored acetate fabrics that captured the "spirit of Modernism." For more, see: Rogers, "Rogers Brushing Lacquer Used in Millions of Homes" advertisement. *Milwaukee Journal* [Milwaukee, WI] 14 May 1929, 8; Celanese, "Enriched with the Very Spirit of Modernism" advertisement (1928).

[48] For more, see Neil Harris, *Cultural Excursions: Marketing Appetites and Cultural Tastes in Modern America*. (Chicago: University of Chicago Press, 1990).

[49] Regina Lee Blaszczyk, *The Color Revolution* (Cambridge: MIT Press in association with the Lemelson Center, Smithsonian Institution: 2012).

progress."[50] Faded, dull colors were for a past time and for the dead, whereas vibrant colors were the hallmark of a reinvigorated era and signal of thriving livelihood. In short, color became associated with life and vitality at this time. Kodachrome film stepping into this already primed cultural context with promises to both produce and preserve life through unfading, undying color renderings. Now image-makers could capture true-to-life representations and preserve all the colors of life in a mediated form that, unlike original subjects and natural surfaces, would not age, fade, or lose their colors in time. Whether in still or moving form, in collections of Kodachrome photographs or "action albums" of Kodachrome moving images, these acetate renderings promised that unlike the "old people of today [who] have only their dimming memories to depend on; those of tomorrow will have libraries of this film."[51]

Interestingly, the same acetate materials and properties that made these color images possible also would also be used to produce colorful, still histology images within the biological sciences. As shall be further discussed in Chapter 2, histologists attempted to visualized the cellular building blocks of life through color enriched slides and tinted specimen samples. These samples could only be affixed and permanently rendered in color with acetate plastic slides. As such, across both scientific and domestic contexts, an overarching theme can be seen: that color was connected to and seen as a vital element of life, and that color was best represented through acetate "fixing" materials. Photo-cinematic renderings and plastic slides both promised to fix their subjects into unchanging, enduring visual representations — remediated versions that could transcend the physical limits and negative side-effects of time, whether that was literally color

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[50] Sally A. Stein, *The Rhetoric of the Colorful and the Colorless: American Photography and Material Culture between the Wars* dissertation (Yale University, 1991): 11.

[51] Robert E. Martin, "Home Movies — The 1930 Family Album." *Popular Science* (Jan 1930): 26; 130; Mervine Delaway, "Make and Project Your Own Home Movies." *Illustrated World* (April 1917): 186-87.

fading or fading memories. Unlike the stocks that came before it, Kodachrome film offered a new acetate composition with improved archival potential. Its acetate composition provided the material ability to preserve the essential color components of the film and last longer than other film products. As such, Kodachrome emerged as an idealized color imaging *and* preservation material, and was marketed as a miracle product that could finally produce colored archival record.

Staying Alive

Kodak's marketing for Kodachrome film and their other camera products repeatedly emphasized their ability to reproduce color and permanently maintain a semblance of a subject's vitality. In effect, an overwhelming majority of these advertisements seemed to make a direct connection between color and life — essentially, that life was defined through vibrant color and that one could make both last forever with acetate-based color films and images.[52] However, as much as color was an essential component of natural life, it was also extremely ephemeral and impermanent by nature.[53] As such, it has to be remediated through artificial means in order to make it last: whether this be as plastic flowers or as color photographs which both keep once living things looking "alive" in full color even after their death.

Various advertisements throughout the late 1930s placed a strong emphasis on the ephemeral yet essential nature of color. These ads, mostly appearing in magazines known for their hyper-saturated covers and foregrounded full-color spreads, made prominent use of exotic

[52] see Eastman Kodak, "Bring 'em Back Alive with this Movie Camera" advertisement. *Popular Science* 130.6 (June 1937): 100.

[53] Even though color was largely equated with life, color imaging practices and applications (especially taxidermy and photo-cinematic renderings) also carried associations with artificiality and even death. In taxidermy, for example, the specimen themselves are of course dead. Photography also has a long historical association with death (as in the death photography of children and other *memento mori*).

flower arrangements, verdant vegetation, dappled wildlife, and rosy-cheeked children dressed in the latest, vibrant fashion styles. Placed along side such images, the ad's headlines suggested that by capturing color images on Kodachrome film, one could make your loved ones seem "vividly alive — as if you could reach out and touch them."[54] With this, Kodak established a marketing discourse around Kodachrome and its "living color" reproduction abilities. Kodachrome was presented to the public as a vital tool that every family needed in order to perform the essential task of producing life-like, long-lasting records of their existence.[55]

This same discourse also crossed over into scientific uses of acetate, which were driven by the same concerns over color representations of biologic life. A 1941 *Popular Science* article on scientific preservation, for example, also specifically identified acetate film as a vital tool for keeping biological specimen looking alive by keeping their colors from fading.[56] The "brilliant colors and delicate structures of plant and animal life," the article claimed, could be sealed and indefinitely preserved between sheets of cellulose acetate.[57] A solution to the color-draining effects of death thus seemed obtainable through acetate encasement and containment. Within the same *Popular Science* issue, a feature on Kodachrome color film stock similarly touted acetate

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[54] Eastman Kodak, "All the Wonders of Awakening Life" advertisement (1938); "Beyond Price..." advertisement (1938); "She's So Real...You Want to Pick Her Up and Hug Her" advertisement (1939); and "Seems as if She Could Walk Right out of the Picture" advertisement (1939).

[55] Besides rendering life, World War II photojournalists also used acetate photographic technology, and specifically Kodachrome, to capture the colors of death and wartime destruction. Rather than purely capturing happy family scenes and sunny sunsets, Kodachrome's color pallet also availed itself to depicting the horror of atomic expositions in heightened, graphic detail as exemplified by the final and only color image in Edward Steichen's famed 1955 "The Family of Man" photographic collection. This last image is a Kodachrome photograph taken by Wayne Miller of a blazing, burning red atomic cloud on the horizon. *Life* magazine also printed a full color spread of Kodachrome photographs capturing the icy blues and fiery reds of atomic expositions in their May 3rd 1954 edition. For more see: "New 'Ivy' Pictures Show Fire and Ice," *Life* 36.18 (3 May 1954): 54; and Edward Steichen and Ezra Stoller, *The Family of Man: The Photographic Exhibition*. (New York: Published for the Museum of Modern Art by Simon and Schuster in collaboration with the Maco Magazine Corp, 1955).

[56] "Plastics Preserve Nature's Colors," *Popular Science* 139.5 (Nov 1941): 72-74.

[57] *ibid,* 72.

as the realization of past dreams to indefinitely capture and preserve the hues of life in all the "intense color and life."[58] In both of these cases, life could be protect from time, aging, and its symptom of color loss if it was rendered in an alternative acetate plastic form. At the core, this is the same sentiment behind microfilm mediation, as well as the larger understanding of "preservation" established around acetate technology: namely, that artificial materials offered a better chance for longevity than natural materials. This dream and miracle promise turned out to be rather short lived, though, as eventually Kodachrome film, like other imaging materials, did lose its colors over time. Color quality remains a vital element within visual imaging and preservation efforts, and a new generation of digitally-based interventions have since been marshaled to correct these color fading "errors." Like other innovations before, however, these tools are often wielded in extreme ways that do not simply "correct" but rather complete re-construct and recreate representation that are, essentially, too "good" and exceed what the natural appearances and limits of the previous material format would have allowed. High definition recoloring projects, for example, generate images that do not preserve the qualities of the analog image, though they do appeal to the contemporary tastes (of some) within today's visual culture. The larger questions and controversy swirling around these imaging "preservation" interventions is what, exactly, is being privileged and saved: if this encompass the original materials, features, and aesthetics of the object in question, whether it be flowers that fade or acetate film that will also lose color over time, then the goal should not be to "preserve" these by making their colors permanent nor manipulating their remains to appear as if they were just born today. Those in agreeance with this perspective support restoration efforts only in so far as the "[restore] the film

[58] Eastman Kodak, Untitled Kodachrome Film advertisements (1940-42).

to the highest quality possible but not employing any means to ‘update’ or ‘improve’ the image or the sound in some misguided effort to refashion it to fit in better with modern-day expectations.”[59]

Nevertheless, acetate plastic and imaging materials were first introduced within twentieth century scientific, institutional, popular, and domestic sectors as doing just the opposing: as turning organic life into something better through heavy-handed technological improvement. Indeed, the directive put forth by Kodak and imbedded into the discourse surrounding their products was that the only way to make color and life truly long-lasting was through imaging technologies and artificial materials rather than organic or natural ones. Rather than something feared or disparaged, however, artificiality was in many ways embraced as part of acetate’s “charm” and crept into discussions concerning what kind of color versions of life Kodachrome was truly rendering. Kodachrome’s slant towards hyper-realism and exaggerative coloration — especially its infamous bloody tomato reds — gave some images an artificial appearance that surpassed anything in nature. Rather than disparaged for this, Kodachrome was largely embraced as a welcomed colorful re-imagining of daily life (and continues to be nostalgically valued today in contemporary Instagram visual culture, as discussed in the Coda). Rather than detracting from its popularity, Kodachrome became known and even desired for its rich, hyper-saturated color palette. Some domestic users even preferred these renderings to reality, and favored artificial Kodachrome appearances precisely because they improved upon real life and made it look “better.”[60] Ultimately, artificial materials and engineered versions of original life were

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[59] Glenn Kenny, “Film Restoration in the Digital Domain: A Chat with James White” *Some Came Running: Enthusiasms and Expostulations* (12 March 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

[60] Allan Kattelle, *Home Movies: A History of the American Industry, 1897-1979* (Nashua: Transition Pub, 2000).

increasingly met with popular favor rather than fear, in both photographic and taxidermic "image-making" applications.

Suspended Skins, Colorful Coverings

As praised within numerous editions of the Field Museum's annual reports, acetate taxidermic skins achieved an unparalleled level of realism through the suspension and retention color similar to Kodachrome's. The material composition of acetate plastic perfectly captured and reproduced the finest surface details of texture and color, and preserved the specimen's natural appearance much longer than natural skin. The popular press lauded these acetate skins and continued to positively portray acetate plastic as a new and improved form of protective covering. In his final article on the Chicago National History Museum for the *Chicago Daily Tribune*, Chesly Manly detailed the Museum's impressive collection of animal mounts artfully preserved in bronze, marble, and cellulose acetate. Interestingly, new acetate plastic were positioned on the same plane as ancient materials which were classically used within the fine arts as well as credited for advancing civilization. According to Manly, the mounts preserved in acetate (including Bushman, of course) enjoyed an extended afterlife thanks to their new protective hides. Their acetate coverings not only "produc[ed] more life-like results in color, translucence, and surface detail than the skin itself," Manly continued, but were also resistant to aging and decomposition.[61] In a provocative coincidence, Manly's article shared the page with an advertisement for the new "Koroseal" plastic raincoat [Fig. 1.4]. Koroseal was first engineered by the B.D. Goodrich Company as a durable material that could resist the effects of time and

[61] Chesly Manly, "Museum Shows Taxidermist's Art at its Best," *Chicago Daily Tribune* [Chicago, IL] 20 April 1956, page 6.

aging better than any existing material, natural or artificial.[62] The Koroseal raincoat ad echoed Manly's positive sentiments in its description of how this improved plastic coat, which mimicked fabric, functioned as a protective shield from the forces of nature.[63] In essence, Koroseal was marketed through the same rhetoric used to "sell" acetate taxidermic skins to the public: mounts encased in acetate, as Manly described, were enviously protected from decay, and a man enrobed in a Koroseal raincoat was described as enjoying a similar protected existence.

[Fig. 1.4] *Chicago Daily Tribune* [Chicago, IL] 20 April 1956, page 6.

Various articles in *Popular Mechanics* also presented acetate as a welcomed replacement and improvement upon natural life. For example, one early 1936 feature proclaimed that modern advances in acetate taxidermy allowed for the unparalleled creation of uncanny, better-than-life

[62] see F.K. Schoenfeld, A.W. Browne, Jr., and S.L. Brous, "Recent Developments with Koroseal," *Industrial and Engineering Chemistry* 31.8 (August 1939): 964-968.

[63] A separate advertisement for plastic contact lenses also appears on the page — yet another example of plastics permeating through the body and public discourse.

reproductions. Life could now be reshaped and artificially manufactured through human ingenuity in what was believed to be "a medium that [would] last indefinitely."[64] M.J. Bauer presented a similar utopic championing of this heightened ability to redesign and re-fabricate the materials of life in his 1946 piece, "Twice as Natural and Large as Life are the Animals Mounted by Modern Techniques in Taxidermy." Here, Bauer praised Walters' acetate replication methods and cited them as advancing natural life into a new realm of perfection. As Bauer described, natural bodies were a problem, especially because they died and decomposed. However, "plastics seemed the answer."[65] Skin coverings and other bodily materials could now be translated into acetate, which seemed to resist decay and hold onto to the appearance and colors of life better than anything "real."[66] Walters' use of acetate would continue to permeate both institutional practice as well as public discourse, and would segue from its first niche applications in reptilian taxidermy to the reproduction of plant life, birds, whales, and even hairy mammals like Bushman the gorilla.

With hairy specimen, acetate skins were also used as a secure platform to preserve the original hair. The specimen's hair follicles were directly embedded within the acetate surface, just as they were anchored into the natural skin. In this application, a truly part-organic, part-synthetic re-creation was formed: the original hair and reproduced skin were fused together into a new, singular entity. The Field Museum's 1936 news bulletin recounted this process of creating hybrid organic and synthetic reproductions with great excitement. Karl Schmidt, Assistant Curator at the Museum, glowingly detailed how a new Cassoway bird mount was created by

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[64] "The Marvels of a Strange Art," *Popular Mechanics* (May 1936): 127a.

[65] M.J. Bauer, "Twice as Natural and Large as Life Are the Animals Mounted By Modern Techniques in Taxidermy," *Popular Mechanics* (March 1946): 154.

[66] *ibid*.

mixing acetate replica pieces with original bio-matter. Acetate castings of the bird's head and bare legs were combined with its real feathers and other ephemeral remains to produce a hybrid capable of retaining its realistic surface texture and color. Schmidt and others at the Field Museum championed this hybrid creation as "solv[ing] the problems presented by the fact the original dried skins (...) have lost all their brilliant coloration, and (...) their natural translucence."[67] As Donna Haraway would later describe in her writing on taxidermic practice (reiterated in her subsequent writings on cyborgs and post-human entities), taxidermists ambivalently sought to preserve and naturally represent life while also improving upon and even transcending the natural limits of organic materials. Acetate emerged as a medium especially well-suited for such goals, and it offered to preserve life even if only through artificially engineered means. Schmidt's Cassoway creation can also be seen as an early forefather to the infamous pink flamingo lawn ornaments first sold to America consumers by Union Products in the late 1950s.[68] As Jennifer Price describes, this kitsch plastic bird epitomizes attempts to forge an unnatural link to the natural world; to create and preserve a possessable version of "Nature" through the inherently compatible use of human intervention, artificially augmentation, or outright simulation.[69] Yet despite these contractions, taxidermists like Schmidt and eventually anyone willing to pay $7.95 for a pair of pink flamingos at Kmart elected to use plastics to fix for themselves a piece of wild"life" recast as a representative figurine.

Promises and Problems of "Fixation"

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[67] *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1935,* X.3 (January 1936): 297.

[68] Jennifer Price, *Flight Maps: Adventures With Nature In Modern America*. (New York: Basic Books, 2000).

[69] *ibid*

While taxidermy, casting, and prosthetics similarly utilized acetate to assist in the maintenance of life, they also developed individual and at times contradictory positions on what constituted "life" and how it should be preserved. For example, taxidermic preservation used acetate to immobilize bodies and freeze time, while orthotic prosthetics attempted to restore mobility and facilitate efficient bodily movement. Acetate's complex utilization within these fields also intersected with differing historical positions on modernization and modernity. Such positions were especially thrown into crisis during times of war and cultural destabilization — times when many turned to plastics as a solution to such problems. In short, acetate emerged and was publicly received during these uncertain and devastating periods as a way to combat material destruction, disfigurement, decay, and even death. Through acetate, one hoped to fix and perhaps even improve upon natural life.

"Fixing" life through acetate also presented taxidermists with several paradoxes. In order to fix the effects of time, death, and decay, specimen had to be killed and locked into fixed, unchanging positions. Essentially, in order to artificially preserve life, taxidermists first had to end their subjects' natural life. Taxidermic representation, in short, required disembowelment: in order to preserve life, the decay-prone internal viscera had to be removed, and the organism had to be reduced to a surface existence. In terms of other preservation practices — including architectural restorations — it is in fact common practice to disregard the interior of the object, building, body, etc., in favor of its external appearance. Architectural preservation, for example, often focuses on saving or restoring the facade of a building while "gutting" its interiors. Biological preservation efforts, such as taxidermy, operate in the same fundamental manner: they privilege exterior aesthetics and surface appearance over internal structures. Specimen are preserved as empty husks and hollow surfaces freed from the messy tethers and limitations of putrefying internal organs. This method suggests that preservation is accomplished through detachment and, in essence, disembodiment — fundamental assumptions that continue within current media preservation practices. Digital preservation scholar, Howard Besser, laments how the leading paradigm shifts within moving image preservation continue to operate under this logic: namely, that fragmented pieces and extracted content are saved as disembodied "assets" instead of as complete, intact works or "artifacts."[70] At its core, this is the same process once conducted within acetate taxidermy: external pieces of the objects were detached, duplicated, and put on public display as the preserved essence. Now, the same is being done to acetate film objects: their internal content is extracted, copied, and made available for public access. The processes are mirror images of each other, grounded in the same belief that through disembodiment and reproduction, preservation is made possible.

Though counterintuitive, taxidermists had to replace many of their subject's real, corporeal components in order to realistically represent life. On the one hand, taxidermists strove for the utmost in realism, which included the re-creation of natural poses representing subjects in motion. On the other hand, such poses needed to be rigidly held in place through artificial suspension in order to last. Since the movements and mechanics of life were difficult to maintain, taxidermists settled for the *appearance* of natural movement and strove to create permanent visual illusions of life-like movement through artificial immobilization. In short, enduring preservation could only succeed by turning life into a visual image and surface representation. Other sensory experiences and ephemeral aspects of life — including movement, touch, taste,

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[70] Howard Besser, "Digital Preservation of Moving Image Material," *The Moving Image* (Fall 2001): 39-55.

smell, and sound — were consequently sacrificed for visual suspension and unchanging preservation.[71] In final execution, taxidermic mounts represented life through a visual experience and reductively presented it as a surface existence.

Attempts to immortalize life through immobilized, "dead" representations forced taxidermists to address a paradoxical question: does artificial preservation lead to the obliteration of life and its essential qualities, while ultimately bringing about the same permanent stasis found in death? Even though Walters acknowledged this paradox of preserving of life through death-like fixation, he also concluded that while movement "is almost inseparable from the majority of subjects," in the end taxidermists "cannot have motion."[72] While motion is a defining aspect of life, taxidermists must suspend and rigidly hold motion still in order to preserve a specimen's form and living colors — features that were elevated as indicative and essential to life, even above movement. Taxidermic preservation thus turned to acetate as a means of immobilization and as a way to fix the body through stasis. Building from this early usage, medical practitioners would later redeploy acetate and use it within orthotist and orthopedic casting to immobilize their patients.[73]

Medical Appendages:
Shaking Itself Free From the Shackles of Antiquity

[71] Some of these auxiliary sensor elements, especially sound, were also captured through media recordings and recreated in many taxidermic displays.

[72] Leon L. Walters, *New Uses of Celluloid and Similar Material in Taxidermy* (Chicago: Field Museum of Natural History, 1925): 3.

[73] Technically speaking, orthopedic doctors focus more on the surgical treatment and casting of the musculoskeletal fractures; orthotists focus on the design, manufacture, and/or therapeutic application of corrective braces, splints, and adaptive prosthetics. Throughout this chapter, both terms will be used to discuss the use of acetate within medical casting, in general, while attempts are also made to preserve their pertinent disciplinary differences.

Medical casts attempt to mend broken bones and correct misshapen bodies through applied immobilization, or "fixation" as it is also clinically termed.[74] The primary goal of medical fixation is to temporarily halt a subject's movement and circumvent their full mobility. In certain cases — ranging from acute trauma, to chronic birth-defects, to degenerative deformities — only the restriction of bodily movement will heal the subject and restore their quality of life. As Joan M. Kennedy details in her 1974 book on historic orthopedic techniques, immobilizing apparatuses including casts and orthotic braces can also take the place of paralyzed muscles and defective joints. Such devices supported or replaced components of the body with stronger, more functional materials similar to the way taxidermic replicas replaced unreliable skin with preferable alternatives. However, unlike taxidermy and its use of permanent immobilization, medical casting only used temporary fixation to restore and even perfect a subjects' mobility. In further contrast to the tenets of taxidermy, medical casting regarded mobility as an essential component of a functional livelihood. Prolonged arrestment and fixation were, in fact, seen as deleterious hazards and potential complications associated with the overuse of immobilizing splints, especially those made of plaster. As such, casting practitioners turned to alternative materials; they sought non-plastic solutions that could circumvent plaster's undesirable side effects while also facilitating new, desirable methods of medical intervention including the X-ray visualization of broken bones.[75] The medical casting field adopted acetate plastics in part due to its superior transparency and permeability to modern X-ray imaging technology. Just as taxidermy and photography were redefined through acetate, the specific

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[74] C.D. Russell, S. Bateson, and R. Loos, "Clinical and Laboratory Notes: Fracture Fixation with Aire-Lite," *Canadian Medical Association Journal* 58.4 (1948): 388-389.

[75] I. William Nachlas, "A Splint for the Correction of Extension Contractures of the Metcarpohalangeal Joints," *The Journal of Bone and Joint Surgery* XXVII.3 (July 1945): 507-512.

properties and promises of acetate plastics also shaped the development of X-ray imaging and medical casting.

Early Casting Materials and the Acetate Turn

The first modern cast, defined as a rigid "starched apparatus" by *The British Encyclopaedia of Medical Practice*, was introduced in 1834.[76] Orthopedic practitioners and orthotists subsequently developed a variety of casting apparatuses that were fashioned out of starched fabrics, clay, and leather. By 1852, plaster-of-Paris became the medium of choice for clinical immobilization, and would remain the most popular casting material until the integration of acetate plastics during the 1940s-1950s. Despite its popularity, plaster casts had a number of inherent disadvantages: they were heavy, had poor resistance to moisture and weight bearing, irritated the wearer's skin, and prevented X-ray imaging. Writing for the British medical journal, *The Lancet,* David F. Thomas warned that the ubiquitous use of plaster casts should not obscure plaster's negative features. Rather, he urged practitioners to actively search for "something better."[77] In this spirit of continued scientific improvement and quest for better materials, acetate emerged as a solution to each of plaster's shortcomings.

The discourse surrounding plastic casts, specifically those made out of acetate lacquered fabric and marketed in the United States, Canada, and Europe as "Aire-Lite," "Glassona," and "Castext," was almost unanimously enthusiastic and echoed many of the same praises sung about acetate's use within taxidermic casting.[78] These acetate casts were mostly valorized for their

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[76] *The British Encyclopaedia of Medical Practice,* Rt. Hon. Lord Horder. ed. (London: Butterworth & Co., 1946): 12.

[77] David F. Thomas, "The Uses of Glassona," *The Lancet* 277.7189 (10 June 1961): 1260-1261.

[78] Cellulose acetate casting materials were produced in Great Britain under the trade name of "Glassona" by John T. Smith & Nephew Ltd., and Hull; and in the United States as "Airlite" by TowerCo Inc, and "Castex" by Bauer & Black.

versatility, surface impermeability, and unparalleled X-ray permeability. Unlike plaster casts, Aire-Lite, Glassona, and Castext were flexible and lightweight while simultaneously rigid and durable. They were manufactured and sold as pliable, fabric rolls that became stiff when top-coated with a solidifying acetate lacquer. Before receiving their acetate topcoat, the non-lacquered fabric could be directly applied to the patient's skin and exactly modeled to their contours. In some full-body applications, subjects were even completely encased in acetate "second-skins" and entombed within them as if preserved mummies [Fig. 1.5]. Once fitted to the body and sprayed with lacquer, the bandage would harden into a durable surface that proved even stronger and more resilient than skin. Unlike previous methods, these acetate casts could also be directly applied to open wounds and sores. Direct contact between the bandage and opened lesion facilitated patient comfort, cleanliness, and faster healing time; this positioned acetate as not only a superior replacement for other bandaging materials, but also as a suitable stand-in for the wounded skin. Ironically however, acetate's unique surface endurance and strength was also signaled as one of its few "weaknesses." When applied in excess, these casts would be nearly impossible to cut off the patient. This, along with the long drying and setting time associated with the lacquer top-coating, led some to temper their otherwise enthusiastic praise. Some users also noticed that their casts tended to shrink over time. Interestingly, shrinkage would continue to be an issue with acetate, resurfacing later in the 1980s-90s as one of the defining hallmarks of "The Vinegar Syndrome" and harbinger of the medium's ultimate demise.

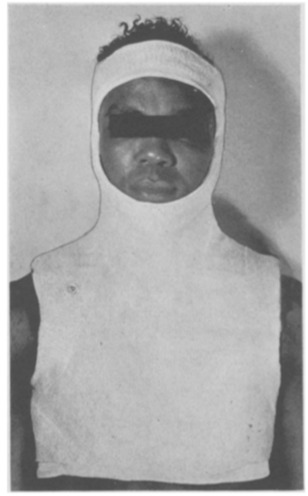

Fig. 3. Minerva type of Aire-Lite cast on a case of post-traumatic arthritis of the cervical spine. The portion of the cast covering the larynx and ears may be fenestrated or left unsprayed with the cementing fluid, as desired.

[Fig. 1.5] Kulowski, J., A.M. French, and H.R. Erickson. "Aire-Lite: A New Medium of Clinical Immobilization." *American Journal of Surgery* 66.3 (December 1944): 318.

Under Observation In Acetate

Aire-Lite, Glassona, and Castext also emerged as superior replacements for plaster casts thanks to their permeability to X-ray imaging. These acetate casting materials uniquely combined physical durability with visual penetrability, and thus became the new standard in restorative orthopedic practice and corrective orthotics. With this, the medical casting field redefined itself and entered into a new "modern" era of practice. As noted by R.B. Duthie, Professor in orthopedic medicine, medical casting was "shaking itself free from the shackles of antiquity" through the modern integration of new, advanced materials like acetate.[79] In his article on the wartime application of plastics, Edwin Teale further described how by 1941, military doctors were increasingly using clear plastics in the construction of surgical splints. These see-through splints enabled doctors to "keep close watch on the progress of their work during the grafting of

[79] R.B. Duthie, "Foreword," *Orthopaedic Splints and Appliances.* By Joan M. Kennedy. (Baltimore: Williams & Wilkins Company, 1974): iii.

flesh and skin."[80] As such, acetate bandages helped to usher in a new, advanced method in the treatment of burns, broken bones, and facial reconstructions [Fig. 1.6]. The transparent, see-through properties of acetate facilitated direct clinical observation which, in turn, enabled doctors to better fix their patients.

[Fig. 1.6] Teale, Edwin. "Plastics in the War." *Popular Science* 138.1 (January 1941): 82-83.

Direct clinical observation was a defining aspect of emerging, modern medical practices. As Michel Foucault wrote in his history of the modern clinic, doctors increasingly valued visual modes of observation and intervention; he termed this emphasis on visual-based treatment the "medical gaze," and defined it as an act of power rooted in the ability to look inside and beneath the body's surface. In order to fix life, doctors had to see life, and thus essentially equated life to a visual experience. As such, medical practitioners emphasized the importance of visuality and imbricated life with sight in a similar way that taxidermists turned "life" into fixed images put on visual display. Even though the medical gaze was applied to restore a patient's body, Foucault also counter-argued that it ultimately stripped them of their humanity. The desire to peer inside and visualize a patient's internal anatomy led to a devaluation and desecration of their external surface. A similar devaluing of the body's opaque skin surface can also be found within

[80] Edwin Teale, "Plastics in the War," *Popular Science* 138.1 (January 1941): 84.

taxidermic casting and its methods of discarding the original skin as a hindrance. Within both practices, the desire to “see life” was paramount. Rendering life and the body visible not only defined modern medicine and taxidermic casting practices, but similarly fueled the increased use and success of acetate casts. Unlike past casting materials, acetate appeared transparent under X-ray imaging. Some practitioners would even retrofit existing non-acetate casts with cut-in plastic windows in order to facilitated their direct observation of skin grafts, wounds, and reset bones. Similarly, surgeons utilized acetate windows as “portholes,” as Carl Dreher described in his writings for *Popular Science*, through which “the healing of a bomb wound may be observed, cultures may be obtained for analysis, etc.”[81] With this, acetate provided a transparent visuality that pierced through opaque surfaces like plaster casts and human flesh, allowing doctors to monitor and track their patient’s healing processes.

Invisible Clarity, Visible Color

In their 1944 article for the *American Journal of Surgery*, J. Kulowski, A.M. French, and H.R. Erickson, inventors of Aire-Lite bandages, introduced their new casting product by foregrounding its superior invisibility under X-ray. Appealing to the medical field’s obsession with visual-based practices, they presented Aire-Lite as uniquely transparent and permeable to X-ray imaging. Kulowski, French, and Erickson thus championed their acetate casts as pioneering an advanced era of medical treatment, and marketed them as the perfect “modernized” means to fix the body. Their new casts were touted through every media outlet, including medical trade magazines such as *The Lancet* and the *American Journal of Surgery*; national popular publications including the *New Scientist* and *Popular Mechanics*; and even

[81] Carl Dreher, “Lots of Things are Made of Plastics — But What Are Plastics Made Of?” *Popular Science* 142. 1 (January 1943): 218.

smaller, regional newspapers like the *Spokane Daily Chronicle*. All of these publications unanimously praised acetate casts for being as strong as steel yet soft and skin-like. As if by magic, they offered an artificially constructed "skin" that was invisible under X-ray yet could also be produced in an array of modern colors or unobtrusive flesh-tones.[82]

Similar to taxidermic skins, medical casts reconstructed a perfected version of life through a material that was valued for its ability to be invisibly see-through as well as offer a visible flesh-like appearance. Both taxidermy and medical casting depended upon acetate's unique, semi-permeable surface properties to realistically make life visible. As previously detailed, taxidermic replacement skins utilized acetate's semi-transparency to mimic the luminous quality and colors of "live" flesh. In his article on modern innovations within restorative casting, John T. Scales detailed how acetate was similarly able to produce smooth, flesh-colored surfaces — an ability it was highly praised and aesthetically valued. In addition to its aesthetic advantages, acetate casts also produced surfaces that were resistant to physical wear while permissive to X-ray visualization. Acetate thus proved invaluable as a casting material, in both taxidermic and medical applications, in large part because it balanced visible aesthetics with a certain, necessary invisibility: museum visitors could see realistic colors delicately suspended beneath the surface of taxidermic skins, and medical practitioners could see through casts as if they were nearly invisible. In short, acetate worked in these applications because it could remain inconspicuous and facilitate visual processes without being an obtrusive presence itself. Such "invisible" facilitation has also underwritten the success of other technologies and interface

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[82] see Thomas H. Peterson, "Report on a New and Effective Cast Material," *American Journal of Surgery* 41.3 (September 1938): 405-411; "Well Cast," *Spokane Daily Chronicle* [Spokane, WA] 3 November 1945, front page; John T. Scales, "Plastic Splints and Appliances in Industrial Orthopaedics," *British Journal of Industrial Medicine* 8 (1951): 288-297; "Bandages of Glass," *New Scientist* 242 (6 July 1961): 27; "'Plaster Casts' With Zippers Made of Waterproof Plastic," *Popular Mechanics* 79.5 (May 1943): 176; "From the Conrad R. Lam Archives: The Castex Jacket, March 1959," *Sladen Libraries News* 3.6 (September 2011): 6.

mediums which, like acetate, set themselves apart through their ability to remain inconspicuous mediating agents.

Immobile Action

A number of advertisements for Glassona and Castex further revealed how acetate was positioned as a welcomed, groundbreaking innovation. A popular 1954 ad for Glassona, which would be reprinted several times in the British edition of *The Journal of Bone and Joint Surgery*, emphasized its unprecedented strength and dependability. Unlike older plaster models, this new acetate cast was able to support a 19-stone (266 pound) patient while remaining light-weight itself. The ad's headline underscored Glassona's lightness by describing it as "feather-weight" and printing this description in a delicate, hollow-point font that seemed to almost float off the page. Below this thin, see-through headline was a neck-down photograph of an obese patient whose protruding gut seemed poised to break through his slouching, fabric loincloth. The ad went on to blamed the patient's excessive weight for reducing his previous plaster casts to dust. His new Glassona cast, however, was praised for withstanding his bodily excesses while not being too bulky or cumbersome to prevent him from working. While this new material was strong enough to endure the most demanding conditions, it was also light and functional enough to not incapacitate the wearer nor impede his daily responsibilities. In addition to offering superior strength, a balance was thus struck between immobilization and mobility, and this was presented as a unique and essential feature of acetate casts. These casts were durable enough to hold together and provide the necessary support, while remaining lightweight and maneuverable.

The facilitation of fast-paced movement was also presented as a top cultural priority, particularly leading into and throughout World War II when fast, industrious movement was equated with victory and survival. Even before the war, acetate became encoded with efficient industrial operations. From a manufacturing perspective, acetate revolutionized the plastics industry through its efficient and fast-paced processing. As Meikle noted, previous methods used to process cellulose nitrate were slow, dangerous, and wasted precious resources. Conversely, acetate products could be quickly and cheaply manufactured through new injection-molding techniques, which led acetate to become industrially as well as culturally connoted with modernized, industrious production.[83] Acetate technology was also utilized to improve the speed and proficient performance of industrial workers; specifically, they were equipped with supporting braces, and trained through photographic and cinematic motion studies produced and distributed on acetate film stock. Preceding and following World War I, industrial psychologists Frank and Lillian Gilbreth pioneered the use of acetate in their photocinematic scrutinization of factory workers. Through acetate-based snapshots and moving picture technology, worker's movements were recorded through time and space, and their physical efforts were improved through various interventions including corrective brace supports. Echoing the tenets of the Conservation Movement, ineffective locomotion and wasted industrial resources were equated with the squandering of natural resources. In the same spirit, the Gilbreths worked to perfect human locomotion through careful scientific intervention, acetate-based imaging technologies, and medical apparatuses. Their work would continue to inform an entire cultural and industrial movement dedicated to time-motion studies, Taylorism, industrious mass-production, and the ergonomic perfection of worker's bodies.

[83] While the economic aspects of acetate production invites Marxist criticism, such a critique will not be primarily addressed here. An interrogation of materiality and the fetishization of old, failed technologies will, however, be addressed in the Coda.

Advertisements for acetate braces from the 1940s-50s reflected this growing obsession with perfected bio-mechanics and speed, as well as a different perspective departing from taxidermic immobilization. Whereas acetate was once praised for its ability to fix and freeze subjects — keeping them from all movement, including the momentum of natural decay — acetate casting products were now praised for their ability to facilitate the continued and perfected movements of life. While earlier taxidermic practices suggested form and color were more important to "life" than movement, later casting practices positioned movement as essential to survival and utilized acetate interventions to ensure civilization's progressive continuation. Wartime ads for acetate casts especially underscored these differences, and revealed a divergent set of priorities and perspectives on what constituted a modern, sustainable life as well as how this could be best achieved through plastics.

The U.S.-based Bauer & Black company's Castex ads epitomized this new discourse, while unabashedly framing acetate as the revolutionizing savior "material you've always wished for."[84] In their full-page ads, placed in the July 1943 edition of *War Medicine* and the January and July 1944 U.S. issues of *The Journal of Bone and Joint Surgery*, Castex was positioned as facilitating vital mobility during the fast-paced war. The 1944 ad especially spoke to an ingrained tension between the necessity for a cast that simultaneously suspended as well as supported movement [Fig. 1.7]. The ad featured a large, centralized photograph of a female switchboard operator extending her splinted arm to connect a new phone line. Above her, a smaller cartoon depicted a woman in an arm sling and high-heels, comfortably reclined and cross-legged in a plush armchair. Further emphasizing this visual juxtaposition between the domestically-coded,

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[84] Bauer & Black, "This molded leg shell weighs just 8 ounces" advertisement for Castex rigid bandage, *The Journal of Bone and Joint Surgery* XXVI.3 (July 1944): 17.

inert woman and the industrious worker is the headline: "Time need **NOT** stand still." Calibrated to address a wartime climate, the ad continued to state: ""There's no time to lose...for *any* of us...when victory depends on *speed*. And time needn't stand still for fracture patients" (emphasis original).[85] While older slings, plaster casts, and other clinical fixation devices required workers to stay at home nursing their injured bodies, lightweight and durable acetate casts like those made of Castex promised to have patients back on the job and efficiently multitasking their healing time with working time. In short, Castex would immobilize the fracture, not the patient. Thanks to its plastic composition, it ensured life would continue to flow at its necessary fast-paced speed, and that American civilization would thus be saved from wartime defeat.

[Fig. 1.7] Bauer & Black. "Time need NOT stand still" advertisement for Castex Rigid Bandage. *The Journal of Bone and Joint Surgery* XXVI.1 (January 1944): 10.

As exemplified in this ad, a contrast emerged between how time and movement were negotiated following World War I and within taxidermic practice, versus the attitudes and priorities that emerged during World War II and within medical casting. Each of these periods and practices were undoubtedly marked by anxieties regarding survival, progress, and the changing shape of civilization; each also turned to plastic innovations and their promising

[85] *ibid.*

properties as panaceas to combat these fears. However, while the tenor within taxidermy and post-World War I America was largely characterized by a reactionary ambivalence towards speed and the rapid momentum of industrialization, attitudes surrounding medical casting and World War II shifted to promote and even depend upon these same elements. The devastating aftermath of the first World War led many to question whether or not humanity had gone too far, too fast: if by developing modern industries and technologies mankind only succeeded in bringing about his own destruction and death. Perhaps speed and movement, elements that defined modernity and modern progress, were things to be skeptically fought against rather than blindly sought after. Such doubts and fears instigated a post-war reconsideration of the supposed "progress" brought about by modernization, as well as a renewed interest in slowing life down in order to save and preserve it.

Ironically however, modern technologies like acetate were developed to allay these same technology-fueled fears. Taxidermic practices, which emerged during the post-WWI period, especially attest to these desires to arrest movement and suspend time through the properties of fixation offered through acetate technology. By slowing down life's movement towards entropy, taxidermists attempted to ensure the continuation of endangered life, even if only in a frozen visual form. This ethos would shift, however, by the second World War: now fears and anxieties constellated around America not being able to keep up with the rapid technological and militaristic advances of its enemies. It was necessary, now more than ever before, to move faster and better and beat the enemy to the first fatal blow. As such, scientific advances, ranging from splints to atomic weaponry, turned to plastic technologies to aid America in its fight for cultural survival and technological superiority. This revaluation of speed would further crystalize in the

1950s. As historian Hillel Schwartz has described, residing preoccupations with efficient movement and fluid aesthetics in the 1950s gave birth to new artistic expressions like modern dance and transportation methods like escalators. Paralleling these interests in body mechanics and mobility, the medical field also began developing new prosthetic devices which utilized acetate materials to improve and restore compromised movement.

Prosthetic Apparatuses

Prosthetic apparatuses can be seen as combining the efforts of both taxidermic replication and medical casting; they strive for the realistic mimicry of flesh (as in taxidermy), while they also attempt to restore locomotion (as in casting). Essentially, prosthetics function as a kind of "taxidermy of the living": like taxidermic surrogates, they provide plastic substitutes for missing or compromised organs, appendages, and body parts. However, unlike taxidermy, these prosthetic pieces work to restore the living's functional movement rather than simply preserve and stultify the dead. Building upon the previous sections, and applying the same framework of understanding acetate as an intervention of biomedical engineering to improve upon the failed, fragile natural world, this section will consider how prosthetic devises similarly utilized acetate plastics to reshape compromised bodies and fashion an improved version of lived existence. Following the taxidermic sciences, medical casting, and the experimental biosciences in general, prosthetic apparatuses were applied to not only substitute the body's missing elements, but to also improve upon its natural design and materials.

Prosthetics, of course, have a rich and complex history as a medical science, a theoretical field, and even an art form. Existing scholarship, particularly emerging from disabilities studies, has mostly considered prosthetics through a sociopolitical questioning of medical practice or critical interrogation of how disabled bodies are represented within popular culture.[86] Theories of technology have, additionally, discussed prosthetics in two leading ways: as a philosophical framework for understanding technological interfaces, post-humanism, and cyborgs; or as a metaphorical framework for theorizing how different media function as artificial visual and memory aids.[87] Prosthetics, as metaphors, have been extended to include technological devices and artificial objects used to aid or advance natural processes. Telephones, photographs, computer processors and hard drives, for example, all serve to improve upon natural processes and extend physiological limits of communication, vision, and/or memory. While approaching prosthetics through this framework has proven generative within the field of new media and technology studies, a consideration of the actual prosthetics themselves — their material composition and applied design, for example — is equally valid. As Katherine Ott, David Serlin, and Stephen Mihm suggest in their modern history of prosthetics and as Marquard Smith and Joanne Morra model in their recent anthology, a generative and under-theorized approach to prosthetics lies in questioning the material culture of the devices themselves. This section, therefore, frames its interrogation of prosthetics by questioning materiality. Specifically, it investigates how acetate plastic came to be used as a prosthetic material, why this was, and how this intersects with other disciplinary uses as well as the larger cultural discourses surrounding plastic technology.

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[86] see Christopher R. Smith, and Anthony Enns, S*creening Disability: Essays on Cinema and Disability* (Lanham: University Press of America, 2001).

[87] see see Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991) and Lev Manovich, “Visual Technologies as Cognitive Prostheses: A Short History of the Externalization of the Mind,” *The Prosthetic Impulse: From a Posthuman Present to a Biocultural Future*. M. Smith, M. & J. Morra, eds. (Cambridge: MIT Press, 2006): 203-220.

While acetate would not be widely integrated into prosthetic fabrication until after World War II, major changes within the science of adaptive prosthetics occurred following the American Civil War and on a larger international scale after World War I. Ironically, new technologies redefined how the body could be destroyed as well as reconstructed during these wartime periods.[88] During World War I, especially, improved grenade and machine gun designs claimed thousands of limbs (as well as lives) and led to a staggering number of disfigurements.[89] European soldiers fighting in the trenches were especially ravaged by devastating facial injuries. These soldiers returned home with such severe facial impairments, in fact, they were unable to function within society as socially intelligible or industrially productive human beings. An increased need for facial reconstructions consequently arose and gave birth to an new type of medical prosthetics industry. For example, the American Red Cross founded the "Studio for Portrait Masks for Mutilated Soldiers" and employed Anna Coleman Ladd, a fine-arts sculptor by training, to lead the studio's efforts in both France and the United States.[90] Between 1917-1919, Ladd and other prosthetists like her constructed scores of masks and other replacement parts out of copper, iron, and other metals [Fig. 1.8]. They assumed at the time that these materials were the best available: they were sufficiently lightweight, relatively durable, and did not irritate the sensitive facial skin. These metal masks, however, were also quick to wear, chip, and decompose — leading to the ultimate failure of the prosthetic device as well as the

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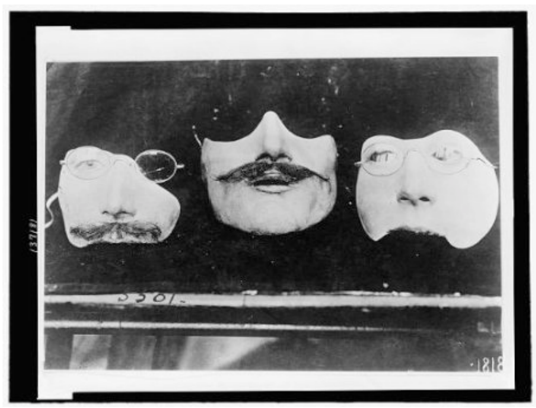
[88] Plastic surgery also advanced as a medical and aesthetic practice during the 1920s. Plastic surgical practices include skin grafting and other organic/ artificial surface augmentations of the body, which could be generatively placed in conversation with how taxidermic surface are manufactured. However, plastic surgery will not be discussed in depth here, since it has primarily used other plastic materials (including silicon) and not acetate, per se.

[89] Suzannah Beirnoff, "The Rhetoric of Disfigurement in First World War Britain," *Social History of Medicine* 24.3 (2011): 666-685.

[90] Caroline Alexander, "Faces of War," *Smithsonian* 37.11 (February 2007): 72-80.

failure of Ladd's studio. Right before it closed, a short documentary featuring Ladd's studio was fortuitously captured on an early version of acetate safety stock.[91] The film shows Ladd at work, busily fitting masks out of clay, plaster, and metal; while these masks were destined to break, however, they would remain successfully intact, even into the next century, as images captured on acetate film.[92] As perhaps foretold by this film, the future of prosthetics would indeed lie in plastics. By the 1940s, acetate and other plastics displaced earlier casting materials and infiltrated the field with promises to permanently fix disfigured bodies.[93]



[Fig. 1.8] Ladd, Anna Coleman. "Three masks made by Anna Coleman Ladd for men with facial mutilations, July 1918." Mitra Images <http://images.mitrasites.com/anna-coleman-ladd.html> (2012).

The shortcomings of early prosthetic materials prompted the search for new alternatives, especially in the aftermath of World War II. An estimated 17,000 American soldiers suffered amputations during WWII — an even greater number than in the first World War.[94] As such, the nation faced an increased need for adaptive devices that would either restore the wounded's

[91] *Red Cross Work on Mutilés at Paris, 1918* (1918).

[92] A 16mm print of *Red Cross Work on Mutilés at Paris, 1918,* which is believed to be the original, is currently held by the National Museum of Health and Medicine in Silver Spring, MD.

[93] Acetate would, however, also find itself challenged and replaced by new latex rubber prosthetics towards the later portion of the 1940s. See J. Warren White and Charles J. Frankel, "Progress in Orthopedic Surgery for 1945: XXII. Amputations, Apparatus and Technic," *Archives of Surgery* 213-224.

[94] Caroline Alexander, "Faces of War."

appearance, their mobility, or ideally both.[95] An article in *Popular Science* even functioned as a type of "open call" that attempted to solicit design innovations from the public. Printed in 1946, the article urged American inventors and engineers to submit new ideas for artificial limbs, including improved fabrication methods and lighter, more realistic and better fitting materials. Progress was quickly made towards this goal, as chronicled in the following year's 1947 issue of *Popular Science*. A short blurb, nestled between other snippets that described new engineering feats in aviation and photoelectric technology, announced that plastic materials were now also being used to fashion a new generation of prosthetic apparatuses. As David Serlin argued in his work on prosthetics, labor, and post-war American masculinity, the prosthetics constructed during this 1940s-1950s period differed from earlier devices; the design, construction, and materials used to build post-WWII prosthetics, Serlin claimed, "were catalyzed, to a great extent, by the mystique attached to 'medical miracles' and scientific progress in the late 1940s and early 1950s."[96] Responding to modern demands for technologically engineered materials — which pervaded industrial, domestic, and even bioscientific spheres — prosthetists began experimenting with new designs based on new plastic materials. Their experiments not only revolutionized restorative medicine, but also established prosthetics as its own sub-discipline within the newly emergent material biosciences.[97]

Before the introduction of cellulose acetate, cellulose nitrate was used rather unsuccessfully in a number of prosthetic applications. Nose pieces and false teeth modeled out of

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[95] see David M. Lubin, "Masks, Mutilation, and Modernity: Anna Coleman Ladd and the First World War," *Archives of American Art Journal* 47.3–4 (Fall 2008): 4-15.

[96] David Serlin, *Replaceable You: Engineering the Body in Postwar America* (Chicago: University of Chicago Press, 2004): 25.

[97] *ibid,* 16.

nitrate fell victim to a familiar flaw in the material: they would catch fire and even self-combust when exposed to heat.[98] As an alternative to nitrate, acetate was introduced as a safer, improved replacement. Acetate's first foray into the prosthetics field can be traced back to the early 1930s and the work of Lapierre, a French prosthetists and artisan, who fabricated facial replacement pieces. In his 1938 book on casting techniques in the arts and medical sciences, Carl Clark further noted that celluloid and acetate lacquers were beginning to be used in conjunction with other materials, including metal, latex, leather, and wood, to produce new, hybrid designs. Liquid top-coatings of acetate were now added to provide extra support and life-like surfaces to existing devices. In their final construction, these improved prosthetics also included extra supports that better mimicked human cartilage.[99] With this, acetate emerged as not only an improvement upon existing designs, but also as a new way to mimic compromised bodily materials like cartilage, which were necessary for a subject's smooth and pain-free movement.

Acetate Interfaces

One of the greatest problems facing prosthetic users, especially prosthetic leg users, was the fit of the socket interface. At this connection point, the patient's delicate skin came into direct, abrasive contact with the apparatus. Ideally, the materials lining the socket would function like natural cartilage and facilitate a smooth interface that minimized surface friction. Whereas conventional materials largely failed to provide this, acetate succeeded. In their 1957 article for *Artificial Limbs*, Charles W. Radcliffe, Norman C. Johnson, and James Foort presented the results of their first successful experiments with acetate as a socket liner and cartilage-like

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[98] see Brian F. Conroy, "A Brief Sortie into the History of Carnio-Oculofacial Prosthetics," *Facial Plastic Surgery* 9.2 (April 1993), 89-115.

[99] Carl Clark, *Molding and Casting, Its Technic and Application for Moulage Workers, Sculptors, Artists, Physicians, Dentists, Criminologists, Craftsmen, Pattern Makers and Architectural Modelers* (Baltimore: The John D. Lucas Company, 1938): 205.

replacement. Radcliffe, Johnson, and Foort's prosthetic leg featured an improved socket design finished inside with a coating of acetate lacquer. Their trials with the apparatus proved this lacquer coating not only provided increased comfort for its users, but also protected them from pressure sores, infections, and other maladies associated with conventional, long-term prosthetic usage.[100] Acetate proved itself, once again, to be invaluable and unique, and that it could preserve and improve the bodies and living conditions of its users.

As a result of this study, acetate and other plastic laminates were increasingly integrated into prosthetic construction, especially in difficult cases like Syme amputations. Restoring patients with below the ankle amputations (clinically termed Syme amputations) was an especially problematic undertaking: these prosthetics had to be capable of replicating the complex bipedal mechanics of the ankle and human gait, while supporting the patient's entire body weight and minimizing excessive pressure put on their bulbous stump. By the 1960s, plastics were integrated within Syme prosthetics as a way to remedy the inefficiencies of existing designs. As noted by A. Bennett Wilson Jr. in his article for *Artificial Limbs*, "[w]ith the introduction of plastic laminates into the practice of prosthetics," researchers "were quick to realize that the use of plastic laminates might well result in the development of a Syme prosthesis to a great extent free from the shortcomings of Syme prostheses previously used."[101] Plastic laminates and lacquers made of acetate were thus introduced as superior materials that could solve past problems and better protect patients who were especially difficult to re-mobilize.

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[100] Charles W. Radcliffe, Norman C. Johnson, and James Foort, "Some Experience with Prosthetic Problems of Above-Knee Amputees," *Artificial Limbs* 4.1 (1957): 50.

[101] A. Bennett Wilson Jr., "Limb Prosthetics - 1967" *Artificial Limbs* (Spring 1967): 1-53.

Acetate thus emerged as a saving material within applied medical use, and as such was proudly presented within both scientific and public spheres as a desirable, dependable intervention.

That Fleshly Feeling When I Look at You

Similar to taxidermic and medical casting, prosthetic apparatuses also needed to provide specific visual and tactile qualities, many of which were found in acetate. Acetate's lightweight yet durable composition facilitated wearabilty and comfortable movement, while its ability to mimic natural skin color and texture fulfilled desires to have a realistic, natural appearance. Color tinting and surface texture also emerged as aesthetically important concerns, particularly within facial prosthetics. Just as taxidermic replication utilized acetate to suspend color pigments and produce a realistic artificial skin surface, prosthetic manufacturers used color impregnated acetate lacquers to produce the most life-like and natural seeming prosthetics available at that time. Texturally, surfaces created out of acetate differed from their plastic cousins. While some bemoaned the antiseptic, cold, and dead feel of plastics in general, the discourse around acetate conversely praised its warm, life-like appeal and pleasing surface touch.[102] Similar to the skins produced through Walters' taxidermic method, prosthetics that were externally covered and/or internally lined with acetate offered smooth, life-affirming surfaces.

Even though taxidermy, medical casting, and prosthetics used acetate to differently immobilize or mobilize their subjects, they were united through their shared goals of restoring and "fixing" life through biologic verisimilitude and the supplementation of human flesh. Taxidermy aimed to realistically and visually preserve the body after death; medical casting attempted to restore subjects to perfected appearance and motor function; and prosthetics were

[102] see Celluloid Corporation. *Molding with Lumarith* (New York: Celluloid Corporation, 1936).

designed to provide unobtrusive replacements that allowed users to move through daily life and visually pass as whole-bodied subjects. As recounted in a 1965 article in *Popular Science*, medical science utilized new materials, including acetate plastics, to create artificial limbs that invisibly resemble organic limbs. “Before long, chances are,” the article promise, “you’ll meet an amputee and not realize it. Scientists are beginning to make it possible for people who have lost legs — in war or through accidents — to walk with artificial limbs that look and work like the real thing.”[103] With lifelike exteriors molded out of acetate, these new prosthetic appendages resembled human skin and seamlessly replaced the original limb. In these cases, acetate’s ability to mimic bio-matter, and even improve upon it, positioned it as an ideal candidate for supplementing or even completely substituting organic materials.[104]

Plastic technologies continued to advance the prosthetics industry through various improved formulas, including polyvinyl chloride (PVC). Even today, plastics continue to redefine the field, particularly in the form of silicon rubbers and new mechanized limb designs that mimic and even supersede natural human locomotion. More than simply providing mimetic replacement, prosthetics have also been developed to improve upon natural physiology. Since the 1950s, prosthetic designs have increasingly utilized new technologies, ergonomic materials, and industrial robotics to engineer an idealized form of the human body and even making it “better” than what nature provided. Some individuals, such as popular culture writer Judy Berna, have even electively chosen to “upgrade” their compromised limbs through prothetic substitution. In

[103] “Medical Science Reaches for the Impossible,” *Popular Science* 186.1 (January 1965): 114-118.

[104] Acetate was also utilized to artificially mimic and substitute vital, internal organs. Willem J. Kolff, a Dutch physician hailed as “the father of artificial organs,” pioneered the use of acetate plastics as bio-replacements. Throughout World War II, Kolff experimented with various methods for treating kidney failure, including a prosthetic device that could replicate and thus replace the kidney’s vital filtration functions. In his revolutionary 1945 design, blood was pumped from a patient’s body through acetate tubing and forced through a semi-permeable acetate membrane that sterilized the blood.

her essay "Are High-Tech Prosthetics an Unfair Advantage" for *Wired*, Berna disclosed her desire to "have [her] leg amputated because [she] was confident that the technology in prosthetics could give [her] a much better shot at an active life than [her] deformed foot ever could."[105] Recent high-tech alternatives, like those sought by Berna, combine the latest materials of robotic and industrial engineering with designs inspired by animals, like the Cheetah. While these types of prosthetics may seem unnatural and for some even "monstrous" once again these new innovations and materials science feats were deemed positive improvements rather than demonized. Embodying the cyborg figure influentially described by Donna Haraway, these contemporary devices reshape the natural human frame by retrofitting it with new mechanical and animal-like parts.[106] Just like acetate itself, the human body has become a polymer: a fusion, a hybrid, and a mixture of organic and inorganic parts.

Conclusion

Acetate's development in the early twentieth century intersected with emergent notions that natural existence was endangered and that all the shortcomings of physical life could be overcome through human ingenuity and the latest technological interventions. From consumer goods to natural materials to corporeal bodies, nearly everything could be improved if remade through new plastics. This was the hope and desire, at least, and this belief in mastering the natural world through new technologies and scientific inventions fueled the emergence, application, and public embrace of acetate products throughout the early twentieth century. Importantly, these notions resonated with the materials promises offered by new acetate plastics.

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[105] Berna, Judy. "Are High-Tech Prosthetics an Unfair Advantage?" *Wired*. (14 August 2011): http://www.wired.com/geekmom/2011/08/are-high-tech-prosthetics-an-unfair-advantage/: par. 1.

[106] Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature*.

Acetate offered a clean, streamlined mode of replication that utilized artificial engineering and high technology to provide faithful, longer lasting imitations of rare or fickle materials. By switching to acetate, natural resources could be saved and other areas of lack could be fixed.

Against a historical backdrop formed by Conservation efforts and the catastrophes of World War I, an understanding developed around acetate plastics: that through their processes of mimicry, replication, and replacement things could be improved and saved. These same understandings have continued to influence the very notions of preservation at work within twenty-first century media practices. In today's BBC archives, for example, we continue to find the same prevailing rhetoric: when discussing the conversion of analog acetate film holdings into digital MPEG 4 formats, BBC engineers elect to get "rid of this messy organic process [of film]" in favor of a "shiny new" MPEG 4 container.[107] Clean, unprecedented control is found in the technological offerings of digital and film-less formats, just as control over the messiness of decaying nature and broken bodies were mitigate through clean, new acetate plastic replacements.

Ultimately, a tenuous relationship with Nature or what is considered "natural" and "organic" is brought into new focus through the early material history of acetate. As revealed in this chapter, the early 1920s introduced acetate as a valuable imitation, replication, and replacement material for that which was in danger of extinction or already lost. The 1950s, as Jennifer Price also contends, would mark a turn and a shift: at the same time that acetate media products were beginning to fail, plastics in general were also maligned as inauthentic downgrades for Nature. "Plastics crashed from a metaphoric peak," Price writes, "as the

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[107] Charlotte Crofts, "Digital Decay," *TMI* 8.2 (Fall 2008): xiii-35.

exemplar of ‘Better Things for Better Living Through Chemistry,’ to the cancer at the core of America’s soul.”[108] What becomes quite ironic, however, is that in the twenty-first century, a new ambivalence has emerged to yet again prismatically redirect both pre- and post-1950 sentiments back onto acetate-based media products. On the one hand and as encapsulated in the BBC engineer’s quote above, these antiquated formats are seen as messy bits with all the foibles of an analog “nature,” needing to be replaced by modern technological materials. And yet, on the other hand, these same messy pieces are nevertheless revalued and venerated by hipster-nostaligics who see them as “originals” — they are the first flamingos that carry an imagined historic authenticity, whereas digital remakes are the pink flamingo lawn ornaments that offer a shiny, commercial image.

While the individual cases considered throughout this chapter offer different variations on how to overcome natural limitations and achieve a higher form of “modern” existence, they are fundamentally united in the early twentieth-century belief that acetate plastics were essential to the successful longevity, preservation, and advancement of modern life. Acetate technology intersected with numerous cultural concerns, and its ability to allay fears spurred by war as well as facilitate emerging public needs and desires led to its successful integration and continued development within military, scientific, industrial, and even domestic contexts. For example, acetate’s ability to both arrest and assist movement was adapted to serve post-WWI desires to stop time, as well as needs for speedy, efficient movement during and after WWII. Taxidermic replication, as this also chapter revealed, turned to acetate as a way to liberate its subjects from the flesh; suspend movement, color, and time; and fight against decay through fixed

[108] Price, 165.

immobilization. These overlooked, archaic manifestations and applications of acetate technology reveal a new, expanded understanding of its cultural importance and reception at the time, as well as provide a new perspective on how we continue to think, talk about, and practice methods of improving and saving endangered or weak materials today. Acetate emerged to offer a promise then, and even though acetate has faded away this promise remains: that new technologically-driven methods of reproduction and material substitution are the solution whenever natural or existent materials seem insufficient.

CHAPTER 2

To Know the Truth Beneath the Surface: X-ray Film and Histology Slides

In 1939, the same year Street & Smith gave Superman the power of X-ray vision, famed medical illustrator Dr. Frank H. Netter unveiled his latest scientific and artistic creation: a statuesque, seven-foot tall "Transparent Woman" made of clear synthetic plastic [Fig. 2.1].[1] Debuting at the San Francisco World's Fair as the first of its kind, Netter's woman wore a transparent skin which *Popular Science* described as "creat[ing] the illusion of peering directly into a real body."[2] Visitors marveled at the sight of this see-through woman, whose sheer skin and pin-up pose offered her body over to their gaze. A spectacular network of artificial bones, glands, and internal functions were brought to life beneath her plastic flesh; moving, colorful lights pantomimed the intricate operations of her body, with a special emphasis on the female reproductive system and interior organs of generation. Netter's Transparent Woman continued to captivate the public and arouse curiosity even after the Fair's end. As recounted nearly twenty years later in *Boys' Life* magazine, men, women, and children were still drawn to the exhibit (now held at the Boston Museum of Science) by "a special curiosity (...) [that came] in the form of an overpowering need to penetrate the unknown."[3] This residing desire to penetrate the unknown biological world, and especially the mysterious female body, likewise spurred the medical sciences to develop imaging technologies, including X-ray and histology, that could

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[1] Superman's X-ray vision was first introduced in *Action Comics #11* (April 1939), and was referred to as "X-ray eyesight."

[2] "Transparent Woman Shows How Glands Work." *Popular Science* 134.5 (May 1939): 56-57.

[3] Tony Robbins, "Discovering New Worlds." *Boys' Life* (November 1960): 50-51.

visually open and make transparent the body’s occluding surfaces to reveal its prized inner workings.

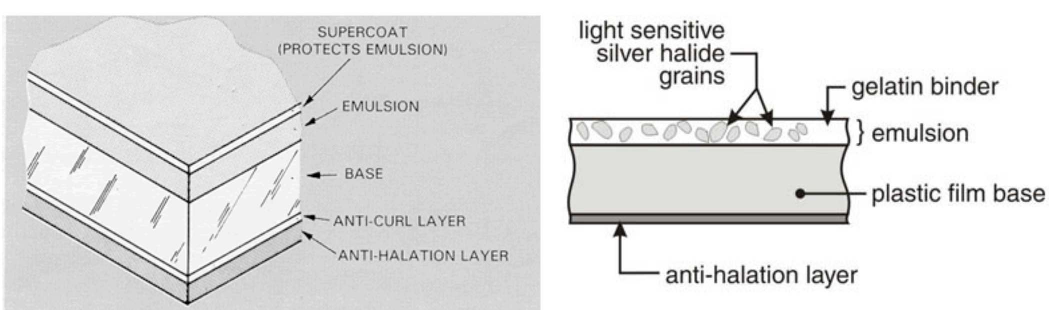
A scene in the workshop during the creation of the "transparent woman," showing the completed torso made of a synthetic plastic

This is how the unique exhibit appears to spectators. It is now on display at the San Francisco World's Fair

[Fig. 2.1] “Transparent Woman Shows How Glands Work.” *Popular Science* 134.5 (May 1939): 56.

X-ray and histology emerged at the turn of the twentieth century to satiate these overarching curiosities and desires to see and know “life.” Histology is the study of microscopic anatomy, cellular structures, and biological tissue; histological images are created by cross-sectioning, staining, and using various lacquer solutions to attach cultured tissue samples to slides for further microscopic analysis. Throughout the twentieth century, both X-ray and histological practices would refine and reinvent their modes of seeing and representation through new materials, including cellulose acetate plastics. Just as Netter rendered his model transparent through plastics, X-ray and histology similarly turned to acetate-based products to better see inside their subjects’ opaque bodies. Rather than just seeing this as an interesting case-study within the history of science, however, there is an even deeper revelation to be found: a trans-disciplinary and trans-historical connection between the type of visuality that X-ray and histology utilized and contemporary practices within film and media preservation laboratories.

The same promise introduced in twentieth century bio-imaging and advanced through acetate materials — to make known a more important “truth” beneath the surface — is the same promise that drives twenty-first century digital preservation initiatives. In these new initiatives, however, the tables have turned: now acetate is the problematic material surface that needs to be penetrated in order to reach the more important, “true” image/contents held inside the film body. When seen as a cross-section, similar to a histological sample, motion picture and photographic film are comprised of several layers [Fig. 2.2]. Each layer serves a specific purpose: the base layer provides a stable foundation for the photosensitive emulsion which contains the image contents and is impervious to organic decay, and the topmost acetate plastic layer is intended to provide a strong and protective yet clear and visually penetrable surface cover. When this top layer is scratched, scared, or starts to suffer from overuse and natural decay, acetate ceases to be the invisible facilitator of vision and becomes an overshadowing visual display of its own materiality [Fig. 2.3]. Advocates of new digital imaging technologies use them to literally peel and strip away the acetate surface in order to extract and “save” the image from its sullied cover and return it to full visual clarity in a new format. This process repeats the same functions and discourses of X-ray and histology, which stated that the surface stood in the way of visuality and should be transversed through new visual technologies (acetate at the time) in order to reveal a more meaningful and prized image.



[Fig. 2.2] Kattelle, Alan. “The Evolution of Amateur Motion Picture Equipment 1895-1965.” *Journal of Film and Video* 38 (1986): 47-57 and *Home Movies: A History of the American Industry, 1897-1979*. (Nashua: Transition Pub, 2000):101.

[Fig. 2.3] “Before and After: 35mm Acetate Film Stripping.” *Chicago Albumen Works* (18 July 2014). Accessed 2 April 2015 <https://albumenworks.wordpress.com/2014/07/18/before-and-after-35mm-acetate-film-stripping/>.

In these ways, this chapter will build upon Chapter 1’s discussion of acetate skin surfaces while also offering a new direction and shift of focus: whereas the surface was prioritized and saved as a lasting image in Chapter 1, here the surface is seen as a barrier to visuality, as an obscuring scrim to break through, and to even discard in some instances. This shift, however, does not constitute a complete break, as plastic surfaces and encasements were also still marketed as preservation strategies within domestic applications (discussed at the end of this chapter). In fact, several affinities can also be found between the use of acetate within histology and X-ray and its use to create lasting surfaces: just as taxidermic and medical casting utilized acetate to hold specimen in place and create non-moving surface replicas of biologic matter, histology and X-ray similarly utilized acetate to immobilize their subjects and turn them into lasting, representative images. Ultimately then, what this chapter reveals is a complex, ambivalent refinement of focus more than a full departure away from the importance of preserved surfaces, especially those made of acetate plastics. Still, a marked change does happen when X-ray and histology begin to use new acetate imaging materials to plumb the depth of bodies to unlock new sights. A new investment in interiors emerged along with an interest in the things held inside containers — themes that continue to inform today's media preservation discourses and agendas that focus on content rather than form, and the interior data or image instead of the material exoskeleton.

While X-ray and histology have rich histories and discourses all their own, this chapter specifically interrogates their use of cellulose acetate plastics as well as the larger conceptual shifts that resulted from these imaging methods.[4] Importantly, both practices substituted their older imaging materials with acetate technology in order to visually access internal bio-matter and life functions and reproduce them as long-lasting, still images that could be safely preserved and comparatively studied over time. One of the larger points brought to the surface here is the primacy of visuality and prioritizing interior content. This same proclivity drives digital imaging and preservation practices today, which direct all of their attention and resources towards those materials and process which seem to produce "better," clearer visual images.

The utilization of durable, clear acetate for these purposes within early medical imaging also intersected with larger cultural applications of plastics during the twentieth century. As such, this chapter also situates these specific scientific uses of acetate along side its larger, discursive integration within popular consumer culture and appropriation within the public sphere. Operating more thematically than purely chronologically, this chapter demonstrates how the introduction of acetate materials within histological practice and X-ray imaging established a desire to see and create images through processes of stripping away the external surface as their

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[4] see William Morton, *The X-Ray or Photography of the Invisible and Its Value in Surgery* (New York: American Technical Book Co., 1896); Alan G. Michette and Sławka Pfauntsch, *X-rays: The First Hundred Years* (Chichester: John Wiley & Sons, 1996); T. Doby and G. Alker, *Origins and Development of Medical Imaging* (Carbondale: Southern Illinois University Press, 1997); Bettyann Holtzmann Kevles, *Naked to the Bone: Medical Imaging in the Twentieth Century,* Sloan technology series (New Brunswick: Rutgers University Press, 1997); José van Dijck, *The Transparent Body: A Cultural Analysis of Medical Imaging* (Seattle: University of Washington Press, 2005); Harry LeVine, *Medical Imaging* (Santa Barbara: Greenwood, 2010).

highest priority. Instead of focusing on the typical mediums associated with medical imaging practices — namely, light rays and radiation for X-ray, glass slides and chemicals for histology — acetate is centralized here as a specific storage medium, imaging agent, and ambivalent surface covering that influentially shaped visuality and the rendering of permanent visual records. Within each of these applications, acetate emerged to support and advance medical renderings, while also appealing to larger cultural obsessions with achieving heightened visual clarity through new imaging technologies — yet another central pillar upon which digital imaging technologies are built along with their promises for superior optical clarity and quality.

Unlike other casting practices, X-ray and histology sought to move past the exterior and engage with the interior regions of their subjects. Particular emphasis was placed upon sectioning through a subject's obscuring surface layers to see inside and represent the body's interior essence as an external image — consequently "externalizing the internal," as Michel Foucault described.[5] Through imaging technologies that essentially turned bodies transparent, medical investigators newly emphasized the internal structures and stagnant supportive components of the body as the key to understanding life. The interior essence of human materiality was identified through early X-ray as the human skeletal system and fixed, unmoving cell bodies through histology imaging. Even though cells and bones are indeed capable of movement, and their mobility is vital for life functions, early X-ray and histological imaging methods visualized them as unmoving infrastructures. Due to the nature of their imaging processes and materials, as shall be unpacked in detail, these living, moving components were rendered immobile and dead (or seemingly "dead") in order to be visually represented. Charles Segwick Minot, a writer for

[5] qtd. in José van Dijck, *The Transparent Body: A Cultural Analysis of Medical Imaging* (Seattle: University of Washington Press, 2005): 15.

Popular Science, captured this approach to visually defining life through static structures in his 1906 article, “The Relations of Embryology to Medical Progress”; he described how, “find[ing] out what structure really is is the goal of all biological science.”[6] “When we discover this secret,” Minot concluded, “we may hope to discover also how structure functions and why it exists.”[7] In an intriguing parallel, Materialists filmmakers would also come to share this interest and used the same acetate materials as histologists and radiographers to reveal the invisible acetate structures of film. While X-ray, histology, and Materialist filmmakers would come to use acetate to peel back surfaces and reveal structure, many working in film preservation today have take to using new technologies to peel back the acetate surface of film strips to reveal the image. It is this image kernel that has become the privileged essence and content of the film object’s “life purpose” rather than its structural materials or base.

From its earliest beginnings in the seventeenth century, histology focused on visualizing, defining, and even manipulating life through its cellular components. Similar to X-ray though, histology also emphasized static support systems through methods that produced unmoving, fixed representations. By visualizing the foundational building blocks of the body as immobile, both X-ray and histology consequently defined life through its unmoving, internal structures rather than it’s moving systems. A conceptual shift, therefore, was ignited within the biosciences that was, in large part, catalyzed by X-ray and histology’s emphasis on tapping into the inner core in order to to truly see and understand the essence of organic life. Mirroring this new way of seeing inside life and defining it through visual images of the interior, this chapter argues that a

[6] Charles Segwick Minot, “The Relations of Embryology to Medical Progress,” *Popular Science* 69 (July-December 1906): 20-21.

[7] *ibid*.

similar image-orientated approach has taken over preservation and imaging efforts in the twenty-first century film lab.

X-ray:
Far Beyond the Groping Amid Fleeting

Netter's Transparent Woman displayed, quite literally, a pervasive cultural infatuation with seeing, knowing, and controlling organic life by rendering it visible. In his history of medical imaging, José van Dijck traced these desires to the Renaissance and early autopsy practices; they coalesced, he argued, into an "ideal of transparency" that exalted clear, unhindered visuality as a top priority. This thirst for un-occluded visual understanding continued into the Enlightenment period — when light, vision, and knowledge were collapsed together — and would further define the scientific Empiricism movement. Followers of Empiricism championed direct, visual observation and ultimately equated vision with knowledge. Their belief that transparent visuality would lead to irrefutable truth became an undergirding pillar for later scientific developments, especially modern imaging technologies beginning with X-ray.

When first introduced in 1895, X-ray emerged within scientific practice and public discourse as a new form of prosthetic vision that could perfect natural human sight as well as medical practice and scientific knowledge. As chronicled in a 1896 *Sacramento Daily Record-Union* feature, X-ray's unprecedented ability to see through opaque bodies "[made] surgery an exact science, and place[d] the healing art far beyond the groping amid fleeting symptoms into the realms of certainty."[8] In his 1923 article for *Popular Science*, entitled "How Science Turns the World Inside-Out by X-rays," Wilfred S. Ogden further praised X-ray technology for introducing a perfected form of transparent vision. X-ray technology promised to visually

[8] "Looking into the Unseen: The X-ray Experiments Rapidly Reaching Perfection," *Sacramento Daily Record-Union* [Sacramento, CA] 25 October 1896, 6.

penetrate opaque materials and finally satiate the enduring quest "to *know* the truth beneath the surface."[9] As popular articles like these display, public discourse invested in the value of transparent vision and its ability to provide irrefutable access to the secrets of life. These initial investments grew into an obsession with knowing and controlling the natural world by making it clearly and externally visible.[10] While early X-ray focused on the bones, this would evolve and expand through the introduction of new, more sensitive X-ray materials including a type of celluloid acetate film stock that could also detect cellular structures. Images of bones still largely dominated X-ray imaging and its way of seeing the essence of human life, but new views of new systems were now also being unveiled during the late 1920-1930s, when acetate radiographs were becoming the new standard. At this point, X-ray began to broaden its definition of life's foundational building blocks into the minute realm of atoms, nuclei, and cells — components that early, non-acetate X-ray materials were unable to see. Importantly, these images and new conceptions of foundational structure were made possible through imaging materials and techniques with acetate plastics at their base.

Previously, the only way to concretely know the truth beneath the surface, especially beneath the occluding surface of the body, was through physical means: one had to manually open the body, grope, palpate, or manipulate it in some other physical way to unearth a diagnosis. The advent of modern medicine, however, would introduce new methods of visual intervention that turned away from the value of touch and towards the value of vision. Both scientific investigators and the lay public concluded that imaging technologies did indeed "reveal

[9] Wilfred S. Ogden, "How Science Turns the World Inside-Out by X-rays," *Popular Science* 103.2 (August 1923): 36-37.

[10] van Dijck, 5.

the hidden truth," namely because they provided "pictures that prove it!"[11] Seeing rather than feeling, in other words, became equated with believing. Through new technologies that provided enhanced visual perception, investigators could now see through a multitude of barricading surfaces or deceptive appearances — including opaque bodies, false documents, and imitation goods — to publicly expose their secrets. While natural perception failed to see or know such hidden truths, the scientific eye and X-ray technology, in particular, promised to illuminate and expose these elusive mysteries better than any human detective or private eye, and beyond any shadow of doubt.

Building upon these foundational beliefs in visuality and penetrative imaging technology, acetate plastics were introduced within medical, scientific, industrial, and even domestic applications as a way to better see and understand the world via clear, transparent, and "invisible" exteriors. Acetate materials — ranging from plastic containers that showed how a device's inner mechanism work, to X-ray photographs that captured images of the body's internal structure — promised to turn opaque objects into increasingly transparent, lasting images.[12] Objects made with acetate and images captured on it were initially seen as impervious to age, degradation, or breakage. X-rays printed on acetate-based stock, for example, promised to be more durable than glass plates and less lethal than self-imploding nitrate-based stocks. Thus, acetate specifically improved upon previous methods to image the base elements of the body by providing a new imaging base that many believed was more durable and less dangerous than older materials. With an increased demand for seeing inside of living subjects, new imaging

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[11] "Detecting Art 'Fakes' with X-Rays: No Longer Need We Depend Entirely on the Guessing of Intuition of the Connoisseurs," *Popular Science* 98.1 (April 1921): 31; and Boyd Fisher, "Amazing New Jobs for X-Rays: How They Pierce the Heart of Metals, Expose Flaws and Fakes, Grow Super-Hens, and Save Men from Hidden Peril," *Popular Science* (August 1928): 128 (respectively).

[12] see "Transparent Models Expose Works," *Popular Mechanics* 88.4 (October 1947): 125.

methods and materials were demanded that could provide safe, lasting images of these internal structures, bones, and cells. In response to these desires, acetate-based imaging materials emerged and promised to ensure the subject's bodily safekeeping and integrity while allowing medical investigators to turn their internal structures into viewable, lasting images. Importantly, acetate products, such as X-ray photographs, also provided sharper imaging quality which could detect new elements of the natural world — including cells, nuclei, and atoms — that were not registered on early glass plates or nitrate film. Acetate technology, thus, revolutionized imaging practices as well as the medical sciences by opening a new window onto the foundations of life and visualizing the smallest details and building blocks of the human body.

From the Physical to the Visual

The ability to see inside bodies through visual rather than physical means was exalted as a modern innovation that would make medical interventions more concrete and empirically certain, while also preserving a subject's bodily integrity and livelihood. Only through seeing inside the body could one know and understand humanity. Medical and scientific investigators, therefore, sought to penetrate the opaque body and open its internal organs to exterior sight and control. During this time, the depth of organs within the body paralleled their presumed importance; doctors believed that these systems, tucked deep within and shrouded in dark isolation, held the secrets of life. The female body especially perplexed medical investigators and aroused their curiosity to plumb its depths, as displayed by Netter's alluring Transparent Woman. Thanks to the interior nature of female anatomy — in particular, the organs of generation which are held inside her body — women became favored subjects of clinical penetration and visualization. According to medical historian Bettyann Holtzmann Kevles, male radiologists were especially keen on using new X-ray technology for gynecological inspection.[13] Armed with novel X-ray vision, they sought to visualize the vagina and uterus, and in doing so hoped to uncover the secrets of femininity as well as expose the literal birthplace and origins of human life.

Before X-ray imaging, however, the only way doctors and scientific investigators could access the body's hidden interior was through physical autopsy. As such, the hands-on autopsying of corpses was used to expose the secrets of life hidden beneath the skin. However, physical excavation was also fundamentally problematic: since autopsy was the only way to see inside, only dead subjects could be used to reveal the secrets of life. Similar to the paradoxes posed to taxidermic preservationists —who had to kill and eviscerate their subjects in order to keep them looking alive — it seemed the only way for medical scientists to see life was through cutting open dead specimen, while also potentially cutting through and destroying the very systems they intended to study. By the late nineteenth century, however, new ocular instruments and modes of visual intervention emerged to redirect expositions of the body away from corpses and towards living subjects. Rather than prying open dead bodies, investigators could now peer into living bodies through clinical observation, visual monitoring, and less physically invasive imaging technologies.[14] Thus, new technologies beginning with X-ray ushered in modern medical imaging and offered an alternative method that was superior to natural vision as well as older, messy and destructive autopsy techniques.

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[13] see Bettyann Holtzmann Kevles, *Naked to the Bone: Medical Imaging in the Twentieth Century*, Sloan technology series (New Brunswick: Rutgers University Press, 1997).

[14] see Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception* (New York: Pantheon Books, 1973); Lisa Cartwright, "'Experiments of Destruction': Cinematic Inscriptions of Physiology," *Representations* 40 (Special Issue: Seeing Science, Autumn, 1992): 129-152.

Departing from the dead views of life previously offered through autopsy, scientists explored other advanced alternatives that could "magically" penetrate their subject's outer layers while still keeping them alive and their bodies intact. Medical imaging technologies like X-ray were popular described as "magical" in large part because they could access views of the body not available through natural vision nor without the destructive physical effects of autopsy.[15] Kenneth Crist's 1935 essay for *Popular Mechanics,* entitled "X-ray the Master of Magic," epitomized medical and popular exaltations of X-ray as magical. Crist mythically described X-ray vision as a "magic eye" and as a "strange, invisible cyclops of science that sees all, [and] reveals all."[16] Crist further suggested that X-ray enhanced vision could function as a multi-purposed panacea: it could "safeguard your life, save your money, serve your business, defend your health, prevent accidents, treat your ills, and help to keep you from being swindled."[17] As popular write-ups like this reveal, X-ray was indeed seen as a miraculous cure-all that could magically improve multiple aspects of life because it rendered life transparent and turned it into a viewable image; this paralleled a wide-spread (over)investment in ocularcentrism, which would continue to influence the medical sciences as well as public applications of transparent materials including early acetate plastics.[18]

Materials of Transparency

The ocularcentric privileging of sight aroused the need for new materials and methods that would enhance or improve natural vision. A variety of artificial materials and prosthetic

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[15] *ibid,* 14-15.

[16] Kenneth Crist, "X-ray the Master of Magic," *Popular Mechanics* 63.1 (January 1935): 90.

[17] *ibid*, 93.

[18] see Martin Jay, "The Rise of Hermeneutics and the Crisis of Ocularcentrism," *Poetics Today* 9.2 (1988): 307-26; and *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought* (Berkeley: University of California Press, 1993).

technologies were historically developed with the specific goal of facilitating transparency and supporting clear, defined visibility. Cultural historians Scott McQuire and Theresa Levitt have identified glass as one such material. As they respectively argued, glass was introduced as a way to increase transparency and open clear views to the inside from the outside. From its first large scale architectural use in the 1820s Parisian Arcades, glass captivated popular imagination and became a utopic symbol for modern advancement, technological mastery, and futurity.[19] Whereas older architectural designs featured dark and secluded rooms, modern designs utilized glass windows to open isolated interiors. Large windows made of sheet glass were praised for redirecting light, illuminating dark interiors, and ultimately bridging divisions between inside and outside. Glass windows thus reshaped notions of visibility, and were tellingly used as metaphors to describe new medical imaging technologies, including X-ray. In the previously detailed *Sacramento Daily Record-Union* article, for example, emerging X-ray technology was described as a new type of manipulated light that enabled physicians to "look into the human frame as one looks into a room through a window," which effectively turned the body "as transparent as glass."[20]

Similar to taxidermic and medical casting, X-ray and histological practices demanded imaging materials that were simultaneously durable as well as transparent. Acetate's compositional and optical qualities positioned it as the ideal imaging material suited for these needs, since it promised to be as transparent as glass, tough as steel, and ultimately longer-lasting than other imaging materials. Consequently, acetate was integrated into X-ray and histology

[19] Scott McQuire, "From Glass Architecture to Big Brother: Scenes from a Cultural History of Transparency," *Cultural Studies Review* 9.1 (May 2003): 106.

[20] "Looking into the Unseen: The X-ray Experiments Rapidly Reaching Perfection," 6.

methodologies, and was embraced as an improved replacement for older, pre-existing materials including deadly nitrate films and fragile glass slides. Beyond these material improvements, however, acetate technology was also influential in that it further advanced the ever-present quests to see inside bodies, understand the essence of life through visualize, and preserve it as a fixed image-based record. Acetate technology would also ultimately be used within X-ray and histology to reshape the body and human life as it naturally or currently existed. For example, X-ray radiographs and enforced casts were used to correct broken bones while various histological methods utilized acetate products to grow and support cells outside of the normal bounds of nature. X-ray images produced on acetate-based stocks and histological cell cultures suspended in acetate-enriched growing mediums were used by scientific researchers, including T. Wingate Todd and Alexis Carrel (whom shall be returned to later in this chapter), to not simply see life but to also intervene into its natural processes and manipulate it into what they deemed to be a more "perfected" version of human existence.

In many ways, glass primed the way for plastics, though it would eventually be overshadowed by their emergence as a superior alternative — a continuing pattern within technological advancement which continues with digital imaging technologies as they now surpass their analog predecessors. Plastics emerged at the start of the twentieth century as a new, futuristic improvement upon glass, poised to replace its use in windows and other transparent surfaces. Writing for the *Industrial and Engineering Chemistry Journal*, George B. Watkins and Joseph D. Ryan detailed how years of careful research by top chemists led to the development of a special cellulose acetate formula that offered heightened levels of transparency combined with tough durability. Acetate "safety glass," as it was named, featured a durable, clear acetate core sandwiched between plate glass.[21] Thanks to its increased clarity and resistance to surface haziness and breakage, by 1927 acetate plastic replaced glass as a superior, unbreakable alternative. In the decades following, plastics flooded the domestic market and soon nearly everything from car windshields to clarinets were made out of tough, transparent plastic. The public largely praised this proliferation of plastics, as seen in a 1940 *Popular Science* article which boasts how new musical instruments made of plastic were not only durable but now allowed one to finally "see where the music comes out." With a similar emphasis on ocularcentric knowledge acquisition, a 1947 article in *Popular Mechanics* championed how complicated devices were now being constructed out of transparent plastics, which allowed users to better see and understand how their internal machinery worked.[22] Plastic portals and encasements were thus presented as superior replacements for opaque or glass surfaces. Ultimately, the general public embraced plastic replacements as superseding glass and becoming the new pinnacle in modern, transparent materials.

While increased surface transparency was an important feature, new acetate-based safety glass was also championed for its ability to keep users safe from physical harm. In the 1933 *Popular Science* article, "Auto Glass that's Crash-Proof," motorist Gus Wilson described in bloody detail how his glass windshield exploded into thousands of dangerous shards when he ran his automobile off the road and into a fence. While his wounds were more disfiguring than life-threatening, his gory description of the incident suggested that glass could pose a serious safety hazard. However, as the article concludes, Mr. Wilson could avoid future incidents and injuries

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[21] Original safety glass designs utilized cellulose nitrate as the plastic core component. However, as in many other applications, acetate was found to be a more durable, safer, and all-around superior cellulose plastic compared to nitrate.

[22] see "Transparent Models Expose Works," *Popular Mechanics* 88.4 (October 1947): 125.

by investing in safety and replacing his original glass windshield with new safety glass. In the same year this article was printed, acetate "safety film" was also introduced as a non-flammable replacement for deadly, combustable nitrate X-rays. Twenty years later, histology would also turn to acetate as a safe, shatter-proof replacement for its fragile glass culture slides as a way to keep its specimen better intact and preserved. Once the material of modern technological mastery and transparent vision, glass was now surpassed by new acetate alternatives; all of these alternative applications and uses thus turned towards new acetate technology and redefined themselves through this new, equally transparent yet less breakable material.

Early X-ray Technology and Materials

Discovered in 1895 by German physicist, Wihelm Röntgen, X-ray technology enabled physicians to peer inside the body with a new kind of light that seemed to make one's skin invisible. As praised by William Morton in his 1896 book on the marvelous benefits offered by early X-ray technology, "there can be little doubt that no more valuable means of diagnosis has ever been afforded to the science and art of medicine."[23] X-ray imaging, in fact, provided the first internal views of intact, living bodies; importantly, these first images were of the skeletal system, and bones were identified as the inner core of the human body.[24] While much of the scholarship surrounding X-ray has focused on its manipulation of light rays and radiation, X-ray also relies upon receptive, photosensitive surfaces to capture and produce its images.[25] Focusing

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[23] William Morton, *The X-Ray or Photography of the Invisible and Its Value in Surgery* (New York: American Technical Book Co., 1896): 141-142.

[24] Harry LeVine, *Medical Imaging* (Santa Barbara: Greenwood, 2010), ix.

[25] see Lisa Cartwright, *Screening The Body: Tracing Medicine's Visual Culture (*Minneapolis: University of Minnesota Press, 1995); Bettyann Holtzmann Kevles, *Naked to the Bone: Medical Imaging in the Twentieth Century,* Sloan technology series (New Brunswick: Rutgers University Press, 1997); and Akira M. Lippit, *Atomic Light (Shadow Optics)*, (Minneapolis: University of Minnesota Press, 2005).

on these aspects of X-ray, this section redirects attention back onto its collection materials and imaging surfaces; it interrogates how plastic film and acetate, in particular, was introduced as an improved way to render stable, precise, and safe radiographs. Importantly, acetate stocks were also used to advance X-ray imaging beyond the realm of bones; through increasingly sensitive stocks and emulsions, X-rays developed on acetate captured views of cells and molecules that were increasingly identified as the smallest, foundational components of life. As such, this section argues that acetate technology revolutionized the medical sciences by enabling X-ray to not only define life through its skeletal support system, but to newly identify molecular building blocks as the essence of life.

X-rays and radiographs (the photographic images produced by X-ray) were essentially discovered by accident. While conducting experiments with cathode ray tubes, Wihelm Röntgen inadvertently exposed a piece of cardboard coated with a photographic developer to the tube's emitted rays.[26] A florescent shadow outlining various objects within the room was consequently transposed onto the cardboard surface. After this serendipitous incident, Röntgen redirected his investigation to focus on the nature of these mysterious "X" rays; he soon discovered that X-rays could pass through seemingly opaque objects and, if captured on a photosensitive surface, could produce shadowy representations of the things hidden inside or beneath an object's surface. From these cardboard beginnings, radiographers turned to other materials as the base for their X-ray renderings. Initially, glass plates were used as the standard imaging medium — just as they were in early photography before the introduction of plastic roll film in 1889.

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[26] Cathode ray tubes would also be used in early television technology, in particular pre-flatscreen television set designs.

While a version of nitrocellulose roll film was already invented at the time of Röntgen's first radiograph production, and was already being used in photography and the newly emerging cinematic field, glass remained the collection medium of choice within X-ray imaging. Unlike photography or cinematography which pulled their film through a camera apparatus, radiography did not require its imaging materials to be as flexible. Instead of using a mediating camera apparatus, radiography passed X-ray light directly through the body. In essence, the body functioned as the "lens": acting as a semi-permeable filter, it allowed some light rays to pass through it and onto the receptive plate placed behind it. In short, radiographic imaging depended upon the direct interaction of its subjects and light rays with its photosensitive surface; it used the body itself, light rays, and the collection surface as its mediating apparatuses. Relatedly, Structural Materialist filmmaking (which shall be returned to in the Coda section) is also characterized by directly acting upon and the imaging surface rather using a mediating camera or lens to produce its final images. By relying on only these three components, it was essential to have imaging materials that were as sensitive and stable as possible, since they were largely responsible for how the image would develop. While glass was initially utilized as a transparent imaging surface, it would eventually be replaced by less breakable, more sensitive, and more available plastic film, which today is has almost been done away with in favor of film-less alternative imaging materials.

Glass' historical, cultural, and aesthetic associations with clear vision, open access, and futuristic potential contributed towards its initial use within X-ray imaging. This would change, however, with the outbreak of World War I. As T. Doby and G. Alker chronicle in their discussion of medical imaging technologies, the War curtailed access to Belgium and the specific type of Belgium glass used to make radiographic plates. A substitute was thus required and, mirroring photography's technological trajectory, nitrocellulose plastic film was turned to as a solution. While some claimed early nitrate plastic films were not as transparent as glass, others enthusiastically embraced new "X-ray photographs" as superior alternatives. Importantly, this transition from glass to plastic was couched in a promise: that new plastic materials would facilitate scientific visualization and improve medical observation through surfaces that were not only as transparent as glass, but, in the specific case of acetate X-ray film, could also be safely saved and referred back to over an extended period of time.

More than merely providing practical and material advantages, however, acetate stock also introduced an important conceptual shift in terms of how X-ray images were used and valued within scientific practice. Before acetate, glass and nitrate radiographs posed storage and preservation issues: glass plates were fragile and easily breakable while nitrate films were violative and easily combustible. Nitrate radiographs were especially problematic in this regard, and posed a serious safety risk. As Kevles has noted, "fires broke out so regularly in American doctor's offices that it was standard for fire departments to be alerted to the dangers from X-ray libraries."[27] Consequently, radiographs were not the easiest medical records to preserve, especially not for extended periods of time. This would change, however, with the introduction of acetate radiographs (or at least it appeared to have changed in the beginning of their use). Acetate was initially believed to be a stable, long-lasting storage medium that could be shipped and archived more easily than glass or nitrate. Because X-rays records printed on acetate stock could be kept longer and referred back to over time, like well-preserved fossils or artifacts,

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[27] Kevles, 110.

medical researchers were able to conduct long-arc experiments and clinical investigations; they could chart bone growth, for example, and other physiological changes more easily and accurately than before thanks to the trusted properties of acetate X-rays. This innovation and improvement upon existent X-ray technology would prove invaluable for researchers like T. Wingate Todd (whom shall be returned to in following paragraphs), who relied upon the long-term study and preservation of X-ray records to support his investigation into human growth and evolution.

New Vision, "Living Autopsy"

X-ray images, in general, were valued for their ability to render internal anatomy as distinct areas of light and shadow. On a technological level, X-ray confirmed existing cultural connotations that associated light and transparent vision with knowledge and a thriving livelihood. Through its manipulation of light, X-ray illuminated the body and made visible the potentially deadly shadows lurking within its interior. While bones and certain organs absorbed X-rays and left behind benign shadows, flesh and normal bodily viscera were invisibly transparent under X-ray imaging. In contrast, abnormal tissue, areas of disease, and certain illnesses (such as pneumonia, tuberculoses, and cancerous tumors) emerged as opaque, cloudy shadows upon the photographic surface. By "throwing light," as many popular print articles described, X-rays illuminated the darkest corners of the body, and thus provided a literally "enlightened" new view and understanding of mankind.[28]

Scientific and popular discourse presented X-ray technology, and especially its integration of new plastic materials, as advancing modern, ocularcentric medical methods. In a

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[28] see John E. Lodge, "New Studies of Bones Show How We Grow," *Popular Science* 127.1 (July 1935): 14-15; 107.

1919 national edition of the *The Washington Times*, entitled "How Your Lungs Look in Pneumonia and Tuberculosis," "X-ray photographs" developed on crisper, clearer double-emulsion nitrate film were praised for enabling physicians to better "watch" their patients, monitor their progress, and treat their internal maladies. X-ray technology also resonated with larger trends in medical and scientific practice which, as Michel Foucault and Lisa Cartwright have theorized, increasingly privileged visual observation over tactile, hands-on sensory methods.[29] By the turn of the twentieth century, clinical medicine had moved away from physical or other sensory forms of examination, such as stethoscopic medical listening, and towards visual interventions.[30] In step with this turn, X-ray imaging became the new standard in modern medical diagnostics and information gathering.

This full-page, illustrated feature not only confessed a positive embrace of plastic technology, but also revealed residing cultural preoccupations with visually penetrating the female body. Both of the article's headlines appealed to sight and reveal to how vision was positioned as a privileged sense within modern medicine and popular culture at the time. The lead banner teased readers with the promise of showing them how their lungs "look" inside, and a second headline enthusiastically proclaimed that, through X-ray visualization, physicians were now better equipped to monitor and treat diseased lungs. X-ray photographs opened up the living body to visual intervention, and were presented as a new type of "living autopsy." Essentially, X-ray mimicked the actions of autopsy while it also improved upon them through advanced visual methods. Instead of relying upon physically cut-open cadavers to provide vital information about

[29] see Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception* (New York: Pantheon Books, 1973); Lisa Cartwright, "'Experiments of Destruction': Cinematic Inscriptions of Physiology," *Representations* 40 (Special Issue: Seeing Science, Autumn, 1992): 129-152.

[30] for a separate discussion of aural technology and, in particular, the stethoscope, see Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Durham, Duke University Press: 2003).

the human body and life, X-ray allowed for living bodies to be visually opened and have their internal contents displayed as fixed images.

As previously discussed, clinical investigators were especially intrigued by the internalized structure of female anatomy. As such, (predominately male) investigators sought to excavate the secrets of their female subjects through physical dissection and, eventually, visual penetration. In keeping with this desire to subject the female body to medical visualization, the "How Your Lungs look in Pneumonia and Tuberculosis" article featured two female patients under the effects of X-ray imaging. Its smaller figures depicts a fully dressed woman strapped to an upright telemetry table. A male doctor, dressed in all white, stands beside her while adjusting imposing beams that enclose her like a metal cage. Even more provocative, however, is the article's preceding headlining figure. Pictured at the top of the article, beneath cartoon renderings of sick lungs, is a young girl horizontally laid out on a glass table with X-ray photographic plates positioned beneath her. Dressed in a gauzy, sheer gown, she is ambiguously presented as a sleeping child, a sensually swooning young woman, and a corpse ready for autopsy. Her horizontal placement on top of the X-ray slab visually echoes a cadaver placed on a dissection table, which further supported X-ray's characterization as a new type of "living autopsy" capable of producing external views of the internal body. The girl herself is also posed in a suggestively opened manner. With an arched back, heaving chest, and arms held underneath her head (a pose that Netter's Transparent Woman would similarly strike twenty years later), her body screams of physical availability and is presented as an offering for the X-ray machine's penetrating medical eye.

Both of these renderings depicted female patients held beneath the gaze of an embodied male observer and his surrogate imaging apparatuses. As such, they perpetuated stereotypical, gendered power dynamics where the female body is presented as a site to be explored and excavated through medical intervention. However, women were also on the other side of medical looking machines and were, in fact, active wielders of X-ray technology themselves. Within the history of X-ray imaging, female radiographers and researchers including Elizabeth Fleischman (1859-1905) and Marie Curie (1867-1934) were influential advancers of X-ray technology. Fleischman was especially characterized as pioneering early turn-of-the-century X-ray experiments through a "womanly curiosity" and "wizardry" that even rivaled her male counterparts.[31] Female figures thus assumed active and multifaceted roles in the development and discourse surrounding medical imaging technologies.[32] A 1913 article in *The Day Book* even described X-ray and new visual technologies as tools used by women to enact their own type of technological gaze.[33] Evoking the mythical stare of Medusa, this type of female gaze and

[31] see "San Francisco's Twentieth Century Witch," *The San Francisco Call* [San Francisco, CA] 10 February 1901, 3.

[32] A 1913 feature in *The Day Book*, entitled ""Single Eye Glass the Real Thing — Also is the X-ray Skirt Direct from Paris," illustrates an active, self-directing type of "New Woman" who defined herself through the appropriation of new technologies. In an embodied display of modern "up-to-dateness," these girls donned the latest in fashion and visual technology as part of a new masquerade. Described in the article as dandy-like "chappyettes," these girls appropriated glass monocles and paired them with latest Parisian fashion import: "X-ray skirts." "The monocle is not the only part of their get-up that can be seen through,"[41] the article's author described in slight chagrin as chappyette's, clad in see-through X-ray skirts, unabashedly paraded around in public with their undergarments on external, visual display. While these skirts were in fact made of gauze fabric and not literal photographic X-ray materials, they nonetheless turned transparent in direct light and opened a view of the wearer's body that was normally hidden from view. Through a pastiche of old (monocles) and new (X-ray skirts), chappyettes took ownership over visual technologies and techniques typically used by male agents to exploit female bodies. Instead of solely being scrutinized under a magnifying monocle or stripped bare beneath X-ray imaging, these newly empowered girls reappropriated these devices and through them established their own authority to look for themselves as well as let themselves be seen by others. Even though chappyettes were demonized by some and even legally prosecuted for choosing to "indecently expose" themselves in public, they nonetheless continued to wear revealing, risque X-ray skirts. As the article concludes: even when the spying sun beat down, the chappyette wore her X-ray and resolutely bared her garments and body beneath it, making her courage and agency as transparent as her sheer coverings. See "Single Eye Glass the Real Thing — Also is the X-ray Skirt Direct from Paris," *The Day Book* [Chicago, IL] 29 July 1913, 28-29.

[33] "Single Eye Glass the Real Thing — Also is the X-ray Skirt Direct from Paris," 28-29.

feminine appropriation of visual technologies were established in popular discourse as freezing, immobilizing acts of vision; this evocation of a feminized, freezing type of technological vision would not only be used to describe X-ray vision, but would also used to describe the methods and effects of histological imaging.

Skinned Alive

X-ray's visual interventions were fundamentally similar to those introduced into other scientific practices, such as taxidermy, in which the latest technologies were used to create stilled images of living embalmment. In short, taxidermic mediation and X-ray imaging produced images of "life" that were twisted amalgamations of life and dead: taxidermy visualized dead specimen as living still-lifes, while X-ray visualized living subjects as if they were autopsied cadavers. X-ray and taxidermic preservation further intersect through a shared preoccupation with translucent skin surfaces. Even though taxidermy and X-ray can be seen as fundamentally different in that the former focuses on the body's exterior and the latter focuses on its internal systems, they nevertheless both act upon and manipulate the skin surface.

Taxidermy, for instance, treats organic skin as a hindrance that needs to be removed, but as plastic skins as a preferable covering surface. In the name of realistic preservation, it also discards the subject's internal viscera, organs, and fluids along with its fragile skin in favor of artificial replicas that can be indefinitely maintained. This was especially true in Leon L. Walters' 1925 celluloid method, in which a mount's natural skin was replaced with longer-lasting, translucent acetate coverings that would function as permanent support structures. X-ray similarly focused upon the structure of the body and how this could be made permanently visible through acetate-supported products. Taxidermy and X-ray also intersect on a conceptual level:

both primarily define life through its static form and structure rather than its moving physiology. As detailed in chapter one, taxidermists saw movement as inimical to their preservation efforts. X-ray mediation similarly saw movement and the external, opaque skin as obstacles that prevented the clear rendering of the body's interior essence — which it initially identified as the skeletal system. Medical casting, too, mirrored taxidermy and X-ray by acting upon its subject's skeletal and physical scaffolding with immobilizing acetates casts and braces, which themselves functioned as an external support structures.

Echoing the sentiments of taxidermists, radiologists similarly sought to transverse the limitations of natural skin as well as freeze their subjects into fixed still-lifes by rendering the skin transparent and visually penetrating it. As Kevles has argued, this treatment lead to a cultural sea change in which barricading surfaces, including natural barriers like the skin, ceased to exist as impenetrable walls; instead, technological intervention and visual imaging practices like X-ray turned these closed surfaces into opened windows or "smoky scrims through which we know we have access."[34] The traditional value and effectiveness of skin as an opaque shield was thus challenged and ultimately eclipsed by desires to render it transparent and reveal the mysterious secrets held beneath its surface. In a reversal of what happens in death or autopsy — where the skin naturally falls away or is forcibly removed — new medical technologies could visually "remove" the skin from living subjects and provide a temporary illusion of opened access to their interior secrets. A 1921 *Popular Science* article, for example, praised the development of a "peculiar liquid" that could render a subject invisible or transparent. Through a complex manipulation of the skin's natural light reflecting properties, this newly engineered

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[34] Kevles, 261.

substance allowed scientists to visually peel away a living specimen's skin, and it was praised as a marvelous scientific innovation that would lead to new experiences and views of life. Ultimately, new medical technologies redefined the removal of skin as no longer solely and negatively associated with death, autopsy, or decay. Rather, the dissolution and disappearance of the body's outer coverings were now re-valued and re-scripted as part of positive technological advancements and futuristic improvement. This rhetorical tactic would similarly resurface in digital processes that remove the acetate layer from photo-cinematic objects in an act akin to the debridement of dead, damaged tissue that will bring forth new, and better life in the form of a clearer visual image.

The 1933 film adaption of H.G. Wells' *The Invisible Man* (dir. James Whales) further reveals how scientific manipulation — and, specifically, turning a living subject's skin transparent — was valued as a modern and even futuristic achievement. In this filmed version, the Invisible Man derived his fantastical power through scientific experiments that turned his skin transparent. As a result, the Invisible Man was given a new form of life defined by technological manipulation and the (dis)appearance of his skin. While natural skin only becomes "invisible" after death and as a result of decay, the Invisible Man's skin was transparent in life and only became opaque upon his death. In a very similar way, transparent cellulose acetate plastic only becomes truly visible through its spectacular process of material failure and decay. This theme of finally "seeing" acetate as "acetate" through its death shall be returned to in chapter six. In Wells' science fiction narrative, however, transparent skin was newly connected with vital livelihood. The taxidermic sciences, and Walters' acetate method of surface preservation also established a connection between life and see-through skin. In his own quest to represent life into the future, Walters relied upon the superior transparency of acetate skins. Ultimately, he created animal mounts which, like the Invisible Man and Netter's Transparent Woman, were given a new life cloaked in technologically-produced, see-through skins. While largely connected to a new, modern form of "life" and praised within medical and popular discourse, X-ray was not without its flaws. Nitrate-based X-rays, in fact would prove to be fatally flawed. In an ironic perversion of an earlier 1896 article in the *Sacramento Record-Union*, which valorized X-ray as a "ministering angel, [that] fold[s] its wings and shower[s] its blessings," nitrate radiographs would soon become angels of death, raining toxic gas and destruction instead of blessings and healing.

Death by Nitrate

On May 15, 1929, one hundred and twenty-three Cleveland, Ohio residents perished in what was then considered to be the most dreadful disaster in city history. A "holocaust struck without warning," *The Palladium News* described, as poisonous gas and fire swept through the Cleveland Clinic in a magnitude that has "only been seen in war."[35] This "holocaust," however, was not caused by enemy invaders nor by natural disaster; rather, it was caused by a medical instrument meant to save the very lives it ended. X-ray film, printed on nitrate and improperly stored within the Clinic's basement, caught fire that fateful morning and cause a blaze that proved fatal to the hospital patients as well as the practice of using nitrate-based radiographs. Even though the European film company, Pathé, had already developed a version of acetate safety film for radiographic imaging, and Kodak had just introduced their own version a year before the Cleveland fire, nitrate X-rays were only phased out as a result of this catastrophe.

[35] *The Palladium News* [Benton Harbor, MI] 16 May 1929, page 1; and National Fire Protection Association (International). (1929). *The Cleveland Clinic Fire (May 15, 1929), 122 Dead in Nitrocellulose X-Ray Film Fire*. (No. F-22-12M), (Boston: NFPA), 2. (respectively)

By 1933, acetate film stock completely replaced nitrate radiographs. Emerging from nitrate's ashes, acetate was trusted to succeed where its predecessor had failed: it promised to intervene and improve X-ray imaging by ensuring the physical safety of its users. In addition to decreased flammability, acetate safety film also provided improved image clarity and light sensitivity. Positioned as a superior replacement for both glass and nitrate film, acetate was thus publicly touted as "safer" and "superior." With this, a discursive atmosphere developed around acetate that highlighted its abilities to preserve life and keep subjects safe, while rendering them increasingly visible. Acetate's use within other scientific and domestic applications during this time — which included taxidermic preservation, food storage containers, and home moviemaking — further contributed towards this overarching understanding of acetate that saw it as a positive technological improvement upon existent life and materials.

Even though X-ray imaging was used to save lives and acetate safety stock was especially marketed as a way to safely image subjects, the technology was still marked by lingering associations with death. As Kevles provocatively put it, "X-ray was the first technology to come with a built-in time bomb," and in many ways it was seen as a threat to human life and wellbeing.[36] X-ray's radioactive lightwaves threatened to poison those routinely exposed to them and, as proven by the Cleveland fire, nitrate radiographs threatened to suddenly and catastrophically explode. Early X-ray technology and especially nitrate radiographs, therefore, were haunted by specters of death. These deleterious detractors, however, were largely overlooked in favor of their positive contributions. While early references in *Popular Science* suggest that even the lay public knew about the "insidious effect of X-ray [radiation] on the skin

[36] Kevles, 4.

and other tissues" during the 1910s, Kevles argued that X-ray and its irradiating rays were still considered benign or unimportant compared to their many benefits well into the 1940s.[37] This willful disregard for X-ray's harmful effects, however, could no longer be overlooked in the aftermath of public tragedy, as in the case of the Cleveland clinic fire. Acetate was thus introduced as a saving alternative, and promised to better protect lives while also providing better and new views of the essential elements of life.

Dead Skeletons, Living Bones

Before acetate technology allowed X-ray to newly visualize the molecular components of life, it mainly produced images of bones. Even though these iconic images belonged to living subjects, bones carried lingering by associations with death. Quite literally, X-rays turned subjects into living, ghostly images of bones and skeletons — images which theorist Akira Lippit has described as "producing at once an optics and archive of annihilation."[38] Skeletal remains, as Kevles has also noted, were historically associated with death and were a source of abject cultural infatuation especially during the late nineteenth century.[39] Historically, one's bones were only visible after their death or through autopsy. Consequently, skeletons came to symbolize the cessation and destruction of life. X-ray imaging, however, would open a new window to see bones within still living bodies, and consequently introduced a different perspective on skeletons as part of living organisms.

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[37] see "Electricity in the Air Blamed for Ills," *Popular Mechanics* (November 1911): 635-36; G. Contremoulins, "Are Modern X-Rays a Public Danger?" *Popular Science* 99.1 (October 1921): 24; and Kevles, 4 and 124.

[38] Lipit, 5.

[39] see Jeffrey Sconce, *Haunted Media: Electronic Presence from Telegraphy to Television* (Durham: Duke University Press, 2000).

However, while X-ray photographs of bones did infiltrate visual culture and circulate as popular and even erotically charged images, as Lisa Cartwright has argued, such skeletal views still aroused certain connotations with death.[40] X-ray's technological limitations added to this, since it could only represent subjects as a series of stagnant, de-animated images. Early versions of X-ray were bound by arrestment and immobilization: they were only capable of rendering unmoving images and required patients to hold as still as possible so that their internal structures would develop as clear images on film. While radiologists attempted to augment early X-ray with devices like the fluoroscope (which could capture moving images), its resultant images appeared as motionless as death itself. Operating within these limiting parameters, early X-ray orientated itself towards imaging unmoving structures like bones and with visualizing structural form rather than mobile function.

While X-ray was also used for other diagnostic and treatment purposes — such as locating foreign objects within the body or treating surface skin disorders — the mending of broken bones emerged as one of its earliest and most iconic uses. As introduced in chapter one, acetate technology was not only used to diagnosis broken bones but was also used in their treatment. Kodak's 1949 advertisement for radiographic materials, placed in the *Journal of Bone and Joint Surgery,* described how doctors could literally "picture the patient's progress" through X-ray imaging and ensure that their reset fractures would properly heal, bringing the patient back to a "perfected" lifestyle. Serving modern medical progress while placating to growing obsessions with visual intervention, Kodak marketed X-ray technology as a form of photographic vision that would allow doctors to see inside their patient's bodies, monitor their

[40] see Lisa Cartwright, *Screening The Body: Tracing Medicine's Visual Culture* (Minneapolis: University of Minnesota Press, 1995).

injuries, and restore their broken bones. Acetate-based X-ray materials were also used to physically treat broken bones, not simply visualize them. In his 1945 article on orthopedic casting innovations, M. Laurens Rowe detailed how strips of leftover acetate radiographs could be sandwiched between layers of plaster to create an economical and effective casting material.[41] X-ray materials were therefore used in both the visual diagnosis and treatment of fractures,which effectively led X-ray technology to became all but synonymous with bones.

Along similar lines, acetate and bones can also be seen as sharing certain material-based similarities and functional qualities. Bones provide the body with an internal support structure that is simultaneously strong and durable, while also impressionable to stress or other physical influences.[42] Acetate is fundamentally similar in its role as a foundational "skeletal" support layer for certain types of photographic film in addition to a topcoat "skin" covering. In the case of photographic roll and sheet films, cellulose acetate served as the base support that stabilized and protected internal emulsion layers.[43] X-ray photographs and skeletons were also understood as similar to each other in that both functioned as fixed, fossilized records of life that would remain long after the death of their subject.

In his provocative discussion of Dr. T. Wingate Todd's 1935 anthropological study of bones, John T. Lodge further established a connection between fossilized bones and X-ray records. Todd's study sought to advance the human race and ensure its progressive "betterment"

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[41] see M. Laurens Rowe, "An Easy and Economical Method of Making Removable Casts," *The Journal of Bone and Joint Surgery* 27.3 (July 1945): 521-522.

[42] see Leslie Brainerd Arey, *Human Histology: A Textbook in Outline Form*, Third Edition (Philadelphia: W. B Saunders Company, 1968).

[43] By 1925, Kodak began producing sheet film on acetate-based stock; at this time, acetate-based Eastman Pan Portrait sheets replaced Eastman Portrait which, since its introduction in 1913, was printed on nitrate. While existent histories are unclear as to when the first use of acetate safety stock began in amateur roll film, by 1934 Kodak released an acetate version of 35mm roll film, and further revolutionized color photography through its introduction of acetate-based Kodachrome roll film in 1935.

through X-ray imaging and charting the skeletal development of children. According to Todd, bones where receptive surfaces that were shaped by natural influences and life circumstances. Essentially, one's bones functioned as a permanent material record that retained traces of their life; as Lodge poetically put it: "[w]ritten on the bones of your body is an amazing record of your past."[44] Seeing bones as malleable archives of the past, Todd believed they held the secrets of human evolution and development; consequently, he sought to uncover mankind's past and improve its future of through X-ray imaging. For Todd, both skeletal remains and living bones held the secrets of human origins. Through their carefully study, he hoped to advance human life and bring modern civilization to a newer, higher level of evolutionary development. Echoing the aims and intentions of the biosciences, in general, Todd desired to perfect the human race and ensure its proper functioning through technological intervention. Todd's work also revealed a desire to create lasting visual records of ephemeral subjects and civilizations — a desire that was especially pressing during this tenuous period leading into WWII.[45]

For the purposes of his study, Todd subjected four thousand Cleveland children to X-ray imaging, beginning while they were still in-utero and continuing over the course of their adolescent maturation. Essentially, Todd utilized X-ray imaging to produce a catalogue of acetate radiographs that doubled as a medical photo-album of his young subjects. Todd noted every physical change in bone growth and skeletal development through illustrative X-rays. Mirroring traditional family albums, which commemorate the growth of children, Todd's radiographs marked the passing of time with a certain ambivalence: while the child's healthy growth was

[44] Lodge, 14.

[45] These same desires directed the use of acetate technology within home photography, moviemaking, and other domestic applications throughout WWII and into the Cold War.

positively charted, it was also nostalgically morned as the end of their childhood. Growing-up and aging are progressive processes that inevitably lead to death; this becomes even more pronounced in the rapid aging of children, whose development into adulthood comes hand-in-hand with the death of their childhood. In defensive backlash against this march of time, visual imaging methods are frequently turned to as mummifying devices that can freeze time and crystalize subjects within an unchanging image.[46] Along with these metaphorical ways of arresting motive subjects, transparent plastics also literally held subjects in place. As described in the May 1947 issue of *Popular Mechanics*, for example, plastics harnesses were used to immobilize squirming, lively babies while their images were photographically immortalized.[47] Family photographs, home movies, and Todd's radiographs all functioned in this same manner: they froze moving subjects into unchanging images captured within longer-lasting materials. In all of these contexts, acetate plastics were used to crystalize moments in time and forge a permanent history of ephemeral life.

As Todd's research exemplifies, X-ray was in large part defined by its ability to create a lasting, fixed visual record. In this way, X-ray imaging and taxidermy can be theorized as intersecting through a shared desire to permanently preserve moving subjects as unmoving, unchanging representations of life. Movement posed a problematic impasse for both radiologists and taxidermists: moving subjects threatened to compromise the rendering of clear, legible X-ray images, and similarly compromised taxidermist's ability to maintain their mounts. As such, each practice constructed a view of "life" that prioritized a subject's static structure over their mobile

[46] see André Bazin, "The Ontology of the Photographic Image," *Film Quarterly* 13.4 (Summer, 1960): 4-9.

[47] see "Transparent Plastic 'Baby Poser' Holds Children for Photographs," *Popular Mechanics* 87.3 (March 1947): 131.

functions and life processes. In sum, X-ray, taxidermy, and histology all privileged immobile form over mobile function; they each created still images and arrested representations that focused on their subject's supportive, structural elements. As such, the image of "life" produced through these practices and promulgated within the biosciences and public sphere was defined by arrestment. Before a fascination with modernity, speed, and movement emerged to redirect interests towards mobility and function, the biosciences initially focused on representing and understanding life through an organism's unmoving components. X-ray imaging spoke to this emphasis on structure and form, and emerged as a promising tool within early bioscientific practice that could reveal the foundational structures that give organisms their form, shape, and bedrock of existence.[48]

While X-ray began with a specific emphasis on bones, however, new innovations in acetate-based radiographs advanced X-ray practice to see further inside the body to the smaller molecular components of life. As early as 1928, scientists were already speculating that X-ray technology could be adapted to capture images of molecular components — minute views that had previously eluded them.[49] Professor George L. Clark, from the University of Illinois, predicted in *Popular Science* that within a couple of years, "X-ray would be able to show us not only the molecules and atoms of which all things are built, but even the tiny suns and plants

[48] Interestingly, the paleontological field experienced a wave of breakthroughs around the same time as X-ray imaging first emerged, which served to further confirmed the significance of bones as the bedrock of existence. While the unearthing of dinosaur bones and fossils dates back at least to the seventeenth century, a rush of new discoveries occurred throughout the mid-late 19th century — including the first near-complete dinosaur fossil to ever be excavated in the United States in 1858, and the 1862 the discovery of limestone fossils in Germany that seemed to be "missing link" between dinosaurs and birds. These exciting discoveries would chronologically lead into the discovery of X-ray imaging, which would also initially define human life through its skeletal structures. In both fields, bones became a rosetta stone for understanding organic life, in both its past and present forms.

[49] see Boyd Fisher, "Amazing New Jobs for X-Rays: How They Pierce the Heart of Metals, Expose Flaws and Fakes, Grow Super-Hens, and Save Men from Hidden Peril," *Popular Science* (August 1928): 31-32, 128.

within the atom!"[50] His prophesy would come to fruition less than a decade later, as reported in the April 1937 issue of *Popular Science.* As reported here, new X-ray techniques and acetate stocks had just been developed that allowed scientists to see new things that older X-rays could not. Through acetate film's heightened sensitivity, superior emulsion layers, and finer image grain, scientists could now see new aspects of life that older X-rays failed to capture. Radiographers were no longer limited to views of bones, but could now also produce X-ray images of cells and tissue — elements that were previously only visible through histological imaging methods.[51] Ultimately, acetate-supported radiographs unlocked a new layer of living matter's secret essence; instead of solely defining life through its bones, X-ray began to visualize the foundational elements of life through its molecular and cellular components, like histological imaging.

Histology Slides:
To Kill Instantly and to Harden into Changeless Permanence all that Gazed upon It

While many histories of histology trace its first appearance to the seventeenth century, it only matured into a medical science by the end of the 19th century. Histological imaging encompasses the microscopic analysis of tissue samples — sometimes living but usually dead — and their internal structures. Histological images are primarily created by cross-sectioning, color staining, and using lacquer solutions to affix organic tissue onto artificial platforms. In his historical survey of the field, Leslie Brainerd Arey further defined histology as the study of an organism's foundational units, which it primarily identified as cells and their microscopic

[50] qtd. in *ibid*, 128.

[51] see "New X-ray Photographs Aid Study of Cells," *Popular Science* 130.4 (April 1937): 13.

structures.[52] Beginning in 1828, before the invention of X-ray and its first internal images of the skeletal system, scientific researchers debated over whether all matter was fundamentally formed by atomic and molecular structures. As Hannah Landecker noted in her discussion of early cellular theory, proving the existence of molecules was one of the larger, fundamental quests directing the biosciences as well as their questioning of what constituted life and visible reality.[53] In an effort to identify the singular, uniting component shared by all living organisms — from the simplest unicellular ameba to the most complex Homo Sapiens — early scientists and histologists, in particular, focused on the cell and identified it as the elemental component "common to both plants and animals and the natural starting point of physiological (...) life."[54] Following this branch within the biosciences that focused on molecular and cellular components as the structural building blocks of all organic life, histologists sought to further visualize, understand, and even reengineer life through the collecting, sectioning, fixing, embedding, and staining of dead cells.

Answering the call of Brian Bracegirdle, who claimed histories of the microscope have overshadowed other aspects of histology, this section redirects attention away from the microscope and towards the other materials, methods, and apparatus used within histological imaging.[55] While developments in microscope technology greatly influenced histological practice, this section will primarily focus upon histology's other chemical and material

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[52] see Leslie Brainerd Arey, *Human Histology: A Textbook in Outline Form*, Third Edition (Philadelphia: W. B Saunders Company, 1968).

[53] Landecker, "Cellular Features: Microcinematography and Film Theory," 910.

[54] Judy Johns Schloegel and Henning Schmidgen, "General Physiology, Experimental Psychology, and Evolutionism: Unicellular Organisms as Objects of Psychophysiological Research, 1877-1918," *Isis* 93.4 (2002): 616.

[55] see Brian Bracegridle, "The History of Histology: A Brief Survey of Sources," *History of Science* 15.2 (June 1977): 77-101.

components, including lacquer fixatives and supportive platforms that utilized acetate. Similar to previous sections, this section unfolds thematically rather than chronologically; it interrogates how later twentieth century innovations in histology were fueled by acetate products, and how this spurred new visual understandings and definitions of life. Ultimately, the argument put forth here is that histology utilized the specific qualities and characteristics of acetate to define life though images of fixed, preserved cells; acetate innovations also aided the work of histological researchers, like Alexis Carrel, who attempted to create undying cells supported and sustained through acetate products that would ultimately reshape life into an immortal experience. Just as acetate brought about an evolution in X-ray imaging that spawned new notions of life, its introduction within histology instituted a reconsideration of what life was and what it could be.

Fixing Life as an Artifact

Similar to taxidermy and X-ray photography, histological imaging sought to capture and preserve life as a fixed representation. Through "fixation," histologists locked dead tissue into unchanging images of arrestment that, ironically, maintained a visual appearance of life. Unlike X-ray, histological imaging did not just peek into its subject's interiors, but also extracted their internal components and literally turned them into external images supported on host materials. In his discussion of histological imaging, Anthony Leong proposed that histology is, at its essence, an exercise in external fixation: it arrests natural decomposition processes while stabilizing and reinforcing tissue samples so they can withstand histological processing.[56] Intersecting with taxidermic preservation practices, histologists ultimately attempted to represent and preserve life through still representations. Just as the motion and movements of living

[56] see Anthony Leong, "Fixation" in *Laboratory Histopathology: A Complete Reference*, Woods and Ellis, Eds. (Edinburgh: Churchill Livingstone, 1994), 12.

organisms were inimical to the preservation efforts of taxidermists and radiologists, histologists attempted to produce images of "life" through dead, unmoving specimen.

In his 1896 article for the the American Microscopical Society, Simon Henry Gage suggested that histologists, like taxidermists, ambivalently wrestled with representing living organisms in a fixed, easily observable state. Even though Gage believed life was defined by motion and ultimately lobbied for a new type of histological practice that studied living, moving organisms (the subject of chapter three), he also confessed that complex organism and lifeforms could not be easily studied alive or in motion. "Most of the tissue elements of the higher forms cannot be thus studied alive," Gage wrote, "and the best that can be done is to fix the different phases of action, as by a series of instantaneous photographs."[57] Therefore, early histology methods utilized dead (cellular) bodies to visualize the internal building blocks of life in a way that was essentially opposite to the X-rays live imaging and instead reminiscent of autopsy.

Histology created still, unmoving representations of its subjects; functioning as a type of still photographic imaging, it utilized chemicals and fixatives to turn its specimen into legible sights that scientific investigators could carefully scrutinize over time. "[T]issues may be fixed in any phase and then studied at length," Gage wrote, "[so that] the investigator observes and keeps [a] record."[58] One of the main goals of histological imaging, similar to X-ray, was to create a permanent visual record of life as an artifact. Histology re-conceptualized life as defined by its smallest, universal pieces: molecular matter and the cells. By preserving these cells, histological images could function as enduring metonyms for the species and organic life, at large; they

[57] Simon Henry Gage, "The Processes of Life Revealed by the Microscope: A Plea for Physiological Histology," *Transactions of the American Microscopical Society* 17 (January 1896): 26.

[58] *ibid.*

would exist as artifacts and remnants that stood-in for the essence of life even after the individual subject's death. With this, notions of "life" skewed away from whole bodies and organisms and towards their enduring common denominators, which could also be more easily visualized and preserved compared large wholes.

In these regards, histology and early X-ray imaging (introduced the year prior to Gage's article) intersected with photography and taxidermy through a mutual reliance upon technological and chemical preservation. Through artificial manipulation, each of these practices exercised a specific type of vision that produced fixed representations of life — a gaze which could permanently freeze its subjects in place. In fact, Gage further argued that histology's greatest contribution and ultimate success was the development of chemical agents that could "do for the tissues the wonder that was ascribed to the mythical Gorgon's Head: to kill instantly and to harden into changeless permanence all that gazed upon it."[59] Histology, thus, was equated with a type of fixing, Medusa-like vision that froze its subjects in place and turned them into permanent objects. This mythical association spoke to the foundational goal of histological imaging, as well as photography, taxidermy, and even X-ray: to render life as permanent, fixed images free from the confounding changes associated with natural decay. Essentially, histology and X-ray where both presented as a form of freezing vision that empowered medical investigators to access new views and understandings of life.

Echoing the belief that technologically aided vision offered a definitive portal to knowledge, histologists maintained that it was only through their fixed, unmoving mediations that one could really see and know the intricate structure of tissues, cells, and the essential

[59] *ibid.*

building blocks of life. In her contemporary writing on cellular imaging, Hannah Landecker described histology as the search for different methods and materials that, unlike X-ray imaging, killed specimen in order to maintain them as controlled, arrested images.[60] This ability to manipulate life was, as Landecker ultimately argued, seen as a confirmation of modern medicine's forward progress and advancement, even though it was advancement through death.

Early Histology Technology and Materials

As early as the 1830s, Canada balsam and lacquer fixatives were experimented with as methods that could permanently suspend de-animated cells in place.[61] Histology's desire to control and understand biological life through its visual arrestment directed the field's turn towards celluloid acetate fixatives and imaging platforms during the early twentieth century. While this turn towards acetate would also eventually lead into a turn towards representing life in motion and through the maintenance of living cells, histology first utilized acetate to create unmoving images of dead cells. Acetate's ability to create lasting, still representations that were also superiorly stable and translucent facilitated histology's goals leading it to become the medium of choice for histologists by the mid twentieth century.

Before the introduction of acetate, tissue samples were originally collected by cutting thin cross-section from organisms, staining them, and permanently affixing them to glass slides for microscopic analysis. Microscopic visualization required that specimen be rigorously processed to meet certain requirements; in order to be viewable under the microscope, for example, specimen had to be thin and transparent enough for light to pass through them. Until 1928, the only known way to obtain samples translucent enough for microscopic analysis involved cutting

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[60] Landecker, "Seeing Things: From Microcinematography to Live Cell Imaging," 707-09.

[61] Bracegridle, 77-101.

very thin slices of specimen and grinding down their surfaces so that light could pass through and reveal their internal cell structures.[62] Most organisms do not exist as thin or transparent surfaces and, thus, cannot be viewed under a microscope in an original, unmediated form. As such, organisms needed to be processed and turned into more suitable surfaces in order to be visually appreciated, much in the same way taxidermic mounts needed to have their skins replaced with alternative materials. Over the decades, histologists experimented with various materials and methods that could withstand their demanding imaging process and produce realistic, durable, and transparent images. While a host of materials were utilized, including paraffin wax and glass, the discipline turned towards acetate as a new, superiorly stable and transparent alternative.

Coinciding with its emergence as a new commercial plastic, cellulose acetate was introduced within histological practice during the early 1920s. According to medical practitioner, P.N. Karnuchow, histology borrowed from trends in photography and radiology, which had already abandoned their use of glass imaging plates for acetate-based materials. Repurposed X-ray film, in fact, would eventually make up the basis of the plastic acetate slides that replace histology's traditional glass slides. Histology's incorporation of acetate also paralleled a similar trend within the food packaging industry; during the 1940s, for example, domestic goods and prepared foods were increasingly packaged in new plastic vessels instead of traditional glass jars.[63] While acetate would only fully replace glass slides by the 1950s, H.S. Williamson noted that new methods in plant histology were already exploring acetate as a potential embedding

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[62] Tom L. Phillips, Matthew J. Avcin, and Dwain Berggren, *Fossil Peat From the Illinois Basin: A Guide to the Study of Coal Balls of Pennsylvanian Age* (Urbana: State of Illinois Department of Registration and Education, 197600), 17.

[63] see "Packages Designed to Catch the Eye," *Popular Mechanics* 75.4 (April 1941): 562, 114A.

material, sample container, and imaging platform as early as 1921. In his article, "A New Method of Preparing Sections of Hard Vegetable Structures," Williamson argued that a specific formula of cellulose acetate lacquer — the same one used during WWI to protect airplane wings — could be used to internally suspend cross-sectioned specimen within slides rather than simply hold them at the surface, like glass slides did.

Even though glass was the standard material used by histologists prior to the introduction of plastics, it was nevertheless problematic in certain regards. Glass slides were costly to produce and ship, and their inherent fragility left them highly vulnerable to breakage. While susceptible to breakage, glass was nevertheless resistant to penetration; this proved equally problematic for histologists in that samples could not be embedded into glass slides. As underscored by cultural theorist Walter Benjamin in his critical discussion of materiality, glass is an inflexible material upon which "nothing can be fixed."[64] Its cold exterior and transparent surface, Benjamin argued, not only makes glass the enemy of secrets but also the enemy of possession. While glass' transparency, facilitation of light, and illumination of hidden secrets positioned it as a prime material within scientific imaging, its resistance to permanent fixation did not compliment all of the goals and methods of histology. The ability to embed specimen into acetate slides, which could then function as permanently sealed containers, was in fact one of the major improvements offered by acetate over standard glass slides and paraffin wax.[65]

Acetate slides were also used to piece back together broken glass slides and other damaged samples. In this application, acetate was literally used to right the wrongs of glass and

[64] Walter Benjamin, *Selected Writings* (Cambridge, Mass: Belknap Press, 1996), 734.

[65] In addition to plastic bases, histologist also utilized acetate-based Scotch tape as a secure, protective alternative for traditional glass cover slips. According to "What's New," an 1960 article published in *Popular Science*, Scotch tape was a permanent and almost invisible product that would not discolor with age — virtues that would make it an ideal material for histological imaging.

improve upon its failures. As Tom L. Phillips, Matthew J. Avcin, and Dwain Berggren noted in their histological study of coal fossils, cross-sections that were broken or had begun to disintegrate could be reassembled and successfully salvaged if embedded in liquid acetate.[66] Mirroring the ways in which acetate was utilized within orthopedic casting to stabilize and mend broken bones, histologists utilized acetate to suspend and repair compromised specimen. Through penetrative embedding, organic materials and plastic slides fused into one seemingly unbreakable object; they essentially became unified part-organic, part-synthetic creations similar to taxidermic hybrids.

Acetate Transfers and Skin Peels

Early accounts credit E. Ashby as an influential pioneer of histology's first acetate-based method: named the "cellulose-film transfer method," Ashby's technique preserved cross-sectioned samples of fossilized plant tissue on acetate films. While other histologists previously used balsam, paraffin wax, and glass to preserve their fossil specimen, Ashby utilized acetate to create superior film transfers that proved clearer, more transparent, and longer-lasting than previous samples. Ashby would coat the exposed, cross-sectioned surface of fossils with a thin layer of liquid acetate; once dry, the acetate layer could be peeled off, and an impression from the fossil would remain permanently etched into the surface. Ashby's cellulose method treated surfaces in a similar regarded as early taxidermy and photographic imaging practices. As described in a 1954 *Popular Science* feature, one particular trend in photography, termed "photomicrography," used a similar acetate transfer method to produce its images. Rather than using traditional cameras or photographic development processes, photomicrography created

[66] Phillips, Avcin, Berggren, 29.

images by pressing objects into softened acetate film.[67] Similar in principle to X-ray, this method used the physical body as the mediating apparatus and used it as the direct source of imaging production. Leon L. Walters' 1925 cellulose acetate method, as previously discussed, also depended upon the direct interfacing between a specimen and the mold that would eventual product an acetate replicated skin. In each of these applications and in a marked contrast to how acetate surfaces are presented into contemporary media preservation discourses, the surface properties of acetate — namely its impressionability and transparency — interacted with the specimen's organic matter to aid in visualization and create fixed, preservable images.

While histologists sought to visualize internal structures like cellular walls, they largely did so through methods and materials that created surface impressions, peels, and replicated "skins." These histological surfaces essentially functioned in the same fashion as Walter's taxidermic skin replicas, which were cast from the external impressions of killed subjects. In their 1930s work on histological acetate transfers, B. Barnes and H. Duerden developed a process in which acetate films were used as skin-like surfaces that reproduced the features of the original specimen. In a detailed account of their process, Barnes and Duerden describe how they applied a thin layer of left-over, "waste" acetate film sourced from industrial cinema production to a prepared fossil sample. The layer would "skin over," as they vividly termed it, and harden into a removable layer that accurately mimicked a pellicular surface. Transposed onto acetate, the specimen's fragile internal structures remained free from natural decay and were rendered with superior transparency compared to samples collected through other older materials. Acetate, thus, emerged within histological practice as a new, improved type of imaging and preserving

[67] "How to Picture Details Your Eyes Can't See," *Popular Science* 164.2 (February 1954): 239-240.

agent; it also emerged within practical, popular application as a new type of crystalizing amber that could encase delicate, perishable specimen and allowed them to persist into the future long after their natural lifespan.

Following Ashby, John Walton also developed a new method in histological sample collection that depended upon the surface properties of acetate and plastic films. Termed the "peel technique," Walton's method involved cutting and etching a slice from a fossil sample then covering its primed surface with a transparent material that would harden into a detachable film. All of the fossil's intricate structural details were brought to the surface through cross-sectioning and etching; these processes exposed the fossil's otherwise shielded interior by scratching through its calcified, protective exterior. Once the outer shell was penetrated, the fossil's interior characteristics could be visually accessed and transferred onto a pliable acetate film in the form of a permanent surface impression. This transparent "peel" preserved the structures as translucent sections that could be independently studied over time and maintained apart from the original specimen, as if they were sloughed off skin cells or, as the physician and poet Oliver Wendell Holmes theorized, photographic impressions shed from the subject's body.[68] Unlike other materials, acetate was simultaneously impressionable yet durable; it was soft and pliable enough to be imprinted by cross-sections, while also sturdier than other histological materials.

Pregnant with Color and "Life"

In his 1956 article for the British medical journal, *The Lancet*, Karnuchow described how histology turned towards acetate as a substitute for paraffin wax and glass slides due in large part to its qualities of impregnation and color retention. Aside from offering clear transparency,

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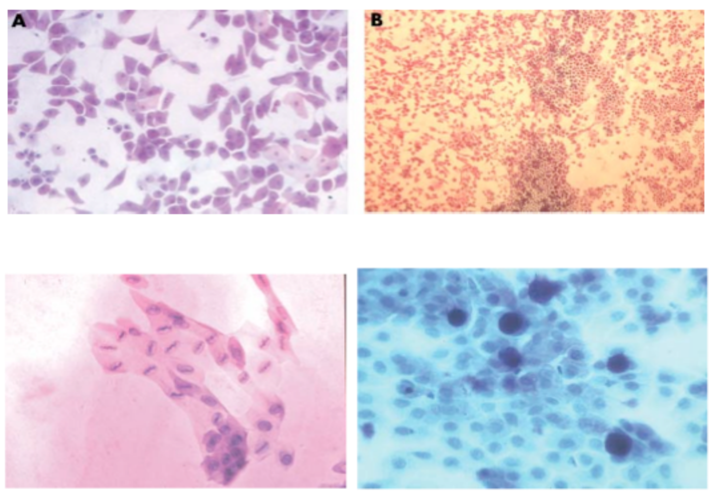
[68] see Oliver Wendell Holmes, "The Stereoscope and the Stereograph" (1859) in *Classic Essays on Photography*, Alan Trachtenberg, Ed. (New Haven, Conn: Leete's Island Books, 1980).

plastics could also be impregnated with brilliant color pigments, which became a defining feature and valued trademark of the modern life and aesthetics in 1950s American culture. As an added and essential bonus, plastics retained their colors longer than other non-plastic products which simply had their color painted onto the exterior. With plastics, however, color could be embedded within the material itself rather than merely applied to the surface. As such, color impregnated plastics resisted chipping, fading, and tarnishing and promised to retain their vitality over time without change; these properties would become equally important and valued by histologists, who by the late 1950s began embedding acetate slides with color stained specimen. While dead themselves, these impregnated vessels were nonetheless used to visually represent the essence of all biologic life [Fig. 2.4].



[Fig. 2.4] Singh, R., A. Jospeh, T. Umapahy, N.L. Tint, and H.S. Dua. "Impression Cytology of the Ocular Surface."*British Journal of Ophthalmology* 85 (28 July 2005): 1657.

Prior to 1956, histologists predominately favored the afore detailed peel method, in which a surface impression was taken of the specimen. This practice was replaced, however, by the late 1950s with an embedding technique that depended upon the unique, penetrative surface properties of cellulose acetate. While remaining durable and protective, acetate was also highly impressionable and receptive to implantation. As such, it emerged as an ideal platform in which to embed organic materials. Histological implantation is accomplished by placing tissue samples or even entire organisms into a slide-shape mold, filling the mold with a molten embedding medium, and waiting for it to solidify around the specimen and into a solid, fixed surface.

Before the introduction of acetate, paraffin wax was popularly used as a malleable, impressionable embedding medium. The paraffin embedding process entailed dehydrating tissue samples in alcohol or a similar organic solvent; "clearing" it in a reagent solution which rendered the specimen transparent; rehydrating it with paraffin; and finally encasing the specimen in a block of solid paraffin.[69] While paraffin initially proved to be a useful medium, the search for an increasingly transparent embedding material that could also render and retain color staining led to the development of new alternatives. In reaction to the shortcomings of glass and paraffin, histologists began experimented with recycled acetate X-ray film as a new type of slide base. Unlike glass, liquid plastics could be impregnated with tissue samples and color-stained specimen; after hardening, the specimen would be permanently suspended within the plastic and could, theoretically, be indefinitely maintained in its all its original colors.

Between Black-and-White and Color

Color staining was an essential aspect of histological practice, and was an influential addition to the previously black-and-white world of medical imaging. Early radiologists could only render X-rayed subjects in black-and-white. While seemingly restrictive, this limited black-and-white color pallet was initially regarded as one of X-rays positive virtues. Before X-ray imaging, Kevles noted, surgeons could only experience internal anatomy as a bloody, confusing

[69] Leong, 12.

messes characterized by “a multiplicity of colors and textures.”[70] X-ray imaging would clarify and simplify this sight by reducing the body to a series of clearly defined, still images rendered in stark black, white, and grey. Through abstraction and the removal of color, the structures and systems of the body were thus rendered more clearly visible. Mirroring the vision of its original creator, who was colorblind himself, as well as echoing nineteenth century cultural beliefs in the authenticity and truth value of black-and-white photography, X-ray redefined the body and scientific vision as free from the muddying and even misleading influences of color.[71]

Departing from this privileging of black-and-white aesthetics, histologists utilized high contrast color staining to bring out the smallest structural details in their collected samples.[72] In his 1906 article on modern medical progress, published in an early edition of *Popular Science*, histologist Charles Segwick Minot noted that attempts to represent life in color were always sought after by histologists, and even predated the invention of X-ray’s black-and-white vision. As early as 1857, coloring methods and materials were introduced within microscopic analysis techniques, with the hopes that blood vessels could be traced and made clearly visible through the injection of colored pigments. Through early experiments with color staining, Minot claimed that scientists “at once recognized the importance of coloration as a means of rending more clear the character of cells and tissues.”[73] Histologists continued to explore and experiment with color as a visualizing method, and increasingly relied upon color as a defining aspect of its images. Ultimately, histologists invested in color as a way to heighten reality rather than distract from it;

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[70] Kevles, 2.

[71] see Sally Stein, *The Rhetoric of the Colorful and the Colorless: American Photography and Material Culture between the Wars* (Ann Arbor: UMI Dissertation Services, 1991).

[72] Contemporary methods in live imaging, including magnetic resonance imaging (MRI), continue to utilize colored scans of the body and privilege it as diagnostic technique over black-and-white X-ray imaging.

[73] Minot, 8.

"we stain sections," Minot wrote, "in order to make things visible which were before indistinct or perhaps invisible."[74] With this, histology's colored images opened an entirely new perspective into the inner structures of life — a view seen in color rather than merely black-and-white. Biological interiors were no longer simplified through black-and-white imaging, but now had their complex structures, intricate details, and hidden secrets revealed through vibrant color tinting. In an almost verbatim echo, supporters of digital imaging and preservation initiatives tout the same benefits of being able to see new and invisible things that were previously missed with old, analog imaging materials. One famed example, as preservation James White recounts in his interview with Glenn Kenny, is how all of the old-school wires and special effects apparatuses became visible in diegesis of *The Wizard of Oz* once it was re-worked into a digital image.[75] "Back in 1938," White contends, "Victor Fleming and his Director of Photography understood enough about the photochemical process that they could expect the wires to be invisible by the time theatrical prints were created in the printing chain, but in working digitally from the first generation elements, the wires are now there, clear as day."[76] These once invisible elements have now been brought to the surface and revealed (for better or worse) through new technologies of visualization.

Death by Color

Even though histology's use of color staining promised to newly illuminate the essence of life, it ironically necessitated and caused the death of its specimen. Jean Comandon, an

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[74] *ibid*, 9.

[75] Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White" *Some Came Running: Enthusiasms and Expostulations* (March 12, 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

[76] *ibid.*

influential French biologist who would eventually enliven the still images of histology through microcinematography (the subject of chapter three), emphasized this inherent paradox in which specimen had to be killed in order to be visualized in color. Comandon claimed that the very methods used by histologists to stain and tint their specimen ultimately ended their lives; the chromatic devices used to render cellular structures in color — which included dyes and fixatives composed, in part, by acetate compounds — also rendered the specimen dead. With this, living organisms and their moving systems were replaced with dead, still views which were nonetheless taken as representative of life. Taxidermic representations followed this same paradoxical approach to seeing life: in order to satisfactorily visualize life in all its natural, living color, their natural, biologic materials had to be replaced. Thus, the very processes used to visualize life, ultimately produced dead and artificially manipulated objects that only performed a masquerade of life. In contrast, X-ray imaging defined itself through seeing inside subjects while still keeping them alive. Whereas anatomists, histologists, and taxidermists all presented dead subjects in color, radiologists imaged live subjects in albeit less-lively shades of black-and-white.

As recounted in the 1941 *Popular Science* article, "Plastics Preserve Nature's Colors," color was equated to the essence of life and both could be kept from fading, even after the subject's death, once encased in acetate coverings. The "brilliant colors and delicate structures of plant and animal life," the article claimed, could be sealed and indefinitely preserved between sheets of cellulose acetate.[77] As such, acetate materials were equated with the long-lasting preservation of color; objects covered or produced in acetate promised to retain their imbued colors longer than other materials, natural or artificial. Unlike other materials, acetate was

[77] "Plastics Preserve Nature's Colors," *Popular Science* 139.5 (November 1941): 72.

specifically marketed as not discoloring with age, which made it the ideal medium to preserve the colors and vital appearances of life.[78] Once pressed between acetate sheets or embedded into acetate, stained tissue samples would remain frozen in place and their colors would be similarly locked into an unchanging, unfading stasis. In a later 1945 piece for *Popular Science* entitled, "Your Are Really Going to Live With **and In** Plastics," Gold V. Sanders further detailed how acetate's promise to preserve colors bridged both scientific and domestic experiences of life. Sanders described in glowing detail how war-driven advances in plastics revitalized the home in the form of plastic goods and products that were injected of vibrant color. New plastic materials including acetate fabrics, artificial woods, and kitchenware were now produced in colorful, long-lasting plastics and became the new, highly desired standard of modern living.[79]

Living Cultures, Immortal Life

While histologists came to rely upon and greatly value acetate's ability to maintain the color and quality of embedded specimen, its ability to support samples at a surface level was also highly valued. This was especially true for histologists who attempted to grow living tissue samples, rather than just maintain embedded dead samples. Departing from taxidermic and medical casting and their reliance upon acetate to arrest and immobilize subjects, certain histological researchers attempted to generate living, moving organisms through acetate. Between the 1910s-1960s, a small cadre of histologists began experimenting with cultivating live cells outside of the body that could continue to live while supported on alternative, host surfaces. Instead of relying upon dead, lacquered, and color stained specimens, this new wave in

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[78] see "What's New," *Popular Science* 176.6 (June 1960): 100.

[79] Gold V. Sanders, "You Are Really Going to Live With ***and In*** Plastics: Intensified War Time Research Finds New Synthetic Materials and Discovers Many More Uses for the Ones We Had Already," *Popular Science* 146.1 (January 1945): 118.

experimental histology focused on cultivating living cells as a way to expand the parameters of a cell's natural lifespan.

Spearheading this movement was French biologist and eugenicist, Alexis Carrel (1873-1944). Carrel argued that cells did not have to conform to the temporal and physical constraints of the entire organism; rather, they could live independently and even indefinitely if transplanted into a different host medium possessing different temporal qualities. For example, a sample of cells or fragment of tissue could be removed from the original host body and implanted into an alternative, artificial medium capable of differently sustaining and nourishing the samples continued growth. Changing the environment or medium of the cell, in other words, would change the specimen's lifespan, free it from aging, and even potentially grant it immortality. Ultimately, through artificial materials including acetate agents, Carrel attempted to create a superiorly engineered host "body" platform that could replace what naturally existed.[80]

While quests for immortality are essentially older than time itself, the belief that modern medical science and technological interventions could free mankind from aging and death permeated popular culture at the turn of the century. In his 1912 article for *Popular Science* on the aging, death, and procreation of lower organisms, H.S. Jennings claimed that everlasting life had been the "secret wish" of all mankind; "from the ancient seekers after the fountain of youth," he wrote, "to the modern physiologists working toward the preservation of life, the prolongation of its processes, and the suppression of death, there have not lacked men who cherished the bold thought that death may be no essential part of life, that possibly some means may be found for

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[80] see Eduard Uhlenhuth, "Changes in Pigment Epithelium Cells and Irs Pigment Cells of Rana Pipiens Induced by Changes in Environmental Conditions," *Journal of Experimental Medicine* 24 (1916): 690; and P. Lecomte, Du Noüy, *Biological Time* (New York: The Macmillan Company, 1937).

counteracting the process of aging, for excluding death."[81] All the negative aspects and seemingly natural, inevitable processes of life including sickness, pain, and death were questioned as necessary and seen as problems to could, and should, be solved rather accepted.[82] Through scientific intervention, artificial chemicals, and technologies, the medical and lay community sought alternative means and methods to replace the "worn-out" parts of the body that led to death and reshape human existence into an ageless, painless, never-ending reality.[83]

In the devastating aftermath of World War I and throughout the 1920s, *Popular Science* and *Popular Mechanics* published several features on modern strives towards immortality. In his 1925 article, entitled "Is Death Really Necessary? Scientists Foresee an Era when Men Will Live a Thousand Years — Amazing Discoveries about the Mystery of Life," John E. Lodge praised the medical sciences as offering an escape route for avoiding death. Thanks to modern science, Lodge claimed, diseases have been cured, the quality of life has improved, and the average life span has increased every year. As Lodge revealed, these successes increased the public's faith in the biological sciences, which in turn led to expectations that they would continue to positively intervene into life and provide increasingly effective technological advancements. As encapsulated by Dr. Eugene Lyman Fisk, director of the Life Extensions Institute: "There is no known limit to what man's intelligence may effect in the way of life lengthening."[84] Artificially engineered chemical agents and materials emerged as particularly promising interventions. Many within the medical sciences, as well as the public at large, believed that artificial chemicals could

[81] H.S. Jennings, "Age, Death, and Conjugation in the Light of Work on Lower Organisms," *Popular Science* (June 1912): 563.

[82] see "A World without Pain? Goals of Longer Life, Freedom from Disease and Painless Treatments Extended as Science Gropes for Nature's Secrets," *Popular Mechanics* 45.3 (March 1926): 353-355.

[83] *ibid.*

[84] qtd. in "A Month's Harvest of New Ideas and Strange Facts," *Popular Science* 112.4 (April 1928): 40-41.

replace an organisms' original, flawed biomaterials and ultimately prolong its life. If organisms could be kept alive and forever "young" by replacing their natural components with artificial alternatives, then the problems of aging and death would be forever solved. Life as it was currently defined — a forward-moving process of inevitable aging and irreversible death — could thus be rewritten.

In his influential 1931 article, entitled "Physiological Time," Carrel suggested that each type of cell experienced and recorded time in its own unique way. Even though the body, as a whole organism, experienced time as a teleological process resulting in degenerative senescence and decay, Carrel believed that individual cells could be refashioned into a perfected, immortal form of life through histological intervention. In his quest for immortality, Carrel experimented with culturing live cells, embryos, and even small organs (such as chick hearts); he transplanted these samples onto artificially engineered slides and surfaces that promised to promote growth and maintain their life longer than the original environment provided by their natural bodies. In short, Carrel attempted to maintain cell cultures as living, actively growing specimen; through technological interventions which included suspending samples within nutrient rich acetate solution, he hoped to hold time, aging, and death in suspended abeyance.[85]

Mirroring the undergirding principles of taxidermy, which sought to create a lasting version of life through the replacement of its frailer materials and natural fluids, Carrel also sought an immortal version of life of through replacing of body fluids, and essentially the entire body itself, with alternative host mediums. While fantastical, Carrel's vision of "living preservation" and enduring life permeated popular culture and public discourse as an exciting possibly made

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[85] see Alexis Carrel, "Physiological Time," *Science* 74.1929 (18 December 1931): 618-621.

plausible through modern bioscientific advances.[86] Descriptions of his undying chicken heart, preserved in an artificially engineered fluid that supplied food and supported the growth of "new life," shared the pages of popular press articles that also featured the latest in albeit more mundane new technologies.[87] Ultimately, Carrel's work helped to generate a popular belief in modern technologies and in science's ability to find the "fountain of youth" through alternative mediums and materials that not only mimic the functions of natural body fluids and life processes, but ultimately improved upon them. This progression from mimicry to replacement parallels the same trajectory of all acetate plastic products: from the replica skins used by taxidermists to the artificial "woods" used by furniture manufactures, acetate plastics were first introduced as perfect mimics of natural materials, and then surpassed them as more preferable alternatives that lasted longer than the originals.

Acetate Fountains of Youth Today

Future histologists would continue to work in Carrel's tradition and utilize acetate as an artificial life-supportive medium that could substitute the natural, bodily environment. Early formulas — such as "Medium 199" and those developed throughout the 1950s-60s, including "Medium NCTC 135" and "Media CMRL 1066" — utilized acetate as part of their artificially engineered life-supporting growth cocktail. These acetate infused mediums were especially successful in mimicking the natural properties and functions of serum: a component within the blood that suspends nutrients and supports cell survival. Acetate was thus utilized as an alternative, artificial type of support agent that created hybrid, part-organic/part-synthetic

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[86] see "Heart of Dead Chicken Beats for Thirteen Years," *Popular Mechanics* 45.2 (February 1926): 217; "Chicken's Heart Still Beats After Twenty-One Years," *Popular Mechanics* 59.4 (April 1933): 583; "Removal and Cure of Organs Outside Body Predicted," *Popular Mechanics* 70.3 (September 1938): 369.

[87] "Heart Tissue Is Still Alive After Twelve Years," 689.

entities. While organic in composition, these lifeforms were maintained through artificial means, leading them to essentially function as early acetate cyborgs. Acetate's ability to sustain cell growth longer than naturally possible suggested that it could superiorly replace organic serum, thus unlocking the secrets of immortality and the fountain of youth sought after by Carrel and throughout human history.

Following in Carrel's tradition, B.M. Shaffer also turned to cellulose acetate as an alternative medium that could maintain and even generate life outside of natural time and the body. In his 1956 work with embryonic chick cells, Shaffer utilized acetate impregnated fabric as a supportive platform to sustain his cultures. For Shaffer, it was vital that these cells were maintained at a surface level rather than completely embedded or submerged within the growth medium. From this surface level, he could monitor, sample, and interact with the specimen in a less invasive manner, allowing him to better keep them alive. Shaffer's experiments with acetate further supported Carrel's claim that cells could be maintained as independent parts apart from the body, thus freed from its restrictive temporal limits. Shaffer's work showed that once removed from the body and placed on acetate, chick embryos (and later human cells) continued their normal gestation: their hearts kept on beating, their bones growing, and all of their secondary systems continued to develop. Once again, acetate was looked to as material that could beneficially support life functions, and as a miraculous replacement for natural products and inferior materials, including the body itself.[88]

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[88] Echoing the work within early X-ray imaging as well as taxidermic preservation, Shaffer also turned special attention towards the skin as an organ to manipulate and ultimately improve through acetate. Early radiologists attempted to mitigate the obscuring, opaque skin; taxidermists like Walters preferred to completely remove and replace it with acetate replicas; and Shaffer utilized acetate sheeting as an improved surface to artificially grow skin grafts.

Acetate was still used as a trusted material in histological culturing into the late 1970s. Sydney E. Salmon and Ronald N. Buick's 1979 histological cancer research, for example, depended upon acetate to "permanent preserve" bone marrow and tumor colony cells. Salmon and Buicks used acetate membranes to permanently affix tissue to the surface of histology slides, which were also made out of acetate. While other disciplines were already beginning to doubt acetate's ability to make good on all its promises to resist time and decay, and even began replacing acetate with other newer materials, histologists like Salmon and Buick still invested in acetate as a material well-suited for their attempts to see inside organisms and manipulate the building blocks of life.[89]

The contemporary use of acetate within the biomedical sciences even continues today. As of 2012, the Electron Microscopy Sciences company continues to market and sell acetate "replicating sheets" for use in histological sample preparation. As described on their company website, these acetate sheets replicate the surfaces of organisms and allow researchers to study samples under more rigorous microscopic analysis and for much longer than would be naturally permitted by the physical properties and limitations of the original, organic specimen.[90]

Contemporary histologists have also continued to use acetate as a non-invasive medium to collect surface impressions and cellular transfers from fragile sources like the eyes.[91] Acetate's

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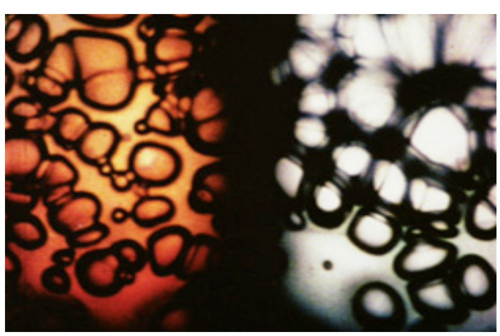
[89] Polyester film, for example, began to replace acetate-based film within specialized photographic applications. By the 1990s, after research into The Vinegar Syndrome confirmed acetate's susceptibility to decay, polyester motion picture film also began to replace acetate safety stock.

[90] "Replicating Sheet - Cellulose Acetate Film." The Electron Microscopy Sciences Hatfield, PA (2011) http://www.emsdiasum.com/microscopy/technical/datasheet/50420.aspx Accessed 1 October 2012.

[91] see J. Lin, L. Luo, P. Zhang, H. Zhen, G. Feng, and X. Zhong. "Application of Cellulose Acetate Membrane with the Technique of Impression Cytology Combined with Immunohistochemical Staining for Detection of Dry Eye," *Yan Ke Xue Bao* (*Eye Science*) 16.4 (2000): 264-266; Penelope Mckelvie, "Ocular Surface Impression Cytology," *Advanced Anatomical Pathology* 10.6 (November 2003): 328-337; R. Singh, A. Jospeh, T. Umapahy, N.L. Tint, and H.S. Dua, "Impression Cytology of the Ocular Surface," *British Journal of Ophtlalmology* 85 (28 July 2005): 1655-1659; Glenda R. Nolan, Lawrence W. Hirst, and B. Josephine Bancroft, "The Cytomorphology of Ocular Surface Squamous Neoplasia by Using Impression Cytology," *Cancer* 93.1 (25 February 2001): 60-67.

dual qualities of impressionability mixed with durability made it an especially useful material for this application; it could non-invasively transfer superficial epithelia layers of the ocular surface onto thin, transparent membranes without damaging the ocular surface. Even though newer and increasingly synthetic materials have emerged within scientific practice since acetate's introduction, and even though acetate's previously trusted abilities to last forever and permanently preserve materials has since been undermined by its own processes of decay and decomposition, it nevertheless continues to be utilized within the imaging sciences.

Despite these continued uses, however, the material itself ultimately failed in its capacity to last forever and remain free from the processes of aging, decomposition due to its own finite material lifespan (the subject of chapter six). Carrel and others may have believed everlasting life was possible, but it certain was not possible for acetate; by the 1990s, it was scientifically confirmed that acetate was indeed as fragile and flawed as the organic materials it replaced. Ironically, the decay process of acetate film stock — the same base material used in X-ray and histological imaging — causes the decomposing plastic to take on the appearance of early histological images of cellular life [Fig. 2.5]. In a perverse twist, the blistering pock-marks and erosions that define the death of celluloid acetate mirror the images of cellular life that were created by histologists working with acetate materials.



[Fig. 2.5] *Bardo Follies. Dir. Owen Land* (1967, 16mm celluloid acetate).

Crossing-over into Popular Consumer Culture

X-ray and histology captured the public's imagination, and ignited their desire to possess the same methods and materials as well as apply them within their practical, daily lives. Numerous magazine features, commercial advertisements, and instructional do-it-yourself articles instructed layman hobbyist on how to adapt the methods and materials used in X-ray and histological imaging. One enthusiastic reader of *Popular Science* even wrote the editor demanding that he "publish an article on how to construct a simple X-ray machine without having to purchase any expensive equipment."[92] This public demand for scientific and medical technologies translated into they the public integration and adaption of this imaging technologies and their specific ways of mediating life.

X-ray technology, for example, was integrated into a variety of domestic and layman jobs while boasting the same rhetoric carried over from its medical and scientific uses. Writing for *Popular Science,* Boyd Fisher described how "[this] discovery first interested scientists, then became important to all men"; "X-ray photography has come out of the laboratory and put on overalls," he continued, to peer into the heart of machinery, jewelry, paintings, furniture, and even home walls to "lay bare the inner-most secrets."[93] X-ray was used in each of these commercial and domestic applications to detect internal flaws and other lurking menaces that threatened to harm consumers. In the factory setting, X-ray photographs of machinery and diagnostic imaging of compromised support structures ensured the safety of workers; in the food manufacturing sector, X-ray machines were adapted to screen candy and other consumables for

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[92] "Homemade X-ray Machine Is His Modest Desire," *Popular Science* 124.5 (May 1934): 12.

[93] Boyd Fisher, "Amazing New Jobs for X-Rays: How They Pierce the Heart of Metals, Expose Flaws and Fakes, Grow Super-Hens, and Save Men from Hidden Peril," *Popular Science* (August 1928): 31.

glass or other hazardous, foreign objects. The same methods used within medical practice, including the X-ray detection of bullets in shooting victims and the diagnosis of compromised, cracked bones, were thus carried over into popular usage and everyday life.

One of the primary uses of X-ray within the non-medical sector was to detect forgeries in art galleries and imitation jewelry. As chronicled in two 1920s articles appearing in *Popular Science,* X-ray technology was invaluable in unmasking counterfeits that may have looked authentic to the human eye but were in fact cheap knock-offs and impostor pieces.[94] Interestingly, acetate technology was used during this same time period to produce imitation jewelry and copies of precious stones and natural materials. Less than a decade later, however, acetate would transition into revealing such imitations through highly sensitive X-ray photographic stock, rather than just mimicking life in the form of artificial products.

Histology's use of acetate also translated into the public sphere. One product in particular, marketed as "Plasticast," promised to equip layman with the ability to collect, display, and preserve their personal artifacts through the same plastic molding and casting techniques utilized in medical casting and histological imaging. Several advertisement for Plasticast, placed within various issues of *Popular Science* and *Popular Mechanics* throughout the 1940s and 1950s, epitomized this cross-over usage of acetate and histological techniques within domestic application. Hailed as "the greatest thing in plastics," Plasticast was marketed to domestic hobbyists as a "transparent, solid, clear-as-glass, tough-as-steel plastic."[95] Users were

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[94] see "Detecting Art 'Fakes' with X-Rays: No Longer Need We Depend Entirely on the Guessing or Intuition of the Connoisseurs," *Popular Science* 98.1 (April 1921): 31; and Boyd Fisher, "Amazing New Jobs for X-Rays: How They Pierce the Heart of Metals, Expose Flaws and Fakes, Grow Super-Hens, and Save Men from Hidden Peril," *Popular Science* (August 1928): 31-32, 128.

[95] Plasticast, "The Greatest Thing in Plastics: Plasticast, A New Home Industry and Hobby!" advertisement. *Popular Science* 154.5 (May 1949): 54.

encouraged to submerge souvenirs — ranging from flowers and butterflies, to photos and biological specimens — into liquid Plasticast plastic. Through this easy and affordable process, ephemeral keepsakes were embedded within plastic and rendered into permanent display pieces. The overarching sentiments of Plasticast's ads echoed the central tenets of histology: to capture and permanently maintain fragile objects in plastic so that they could be viewed through time as arrested markers of life's most important, constituting elements.

Pressed, plastinated butterflies were also repeating motif in Plasticast's ads. These plastic butterflies not only evoked amateur collectorship — since "the butterfly collection" is one of the stereotypical synecdoches for collecting as a hobby — but also served as a reference back to scientific taxonomy and taxidermic preservation. In an earlier 1941 article also published in *Popular Science,* the desire to preserve the "brilliant colors and delicate structure of plant and animal life, even after the objects creating them have died," was identified as the unifying impetuous within biological taxonomy and taxidermy.[96] New plastic materials allowed natural scientists, including botanists Charles E. Sando and G.R. Fessenden, to suspend their specimen into transparent resin blocks and acetate sheets, which promised to indefinitely maintain them in an unchanging, unfading stasis.

The ability to permanently capture and maintain color characteristics was especially important for taxidermists as well as histologists. In both fields, biological specimen are essentially defined and identified by their color variations. In his U.S. government sponsored study on the preservation of botanical and other biological specimen, Fessenden argued that resin plastics and acetate plastic sheets, in particular, could be used to maintain the natural color and

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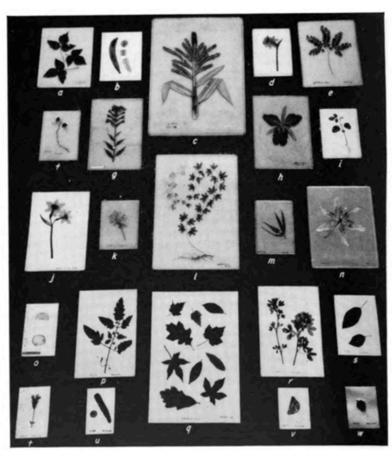
[96] "Plastics Preserve Nature's Colors," 72.

surface characteristics.[97] Plants, flowers, and other fragile specimen could thus maintain their vital, distinguishing qualities if pressed between or encased within plastic [Fig. 2.6]. Fessenden's method, in particular, utilized acetate plastic sheets to permanently encase and "fix" a specimen's natural colors and surface appearance. Essentially, Fessenden and other likeminded histologists utilized acetate to preserve their specimen as lasting, colorful emblems suspended in plastic in the same way that Walters utilized acetate within his 1920s preservation practice. Just as Walters used acetate as replacement skins that would preserve the colors and textures of his mounts, Fessenden covered his botanical specimen in acetate shells which promised to protect and sustain their delicate colors. Even the language used to describe Fessenden's method of "curing" specimen between acetate sheet or "mounting" them within plastic resin resonated with Walters' taxidermic work. This specific utilization of acetate would continue to inspire histological innovations throughout the 1950s, as well home hobbyist's and their play with plastic lamination devices during this same time.



[Fig. 2.6] Fessenden, G.R.. *Preservation of Agricultural Specimens in Plastics*. Washington, D.C.: U.S. Department of Agriculture, Miscellaneous Publications No. 679, July 1949: 2.

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[97] see G.R. Fessenden, *Preservation of Agricultural Specimens in Plastics* (Washington, D.C.: U.S. Department of Agriculture, Miscellaneous Publications No. 679, July 1949).

Several of Plasticast's ads and accompanying illustrations played upon desires for personal possession, and suggested that one could possess the unobtainable by transposing it into plastic. In their 1949 ad, placed in the May issue of *Popular Science*, a collection of small objects entombed within hardened Plasticast were paraded across the top portion of the advertisement [Fig. 2.7]. While this collection of objects, knick-knacks, and trinkets skewed towards the mundane, two stand out as particularly evocative: a posing woman and a pressed butterfly. Echoing the visual language and formal motifs used to represent female subjects — as previously seen in the 1919 article on X-ray imaging and Netter's 1939 Transparent Woman — this plastic woman strikes a familiar pin-up pose. In nearly all of Plasticast's ads, published between the 1940s-50s, a female figurine is a consistently reappearing motif. She is almost always represented in a pin-up pose, with hands held behind her head, and showered by a suggestive outpouring of liquid plasticasting material. Emerging from this plastic birthing fluid, her pristine body is offered to the beholder as an object for visual possession as well as material collection. The ad promised readers that they could indeed possess previously unobtainable things — whether it be the female body or other prized commodities such as gemstones, marble, or ivory — once they transposed them into plastic replicas.

[Fig. 2.7] Left: Plasticast. "The Greatest Thing in Plastics: Plasticast, A New Home Industry and Hobby!" advertisement. *Popular Science* (May 1949): 54.

Middle: detail from Plasticast. "Plasticast: The Greatest Thing in Plastics!" advertisement *Popular Science* (May 1950): 55.

Right: detail from Plasticast. "I'll Show You How to Earn Big Money in Plastics Without Tools or Machinery!." advertisement *Popular Mechanics* 97.3 (March 1952): 37.

Another advertisement, placed in *Popular Science* exactly one year later, echoed these sentiments and especially spoke to desires to create an unlimited amount of realistic, cheap replicas of rare natural materials like ivory, marble, and ebony.[98] Once hardened, Plasticast could mimic the surface appearance of real ivory, or even human skin if so desired. Not only could home model-makers create collectables that mimicked the surface appearance of marble and ivory, they could also use Plasticast to construct "hollow but very strong practically unbreakable castings (...) [that] possess soft skin-like surface[s]."[99] Through this domestic appropriation of plastic casting and embedding materials, layman enthusiasts could now reproduce their own precious materials and create life in the form artificial, life-like replacements.

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[98] Also featured in this ad is a Plasticast version of Castex — the same acetate plastic product that, as discussed in chapter one, was used to by orthopedists to produce lightweight, durable medical casts.

[99] Plasticast, "Plasticast: The Greatest Thing in Plastics! A New Home Industry and Hobby!," 55.

Emphasizing the “home industry” potential of their products, Plasticast’s 1954 ad introduced a new, moneymaking product for home craftsman: plastic lamination. Joining the ranks of Plasticast’s other modeling and casting products, plastic lamination sheets and presses could be used to permanently seal and protect important documents, priceless photos, and other fragile materials not just for posterity or personal collection, but now for personal profit. However, while the printed text referenced monetary value, its illustrative images tugged on emotional heartstrings rather than purely economic pursestrings. Tellingly, the ad featured a photographic snapshot of an infant, conjuring sentiments of inevitable growth and anxieties over the passing of time. While parents could not keep their children small and arrested in youth, they could however keep a permanent image of them in this state if sandwiched between Plasticast sheeting — a theme that will resurface again in Chapter 4 in the form of family photographs, bomb shelters, and infant gas masks. “Millions of people want to protect [their] valuables,” the Warner Electric Co. claimed in their own 1953 ad for home laminating machinery, and sealing them within acetate plastic sheeting was pitched as the best way to ensure this collective desire.[100] Home lamination machines were thus marketed as fulfilling one of mankind’s basic desires, which transverses both domestic and scientific sectors: to produce lasting images and preserved visual representations of life and all its essential, constituting elements.

Conclusion

Medical imaging not only succeeded in rendering the body essentially transparent through acetate materials, but also spawned new understandings of the human body and life as defined by its unmoving internal structures. X-ray technology and histological imaging

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[100] Warner Electric Co., “Get into...Plastic Laminating at Home!” advertisement, *Popular Science* 162.1 (January 1953): 284.

especially defined human life through visual images of bones and, increasingly, minute cells and molecular components. Through this visual intervention, scientists and the general public alike began to increasingly invest in biomedicine's ability to provide unfettered visual access to the secrets of life and, ultimately, perfect life as it naturally existed.

Improving upon older imaging methods like autopsy and materials like glass, acetate promised to facilitate transparent vision and create stable, permanent images of the body's foundational components. Ironically, however, these images of life were being produced through a material that was itself bound to die. Rather than producing undying artifacts of life's vital components, X-ray photographs, histology slides, and other product produced on acetate eventually fell victim to time and decomposition which marred their transparent surfaces and nullified their ability to provide the required clear visual images. Scratches, age spots, cracks and other surface effects from time, use, and natural aging leave acetate surfaces with telltale visual artifacts. While these signs bear a visual testament to the life and materiality of acetate, they also stand in the way of seeing the image contents interned beneath the surface. In this state, acetate fails to function as an innocuous exterior layer and invisible facilitator of visuality, and thus has been recast as needing to be stripped away by digital tools and replaced with newer materials in service of the greater goal: to obtain a better visual image.[101] Over time, acetate's material has become the same "bloody confusing mess" and a "multiplicity of colors and textures" that confounded the vision of early anatomists. In the eyes of many preservationists, these unwanted sights of acetate aging and decay ruin the ability to see, share, and save the essential image contents. Acetate peels may have once been used as an aid in histology visualization and as a

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[101] see "Before and After: 35mm Acetate Film Stripping." *Chicago Albumen Works* (18 July 2014). Accessed 2 April 2015 <https://albumenworks.wordpress.com/2014/07/18/before-and-after-35mm-acetate-film-stripping/>.

preservation method, but now acetate is being peeled away to perform the same purported function. In a continued quest to achieve the clearest, sharpest image possible, imaging materials that are the most seemingly unobtrusive, transparent, and “invisible” will be used as replacements for those who instead manifest their own material presence.

CHAPTER 3

Leaps to Life on a Silvered Screen: Microcinematography and Educational Science Films

On June 13, 1952, American engineer and media theorist Vannevar Bush publicized the invention of his latest bio-imaging instrument: the automatic microtome.[1] As described in the journal *Science* and *Toledo Blade* regional newspaper, Bush's design combined the principles of histological imaging with motion picture technology.[2] In traditional histology practices, imagists had to kill and cross-section their specimen before encasing them in wax or affixing them to static platforms such as microscope slides. Bush's new microtome, however, improved upon these existent methods by slicing paper-thin cross-sections and pressing them into strips of celluloid acetate motion picture film, namely a special stock marketed by Kodak as "Frozen Section Stripping Film" [Fig. 3.1]. Essentially, this new microtome machine created permanent biological specimen made out acetate film. As historian D. Graham Burnett further described, Bush's method resulted in "the three-dimensional world becom[ing] a *moving picture.*"[3] Culminating with Bush's microtome and hybrid organic/filmic specimen, cinematic technologies and materials emerged within early twentieth scientific imaging as a superior way to see the foundational essence of life. Even before Bush, scientific innovators sought to capture images of cells and even living organisms through motion picture technology, and make these moving

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[1] Bush is perhaps best known for his work on the Manhattan Project during WWII, as head of the U.S. Office of Scientific Research and Development. He is also well-known for his his work on early computing technology, including the Memex: an analog microfilm viewer and memory device whose structure and underlying principles are consider early precursors for the World Wide Web. For more on Bush's Memex and his contributions to the pre-theorization of computer technology, see Vannever Bush, "As We May Think." *The Atlantic* (1 July 1945).

[2] see Vannevar Bush, "Automatic Microtome." *Science* 115.2998 (13 June 1952): 649-652; "Atom Scientist Spends Time Improving Cancer Detector; Vannevar Bush Works on Microtome, Device to Aid Microscopic Testing." *Toledo Blade* [Toledo, OH] 13 June 1952: 2.

[3] D. Graham Burnett, "The Thin Film: Vannevar Bush and Vision by Incision." *The Slice: Cutting To See*. AA Gallery (20 November - 15 December 2010): 2 (original emphasis).

images publicly accessible through acetate film materials. Knowledge about life could now be accessed, understood, and disseminated as never before amongst scientists and the lay public, alike. “There was the possibility of actually *viewing* such films through a projector,” Burnett concluded, so that now anyone could “literally tour, say, an embryo, head to toe, slice by slice — an animated flip-book of the body. (...) Here was the body as film.”[4]

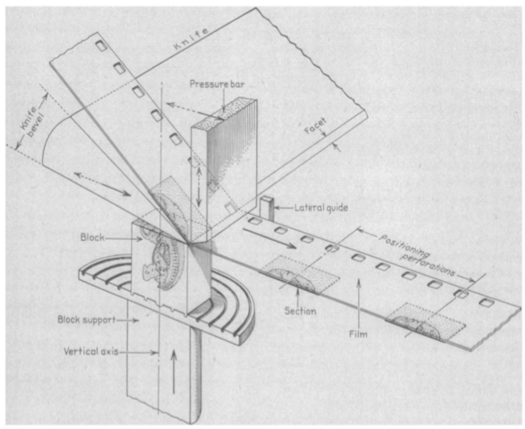

FIG. 3. Scheme for automatically applying serial sections to 35-mm perforated cellulose acetate film. This diagrammatic median view shows the block support carrying an embedded embryo, with the knife completing a cut with the pressure bar still in the functioning position. Forward motion is indicated by a solid arrow on the film, and reciprocal motions are indicated by solid-broken-line arrows. The lateral film guide moves with the pressure bar but is carried on a separate mount.

[Fig. 3.1] Bush, Vannevar. “Automatic Microtome.” *Science* 115.2998 (13 June 1952): 650.

Departing from the previous chapters’ focus on rendering life through suspended animation and permanent still imaging techniques, this chapter proposes that acetate-based materials and film technologies also introduced the importance of movement, access, and circulation into both biological imaging and film object preservation by visualize the building blocks of life as moving, animated elements printed on safely distributable acetate safety film.[5] As discussed in Chapter 2, early X-ray and histological methods utilized acetate materials to externally represent the internal structures of the body. These visual practices initially defined

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[4] *ibid,* 3.

[5] While it seems self explanatory, “movement” is defined here and throughout this chapter as perceived incremental differences in space, size, or distance that occur over time. See Cartwright, Lisa. “The Hands of the Projectionist.” *Science in Context* 24.3 (September 2011): 443-464).

life through unmoving internal elements identified as living yet static bones and immobilized cell bodies. At first, radiographers and histologists such as Simon Henry Gage argued that only static images could capture and adequately represent the complexities of life.[6] Beginning in the early 1900s, however, a new branch of cytology emerged to relocate the foundations of life in living cell entities and their motive actives, especial the movement of blood streams and circulation as the basis of human life. Even though the cinematic medium only provides the illusion of motion, its ability to sequentially project still images and generate life-like movements significantly altered how scientific and lay viewers understood the nature of life. In a larger sense, using acetate safety film to produce and project these images also altered the nature of non-theatrical film distribution; and in an even larger sense, this also laid the groundwork for what would become the popular twenty-first century method of preserving knowledge and information through circulating libraries, image streaming, and public access methods. We tend to think of "streaming" as a distinctive phenomena of digital technology, yet I argue that its roots and foundation can be traced back to the type of circulation made both visually and logistically possibly through acetate analog materials.

Cytology is the study of cells and cell properties; cytologists importantly identified cell bodies as the foundational core of all organisms, and cytologists at the fin de siècle sought to visually represent and animate these foundations through moving imagery methods. These new cytologists — lead by French biologists Jean Comandon in the early 1900s and Alexis Carrel in the 1930s — argued that the secrets of life could only be understood through moving images and dynamic methods of visualizing cells. Instead of defining life through static cellular building

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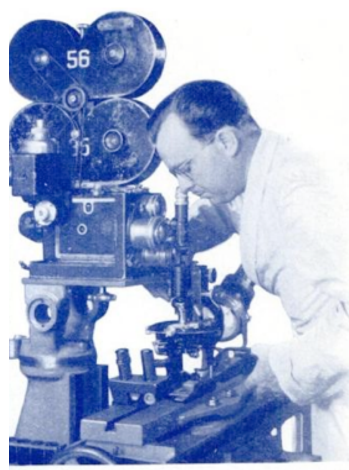
[6] see Simon Henry Gage, "The Processes of Life Revealed by the Microscope: A Plea for Physiological Histology." *Transactions of the American Microscopical Society* 17 (January 1896): 3-29.

blocks, cytologist utilized microcinematography and filmmaking techniques to turn static representations into dynamic, moving sights. Most simply defined, microcinematography is the process of shooting motion pictures through a microscope [Fig. 3.2]. Microcinematographers increasingly utilized acetate safety film materials to capture, publicly project, and widely disseminate cellular life processes. Acetate film began to replace nitrate in the early 1900s as a safer, more stable, and less flammable alternative; acetate proved especially useful in laboratory settings and microcinematography applications where potentially volatile chemicals, heat laps, and other catalysts threatened to catastrophically ignite nitrate.



Here the camera and microscope are combined to give movie patrons an idea of what happens when bacteria develop in a sample of milk

[Fig. 3.2] Lodge, John E. “How *Popular Science* is Put on the Screen.” 35.

Living images of motive cells led to a shift in how the scientific community understood the essential elements of life — a new perspective that would also crossover into public knowledge through the distribution of acetate-based microcinematic images in the form of educational science films. With this, not only did understandings of life change but applications of acetate also shifted: acetate was now valued within scientific and popular applications as a moving image technology capable of capturing movement rather than only supplying static images or immobile preservation. As early as 1906, George Eastman's US-based Kodak company began experimenting with a version of motion picture film printed on a celluloid acetate base.[7] By 1910, Kodak manufactured and sold a 22mm acetate film for the home projection of movies made by their own Edison Studios.[8] Throughout the 1910s, Kodak conducted additional research, development, and product testing to determine whether or not acetate film could also replace nitrate in theatrical, commercial contexts. The European film company Pathé Frères developed their own versions of acetate film through the early 1900s.[9] Beginning in 1912, Pathé distributed acetate film versions throughout France and Germany for non-theatrical projection in homes, schools, and other locations such a laboratories using X-ray radiation, where fire safety was paramount.[10] After several decades of use within these contexts, Kodak released the first commercially available version of small gauge 16mm acetate film for amateur use in 1923. Kodak specifically chose to use an acetate base for these smaller gauges; they never manufactured 16mm film on nitrate, due to its notorious instability and potentially lethal flammability. In addition to its compositional qualities, acetate smaller gauge sizes cut the production and distribution costs of finished film products. This gave birth to the home filmmaking industry (which will be the topic of Chapter 4) as well as non-theatrical, educational film distribution and amateur projection. From this point on, acetate incrementally replaced

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[7] see Albert Sulzer, "The Epoch of Progress in Film Fire Prevention." *Journal of the Society of Motion Picture Engineers* XXXIV (April 1940): 398-408.

[8] see Alan Kattelle, "A Brief History of Amateur Film Gauges and Related Equipment, 1899-2001." Northeast History Film <http://oldfilm.org/content/brief-history-amateur-film-gauges-and-related-equipment-1899-2001>.

[9] Pathé Frères is one of the oldest media companies in the world; rivaling Edison and Eastman in the United States, Charles Pathé pioneered the development of moving image technology in Britain and established Pathé in Paris during the late 1890s.

[10] see Raymond Fiedling, *A Technological History of Motion Pictures and Television: An Anthology from the Pages of "The Journal of the Society of Motion Pictures and Television Engineers."* University of California, Press: 1967.

nitrate film in research labs, schools, and amateur homes; by 1951, new acetate stocks including a professional gauge 35mm stock, also crossed-over into commercial theater use, and finally supplanted nitrate within theatrical as well as non-theatrical contexts.[11]

Even earlier than Kodak's officially recognized development of acetate, Polish inventor Benno Borzykowski claimed to have discovered an improved alternative to nitrate film stock.[12] While Borzykowski's accomplishments are often overshadowed in historical accounts by Kodak's industrial developments, his stock does mark an earlier invention date that commonly thought, lending further support to this chapter's larger arguments about the central importance of acetate beginning in the early turn of the twentieth century. Borzykowski named his acetate-based film "Boroid" and distributed it throughout 1911-1914 in Europe; after the end of WWI, he brought his manufacturing operations over to New York.[13] Both European and American film consumers welcomed Boroid, and acetate safety film in general, as a positive alternative to celluloid nitrate even while acetate was still in its early stages of product development.

Safe, moving images printed on acetate would institute a significant change within the biosciences and the film industry, while also impacting culture in a broader sense. As discussed in Chapter 1, acetate products not only influenced medical manipulations and visualizations of the bodily, but also intersected with larger cultural concerns regarding the preservation of life especially during periods of modern advancement, wartime destruction, and interwar flux. The

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[11] see John Flory, "Films for Learning: Some Observations on the Present, Past, and Future Role of the Educational Motion Picture." Eastman Kodak Company, 1968.

[12] "Items of Interest: General," 429.

[13] For more on the international public's reaction to Boroid, see: "New, Odd, Interesting." *Rodney and Otamatea Times, Waitemata and Kaipara Gazette*, [Warkworth, N.Z.] 14 Pipiri 1911; "British Trade Exhibition." *The Moving Picture World* 16 (5 April 1913): 259-260; "Non-Inflammable Film." *The New York Times* [New York, NY] 8 June 1919.

years before and immediately after World War I, for example, marked a progressive period in terms of increased safety concerns within American industry and society. In the wake of industrial disasters, such the Triangle Shirtwaste Company fire in New York (1911) and the devastating sociopolitical aftermath of World War I, social reformers lobbied for increased measures and new preventative strategies to improve the public's safety.[14] With this, new technologies were called upon to ensure physical "safety," rather than facilitate destruction. Intersecting with this overarching safety movement, film manufacturers in America and abroad began developing new materials to improve the safety of cinematic technologies, including an acetate version of motion picture film named "safety stock."

American companies, popular press outlets, and even governmental agencies promoted acetate-based products as essential for reducing fire hazards and making safe film projection a viable possibility. Acetate films, in comparison to fire-prone nitrate, assured that motion picture projection could be safely integrated in a variety of non-theatrical settings — ranging from laboratory and schoolroom presentations on the origins of life, to factory presentations on industrial safety standards. Following Anthony Slide's definition, the "non-theatrical" genre encompasses films that are not screened in commercial theaters nor traditional profit-making venues; non-theatrical films, by contrast, include laboratory research films, industrial safety films, and educational classroom films which were screened in homes, schools, libraries, and other institutional settings.[15] This chapter will explore how non-theatrical, educational films relied upon acetate film materials to bring scientific images into the public sphere while upholding and reflecting larger concerns with making potentially deadly film projection a safe

[14] see Stein, Leon. *The Triangle Fire*. Philadelphia: Lippincott, 1962.

[15] Slide, x.

endeavor. As chronicled in the March 1920 issue of *Educational Film Magazine,* wide-ranging social investments in safety culminated in a "Safety First" campaign in America, which the article defines as motivated "by the industrial interest of the country — hard-headed, practical business mean and publicists who realized that the safety factor was of the very greatest importance in all lines of industry."[16] Supporting this initial campaign and shifting its focus onto the film industry, in particular, were the additional "demands of educators, churchmen, industrial managers and others for motion picture facilities which are once efficient, practical, and above all safe."[17] Taking these larger social and industrial interests in safety as a cultural framework, this chapter will investigate educational science film productions, exhibition practices, and distribution strategies; it will interrogate how these uses of acetate intersect with larger preoccupations with the preservation and safe keeping of life, while also showing how the mass distribution of acetate safety stock allowed for the circulation of scientific images and new popular understandings of biological life.

Spanning both scientific and popular domains, this chapter questions how cinematic technologies, namely microcinematography and acetate film, shaped modern understandings of life through the public distribution of moving cellular images. Importantly, acetate filmmaking materials were not only relied upon to capture moving images, but were also essential in allowing these image to be moved into public knowledge through non-theatrical projection and educational film circulation. As this chapter will show, film production companies including Kodak and Pathé utilized acetate materials to produce and distribute educational films, which

[16] Pierce, 11; see also Harold Llyod's satyrical send-up of these prevailing safety discourses in *Safety Last!* (dirs. Fred C. Newmeyer and Same Taylor, 1923).

[17] *ibid.*

newly brought the cellular secrets of life to public awareness. Kodak even developed and marketed special versions of acetate film — such as their Frozen Section Stripping Film — that were designed to facilitate the filming and exhibition of biological specimen. These contributions have largely gone undocumented and remained under-explored in the current literature dedicated to the Kodak company, histories of scientific imaging and film technology, as well as how these early uses of acetate technology contributed towards a larger understanding of how moving images should be made, shown, and saved. Take, for example, Kodak's Frozen Section Stripping Film and the case of Vannaver Bush's microtome discussed at the opening of this chapter. The material structure and stability of acetate plastic film allowed for it to be segmented and spliced. In scientific applications, this meant that minutely thin and fragile biologic specimen could be embedded and sliced into slivers of bio-infused film that could then be easily passed under a microscope or even through a motion picture projector to produce a permanent image of ephemeral life. Fast-forward to twenty-first century film archives; now decaying acetate film objects are being sectioned and stripped in a salvage mission, as described in the previous chapter.[18] Rather than saving the acetate base, however, its is the topmost emulsion layer — the part of the film strip that carries the image contents and is not affected by the Vinegary Syndrome — that is prioritized and preserved. This unique, contemporary process of preserving the essential contents combines new digital duplication with the same historic stripping process that previous was pioneered through acetate plastics but is now being turned against it.

While other science and film theorists have discussed the historical developments of microcinematography and scientific visual imaging, in general, this chapter considers how

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[18] "Before and After: 35mm Acetate Film Stripping." *Chicago Albumen Works* (18 July 2014). Accessed 2 April 2015 <https://albumenworks.wordpress.com/2014/07/18/before-and-after-35mm-acetate-film-stripping/>.

acetate film influenced the capturing of micro-life processes, as well as their public projection and dissemination amongst lay viewing audiences.[19] Other scholars, such as Hannah Landecker, have contributed to this area of scholarship by providing a comprehensive historical and theoretical discussions of microcinematography techniques within the lab.[20] Landecker, for example, claims that cinema and science intersect through cellular imaging processes and microcinematography; cinema, she argues, is defined by its smallest units — cell frames — and that the scientific application of cinema was influential in establishing cellular organisms as the basis of biologic life. While Landecker provides a foundational understanding of microcinematography and establishes the historical importance of using cinematic technology within scientific imaging, she does not consider the larger ramifications this cross-disciplinary usage would come to have within film preservation. Filling in this lacuna, this chapter focuses on vital yet neglected questioning of how the material properties and unique contributions of acetate film stock made the production and popular distribution of scientific images possible during a time when safety and loss was a growing cultural obsession. Ultimately, this chapter argues that acetate originally suggested that concerns over insecurity, threatened safety, and loss could be assuaged through the use of new materials that made safe circulation, duplication, and storage possible.

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[19] Lisa Cartwright, *Screening the Body: Tracing Medicine's Visual Culture.* Minneapolis: University of Minnesota Press, 1995; Oliver Gaycken, "'The Swarming of Life': Moving Image, Education, and Views through the Microscope." *Science in Context* 24.3 (2011): 361-380; Janina Wellmann, "Science and Cinema." *Science in Context* 24.3 (2011): 311-328.

[20] Christopher Kelty, and Hannah Landecker, "A Theory of Animation: Cells, L-systems, and Film." *Grey Room* 17 (Fall 2004): 30-63; Hannah Landecker, "Microcinematography and the History of Science and Film." *Isis* 97.0 (March 2006): 121-132; Hannah Landecker, "Cellular Features: Microcinematography and Film Theory." *Critical Inquiry* 31.4 (Summer 2005): 903-37; Hannah Landecker, "Seeing Things: From Microcinematography to Live Cell Imaging." *Nature Methods* 6.10 (October 2009): 707-09; Hannah Landecker, "Creeping, Drinking, Dying: The Cinematic Portal and the Microscopic World of the Twentieth-Century Cell." *Science in Context* 24.3 (2011): 381-416; Hannah Landecker, "The Life of Movement: From Microcinematography to Live-Cell Imaging." *Journal of Visual Culture* 11.3 (2012): 378-399.

Microcinematography:
Living Demonstrations

While the first X-ray images focused on static bones and motionless organs, radiologists almost immediately attempted to animate their still X-rays and turn them into moving pictures. In her seminal work on scientific imaging, Lisa Cartwright claimed that early medical investigators not only desired to see the body's internal components (blood, tissue, nerves), but ultimately desired to see them as living, animated elements.[21] Like most historians, Cartwright identifies Scottish physician John Macintyre and his 1897 experiments with moving X-ray images as the first step towards creating animated renderings of internal biomatter. Macintyre's process involved taking a rapid succession of still radiographs to capture the movements of a frog's leg; he then re-photographed these still images onto a motion picture film strip, and reconstructed the frog's kinetic movements through cinematic projection. When played through a projector, the film produced the illusion of motion, similar to Étienne-Jules Marey's and Eadweard Muybridge's well-known early serial photographs that used stop-motion photo-cinematography to produce moving images.[22] Ironically, it was through static imaging techniques that Macintyre eventually produced moving images that represented, or at least mimicked, life functions; importantly, these were images of living specimen and imitative reconstructions of their movements. Nonetheless, Macintyre's method emerged as the first way to externally visualize the internal, moving movements of living subjects; through cinematic recording and projection, he turned fleeting processes into fixed, repeatable, and permanent images.

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[21] see Lisa Cartwright, *Screening the Body: Tracing Medicine's Visual Culture.* Minneapolis: University of Minnesota Press, 1995.

[22] for more on how Marey's work, especially concerning how it influenced early microcinematography techniques, see: Ostherr, Kirsten. *Medical Visions: Producing the Patient Through Film, Television, and Imaging Technologies.* Oxford: Oxford University Press, 2013.

Other radiologists utilized supplementary devices, such as the fluoroscope, to produce moving X-ray images. As Bill Reiche detailed in his *Popular Mechanics* feature, the fluoroscope emerged shortly after the invention of cinema as a "motion picture alternative" within the otherwise static realm of X-ray imaging.[23] Unlike Macintyre's reconstructed still images, fluoroscope imaging could represent real-time, X-ray moving images by focusing florescent, radioactive light through a special viewing scope [Fig. 3.3]. With this looking device in hand, doctors could directly see the bones and internal organs of their patients in live motion as they were moving. While this was a useful addition to X-ray, early fluoroscope imaging nevertheless had major shortcomings: in addition to the near-lethal amounts of radiation needed to produce viewable images, fluoroscope images could only be seen by a singular *in situ* viewer at that particular moment in time.[24] A new goal thus emerged: to produce animated views of living interiors that could be recorded and shared across time, space, and amongst multiple viewers at once. Equipped with motion picture technology, researchers waited "patiently to capture on celluloid the intimate secrets of plants and insects," and disclose the secrets of life that had long eluded medical visuality and understanding.[25] From human speech processes, to the growth or mending of bones, to embryonic and cellular division, vital life processes could finally be visualized and represented in their full movements and progressive stages of development through cinematic technology and materials.[26]

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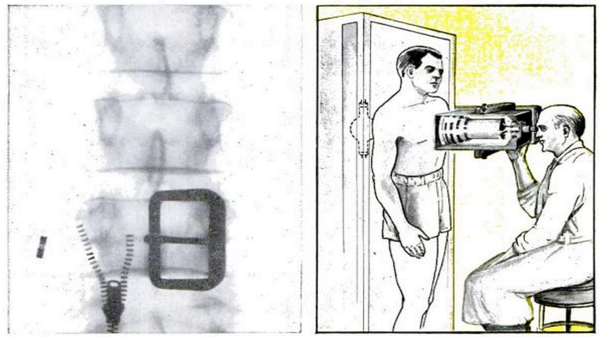
[23] Bill Reiche, "X-Rays 500 Times Brighter." *Popular Mechanics* 90.1 (July 1948): 90-92; 240; 242.

[24] By 1948, researchers were already projecting that fluoroscope images could be broadcast on television monitors and could even be disseminated via television transmission to remote viewing audiences.

[25] Lodge, ""How *Popular Science* is Put on the Screen," 34.

[26] see George H. Darcy, "Languages Now Taught by X-ray." *Popular Science* (April 1939): 26.



[Fig. 3.3] Reiche, Bill. “X-Rays 500 Times Brighter.” *Popular Mechanics* 90.1 (July 1948): 92.

A Flare for the Cinematic

Researchers hoped that by combining X-rays with cinematic technology they would finally produce “motion picture records (...) of the operating mechanism of the human body.”[27] Importantly, cinematic technology and motion picture projection were seen as the only ways in which to visualize life in motion. Whether seeing beneath the skin to capture moving skeletons, or moving deeper still to capture microscopic views of cells and molecular processes, acetate stock emerged in the early 1900s as the only film stable and safe enough to accomplish these functions.

Press outlets such as *Popular Science* and *Popular Mechanics* further emphasized the importance of cinematic mediation within scientific representation. Several articles appearing throughout the 1910s-1930s charted a visible cinematic turn within the sciences. Many articles, for example, used film imagery and cinematic parlance to describe the new, uncanny images of moving skeletons [Fig. 3.4].[28] Wilfred Ogden’s 1923 article, “How Science Turns the World

[27] “X-Ray Movies Reveal Blooming of a Rose.” *Popular Science* (January 1929): 73.

[28] see Wilfred S. Ogden, “How Science Turns the World Inside-Out by X-rays.” *Popular Science* 103.2 (August 1923): 36-37; “Moving X-Ray Pictures.” *Popular Science* 92.4 (April 1918): 554; “Filming Human Organs.” *Popular Science* (January 1930): 49; “X-Ray Movies Aid in War on Disease.” *Popular Science* 127.1 (July 1935): 18.

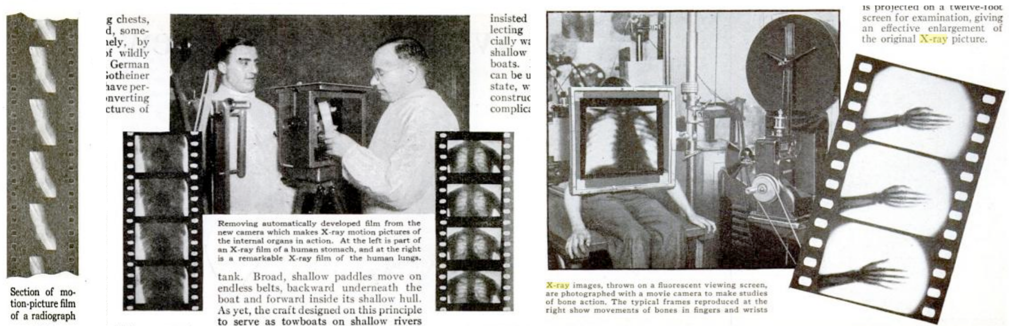
Inside-Out by X-rays," used the magazine's centerfold and film strip format to create an especially provocative juxtaposition [Fig. 3.5].[29] On the left edge of the layout, an actress is shown biting into an apple through a series of close-up film stills. From across the fold, an X-rayed skeleton stares back at the actress while mirroring her chewing motions. While these images and actions were reprinted in the magazine as still photographs, they alluded to cinematic movement through the visible presence of the film strip's sprocket holes. When set into motion through a projector, these images would play "like a vast scientific movie strip" that finally and fully reveal "how the human body unfolds."[30] The caption below further emphasized that these were "actual reproductions of a remarkable X-ray movie film," a fact once again confirmed by the inclusion of cinema-specific film strip borders, cell boxes, and sprocket holes.[31] While these material features are usually concealed from view as the invisible supports facilitating motion picture projection, they are included and visually foregrounded here in order to emphasize the new moving image format. Ogden concludes his article with the prophetic proclamation that X-ray movies would continue to prove their value and "assure their usefulness to science in studying the structure and movements of the bones while the body is in motion."[32]

[29] see Wilfred S. Ogden, "How Science Turns the World Inside-Out by X-rays." *Popular Science* 103.2 (August 1923): 36-37.

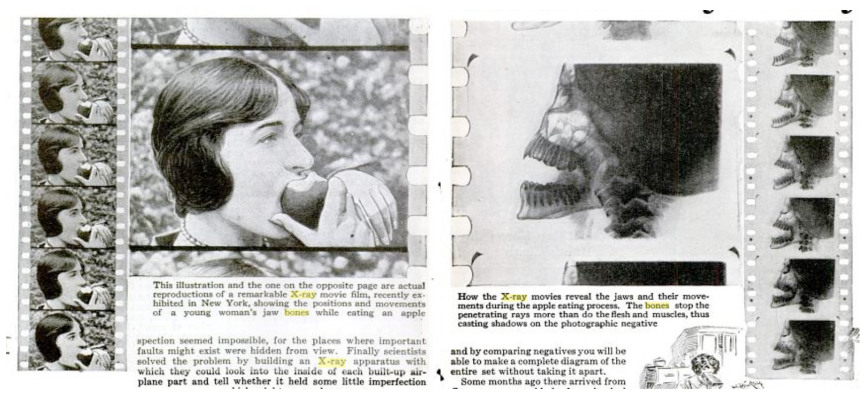
[30] Lodge, "New Studies of Bones Show How We Grow," 14.

[31] *ibid*, 36.

[32] *ibid,* 7.



[Fig. 3.4] Left: "Moving X-Ray Pictures." *Popular Science* 92.4 (April 1918): 554.
Right: "Filming Human Organs." *Popular Science* (January 1930): 49.
Bottom: "X-Ray Movies Aid in War on Disease." *Popular Science* 127.1 (July 1935): 18.



[Fig. 3.5] Ogden, Wilfred S.. "How Science Turns the World Inside-Out by X-rays." *Popular Science* 103.2 (August 1923): 36-37.

With this, still images of immobile structures increasingly turned into cinematic images of functional mobility. Thanks to motion picture technologies including acetate film stocks, unmoving scientific images could finally be rendered in motion and widely distributed amongst a mass public audience. Acetate thus provided essentially in bringing medical imaging practices, including X-ray, cytology, and cell culturing, to life and into public knowledge. Ultimately, the cinematic medium and acetate materials opened a new widow into the world of living, moving bodily foundations — a window that allowed lay viewers unprecedented glimpses into the world of microcellular life.

Microscopic Origins

Before scientific investigators began using cinematic cameras, they utilized microscopes to visualize cellular life. Microscopic analysis importantly enabled scientists to identify cell bodies and cellular functions as the essence of life. Microscopy would also prove to be a transitional method, in that it used both fixed preparations as its source material as well as living cells maintained in culture. Thus, microscopic visuality generated both still and moving images: microphotographs could arrest the whirling processes of cell division and unending flow of microscopic organisms, and microcinematography could capture these vital movements in motion. While each of these approaches placed a different emphasis on cells' movement-based processes and functions, they nonetheless used microscopic imaging to identify cells as the center of life.

According to cellular theories of life, established during the nineteenth century by European scientists, all organisms and living entities are comprised of the same core cellular material. Every bone, drop of blood, and inch of flesh is composed of microscopic cells. Cell theory not only proposed that all organisms regardless of their complexity were composed of cells, it also argued that cellular movement was the basis of an organism's growth and livelihood. Mitotic cell division, for example, is the most basic and required process for generating complex organisms, and is a process that only occurs through the active replication and complicated movements of cellular materials.[33] The creation and maintenance of all biological life, therefore, depends upon these orchestrated movements; life is thus produced through the motion of cells, and in turn can only be understood by seeing and studying them in motion.

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[33] Michaelis, 85.

Edgar C. Wheeler further described the foundational tenets of cell theory and the importance of seeing cells through microscopic visualization in his writings for *Popular Science*. In his article, entitled “Amazing Experiments Reveal Secrets Hidden in Our Bodies,” Wheeler described how microscopes opened scientists’ and the lay public’s eyes to “the smallest unit of life known on earth — the single living cell (...) bringing nearer than ever before an answer to the greatest riddle of the universe — the secret of life.”[34] Through microscopic visualization, viewers could now see and identify cells as the “foundation bricks of life”; importantly, however, these foundational bricks would soon be animated and shown in even greater verisimilitude through moving picture mediation.

Early Imagers

Initially, cellular imaging began as a process of producing still images from dead samples. Just as the moving images of cinema developed out of still photography, microcinematography also began as a collection of still images. The first animated projections of cellular organisms were in fact constituted by dead, fixed cross-sections. In her historical account of cellular imaging technology, Hannah Landecker anchors the emergence of microcinematography in hybrid photography-meets-motion picture imaging methods as exemplified by the early stop-motion experiments of Swiss biologist Julius Ries.[35] Ries produced one of the first stop-motion laboratory films in 1907. Using a method similar to Macintyre’s X-ray images, Ries depicted a sea urchin’s embryonic cell development through a sequence of time-lapse photographs. He photographed individual, fixed cross-sections and then ran them

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[34] Wheeler, 25.

[35] Ries produced one of the first stop-motion laboratory films in 1907, which depicted a sea urchin’s embryonic cell development through a sequence of time-lapse photographs. Ries killed and cross-sectioned several sea urchins at different stages in their developmental process.

through a cinematic projector to create the the illusion of watching a singular, living sea urchin as it developed. Thus, his dead samples were "animated" in the fullest sense of the term by cinematic projection, and created the artificial appearance of life and movement in otherwise non-living, non-moving samples. Landecker's research on Ries shows how cellular imaging initially began as a process of capturing still images from dead samples and reconstructing illusions of movement. Importantly, this manipulated reconstruction took place through projection processes which would be improved and facilitated through the material properties of acetate film — an aspect that is absent from Landecker's discussion even though moving image projection was highly dependent upon acetate's material composition.

In the immediate wake of Ries' experiments, biologists and the lay public alike realized that the full nature of cellular organisms could only be understood if witnessed in motion. As chronicled in the October 31, 1909 edition of the *The New York Times*, thanks to moving picture imaging "[a]ll the activities of microbes, including the Brownian movements, which are so little understood, [could] now be studied with a precision hitherto inconceivable."[36] At this same time, a new branch of cellular sciences known as "New Cytology" emerged and intersected with growing interests in moving picture imaging, techniques in microcinematography, and acetate film materials. This new trend in cytology reacted against histology's use of dead samples and images of unmoving cellular structures.[37] According to Carrel, earlier histologists "contented themselves with the study of the form, and overlooked that of the function," and "on account of this fundamental error, the work done for nearly a century by a host of cytologists and

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[36] "Microbes Caught in Action: Moving Pictures of Them a Great Aid in Medical Research." *The New York Times* [October 31, 1909]: C3.

[37] see Alexis Carell, "The New Cytology." Science 73.1890 (20 March 1931): 297-303.

histologists has ended in an incomplete science of the cells and the tissues."[38] To see cells as only structural elements, in other words, was to overlook the very properties that made cells living entities capable of creating and continuing life. These vital processes include intercellular communication, respiration, energy storage and release, synthesis, excretion, growth, differentiation, reproduction, reaction to stimuli, motility, contractility, conductivity, absorption, phagocytosis, and secretion — a long list that itemizes only a few of the various movements required to sustain living organisms.[39] Leading the New Cytology movement was French biologists and filmmaker, Jean Comandon, who began his experiments with microcinematography in 1910.[40] According to New Cytologists, preceding histologists "contented themselves with the study of the form, and overlooked that of the function," and "on account of this fundamental error, the work done for nearly a century by a host of cytologists and histologists has ended in an incomplete science of the cells and the tissues."[41] To see cells as only structural elements, in other words, was to overlook the very properties that made cells living entities capable of creating and continuing life.[42] At this same time, French biologist Alexis Carrel developed new live tissue culturing techniques that would proved vital to the success of

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[38] Carrel, "The New Cytology," 297.

[39] see William A. Beresford, *Lecture Notes on Histology*. Third Edition. Oxford: Blackwell Scientific: 1983.

[40] A number of other European biologists, medical researchers, and New Cytologists also employed microcinematography in their experimental work. Before World War I stalled the scientific development and wide-spread laboratory application of acetate-based microcinematography, German biologists including Kutner, Richer, Scheffer, Siedentopf, Sommerfeld, and Scheffer produced a number of cell culture films. After the War, the New York Institute of Photography produced the first microcinematic film in the United States.

[41] Carrel, "The New Cytology," 297.

[42] These vital processes include intercellular communication, respiration, energy storage and release, synthesis, excretion, growth, differentiation, reproduction, reaction to stimuli, motility, contractility, conductivity, absorption, phagocytosis, and secretion — a long list that itemizes only a few of the various movements required to sustain living organisms. For more, see William A. Beresford, *Lecture Notes on Histology*. Third Edition. Oxford: Blackwell Scientific: 1983.

microcellular filming. As discussed in Chapter two, Carrel used culture solutions enriched, in part, with cellulose acetate chemicals to support and keep cellular tissue alive outside the body. These living cells could then be recorded with newly emergent acetate filmmaking materials to produce living, moving images.

Before acetate, microcinematographers and scientific filmmakers used nitrate film. They immediately pursued more stable, less flammable motion picture materials, however, and by the 1910s widely adopted acetate as the preferred way to capture and present life in animated movement. Acetate's improved features were especially celebrated in the popular press and trade magazine; some articles even claimed acetate was "life-affirming" compared to "dangerous to life" nitrate, and that if one valued life they would invest in acetate-based materials.[43] Acetate was thus positioned as a positive alternative to nitrate, which was publicly demonized as "a dangerous substance" that required the use of special fire-insulated projection booths, licensed professional operators, and other measures to safeguard against its inherent, deadly threats.[44] Thus, acetate quickly became associated with ensuring and promoting "life," in a dual sense: as a cinematic medium it gave animating life to dead, still images, and as a safer non-flammable stock it preserved the life of its users. Numerous reports, advertisements, and articles from the first half of the 1900s (which continued even into the 1960s, when newer alternative like polyester film and videotape began to displace acetate), attested to the essential value of acetate film. In both scientific and popular publications, acetate was discursively promoted as a superior way to visualize images of cellular movement and disseminate this knowledge about the

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[43] see "SAFETY FIRST!" *Educational Film Magazine* 3.3 (March 1920): 5; and Damon, Louis A. "Why the Safety Standard?" *Educational Film Magazine* 4.3 (September 1920): 10-11.

[44] see Dana Pierce, "The Underwriters' Responsibility to the Public." *Educational Film Magazine* (January 1920): 10-11.

foundations of life to the public. An advertisement for Kodak, printed in the January 1930 edition of *The Educational Screen*, even suggested that the nature of biologic life and its fundamental microcellular processes could only be explained and brought to real life through cinematic moving pictures [Fig. 3.6]. Before motion pictures and educational science films, the ad claimed, "there was no adequate way to explain [complex] principles," especially those that involve "*motion* — an element difficult to convey with either the spoken or printed word."[45] With microcinematography, however, "[i]mmediately the subject leaps to life on a silvered screen."[46]

[Fig. 3.6] Eastman Classroom Films. "At the Snap of A Switch *Words* become *Reality*" advertisement. *The Educational Screen* (January 1930): 21.

Bringing complex cellular images to life through motion rendering thus became to goal and defining feature of both acetate and New Cytology. Through filmic representations and manipulations, scientists could better observe the intricate nuances of cellular phenomena which

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[45] Eastman Teaching Films, 21.

[46] *ibid.*

were impossible to see through other still imaging methods. Ironically, however, part of these new understandings of life were also gained through visualizing death. For example, apoptosis (or natural, programmed cell death) also depends upon a series of kinetic processes, which were now observable and understandable through motion picture renderings. Zeiosis (or blebbing) is one such process, where the dying cell membrane bulges, shrinks, and pops.[47] Even more ironically, these same blebbing motions which define cell death would later be identified as characteristic of celluloid acetate's own material decomposition and death. While depicting death was an aspect of microcinematography and New Cytology, they largely focused on living systems and samples. In fact, New Cytologists embraced microcinematography and acetate moving pictures in large part because they saw them as improved "tools for vivisection" and "living demonstrations."[48] Unlike taxidermists and histologists who preferred dead, immobilized subjects, these cytologists believed that life's essential functions could only be revealed through living specimen and moving image technology. As Lawrence Augustus Averill described in his column for the *Educational Film Magazine*, motion picture projection allowed "cold, lifeless pictures [to] become suddenly (...) thrilling and vibrating with life. (...) The limitations of the [still image] are obliterated in the film (...) films are natural, ever-changing, varied, living."[49] This instituted a change in the biosciences as well as larger cultural understandings of "life": all living things were supported by "cells and tissues [that now] appear as being endowed with properties which make them not only the building stones, but also the builders of an organism

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[47] In addition to apoptosis, Blebbing is also an important element in other cellular processes, including locomotion and division. See I. Costero and C.M. Pomerat, "Cultivation of Neurons from Adult Human Cerebral and Cerebellar Cortex," *American Journal of Anatomy* 89 (1951): 405.

[48] Landecker, "Seeing Things: From Microcinematography to Live Cell Imaging," 708.

[49] Averill, 12.

capable of developing, maturing, growing old, repairing wounds and resisting or succumbing to disease."[50] New Cytologists thus adopted and fused together microscopic technology with cinematic technology to solve "[p]hysiological questions of the greatest importance, [which were] impossible of elucidation in the past" and re-defined life as driven by cellular movements and activities.[51]

In addition to representing organisms as they lived and moved, acetate filming also revolutionized cytological research by providing a preservative function — both in terms of preserving specimens' lives, as well as preserving scientists' resources and results. In previous histology preparations and early time-lapse photography methods, several specimen had to be killed and dissected to produce still image representations of developmental stages or steps in the experimental process. While imaging techniques like these required killing many specimen in order to visualize them (similar to autopsy or taxidermy), microcinematography could capture the development or testing of a single, living specimen as an repeatable, permanent film record. The filmic medium itself is highly replicable and reproducible, and even during the early years of acetate technology, film strips could be copied, distributed, and kept en mass with relative ease, especially compared to nitrate stocks. Within scientific lab contexts, the footage of a singular experiment or documentation of a singular specimen could be duplicated and widely distributed amongst several researchers without the need to procure more specimen samples or repeat the same testing procedure. The experimenter's time and laboratory resources, as well as the actual lives of biological specimen, where thus all conserved thanks to the duplication and

[50] *ibid*, 303.

[51] *ibid.*

dissemination of acetate-based of film.[52] The filmic images essentially replaced the original specimen, in large part because acetate film materials were seen as seen as longer-lasting, more permanent, and more preservable than nitrate or even the original organic specimen. Essentially, acetate film records functioned like as the acetate taxidermic skins discussed in Chapter one: acetate skins and acetate films replaced the original biologic material of the specimen with what was considered to be a longer-lasting, preservable material alternative. Unlike taxidermic skins, however, these filmic mediations did not simply preserve a static object, but rather produced moving image representations that were enlivened through cinematic projection.

Projection and Making Movement Happen

One of cinema's defining elements is projection — which is defined here as the process of directing light through a series of still frames to create the illusion of motion and produce an enlarged, moving image on screen. Cinematic projection instigated an overarching visual and epistemological shift. Cinema's illusion of movement, as well as its manipulation of time, speed, and scale, allowed viewers to see minute life processes and understand them in new ways: things that were previously seen as slow or stagnant, were now revealed as sites of dynamic movement and living activity.[53] From the onset of his experiments with microcinematography, Comandon also realized the immense potential of using cinematic projection to expand the scale and clarity of microscopic life: "microbes could be photographed distinctly and brilliantly upon the film," he believed, and subsequently projected or "thrown on to the screen" to make microscopic elements and previously imperceptible functions accessible to scientific and lay observers.[54] Lisa

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[52] Slide, 45-6.

[53] see Janina Wellmann, "Science and Cinema," *Science in Context* 24.3 (2011): 311-328.

[54] Talbot, 162-3.

Cartwright has further argued that cinematic projection renders physical phenomena into a more "viewer-friendly site (...) a site whose appearance was radically reordered to reflect the body's new status as a mobile, living system."[55] With this, cinematic projection generated new images of living organisms and their vital functions, which in turn generated new perspectives and theories of natural existence.

Cinema emerged at the turn of the twentieth century as a novel way to render and manipulate movement; in fact, cinema's earliest appeal as a new, visual spectacle was its ability to animate still images and almost magically turn them into moving images. As early cinema scholar Tom Gunning discusses in "An Aesthetic of Astonishment: Early Film and the (In) Credulous Spectator," early film spectators derived pleasure by seeing projectionists bring still images to life before their eyes; the unique appeal and experience of cinema was firmly anchored in its remarkable, almost unbelievable ability to create motion.[56] Cinematic manipulations of motion were not only pleasurable for spectators, but also useful for scientists. Biologic processes ranging from cell division, to embryonic development, to the blooming of flowers all occur at such a slow speeds and slight magnitudes that they would remain imperceptible if not for fast-forwarded, magnified cinematic projection. Film projection thus influentially allowed for the speeding-up, or slowing-down, natural movements, which proved especially useful for scientists who desired to see life process that were either too fast or too slow to normally perceive.

Projection also brought cellular images to life within public awareness and knowledge through their externalized, mass display. Even though microscopes rendered certain cellular

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[55] Cartwright, *Screening the Body: Tracing Medicine's Visual Culture,* 82.

[56] see Tom Gunning, "An Aesthetic of Astonishment: Early Film and the (In)Credulous Spectator." *Art and Text* 34 (Spring 1989): 31-45.

behaviors and movements visible well before cinematic mediation, these views were only accessible to singular scientific observers within laboratory contexts. The mass projection and display of these images, however, allowed them to enter into the public sphere and become accessible to a larger population of lay viewers. As film historian Frederick Talbot aptly encapsulated, cinematic projection "opened the gates of a kingdom long considered beyond the reach of all but the privileged few"; as such, the public distribution and projection of science films newly enabled layman, not just scientists, to see and understand the cellular nature of life.[57] Through the populous, easily understandable language of images which even the unschooled and textually illiterate could "read," the cinematic medium allowed non-scientific specialists to engage with scientific knowledge. Film companies also capitalized upon cinematic images as a universally accessible medium, and used this to sell their products. "Pictures live," the Spencer Lens Co. proclaimed in an advertisement headline, "and produce a universal understanding."[58] As such, motion picture technology was quickly adopted for public educational enrichment. Educational science and laboratory research films, in particular, would "provide a college for the masses, a first aid to science and a distinct help to education, having verified history and brought the march of world events to the very doors of the people."[59] This door into the public realm, however, would only be fully opened after the introduction of acetate safety film materials, which rendered projection safe enough for public application.

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[57] Talbot, 165.

[58] Spencer Lens Co., 123.

[59] "A College for the Masses," 12.

Acetate Safety Stock and Making Movement Safe

In her essay on the physicality of projection, Lisa Cartwright described it as a complex and often dangerous interaction of arc lamps, gas jets, and the film stock.[60] The lamps and jets focus a direct, intense beam of light through the transparent film strip and, in doing so, produced an intense amount of heat. Coupled with the unstable flammability of early cellulose nitrate film, this created a significant fire hazard. Nitrate film was highly unstable and fire prone — fifteen times more combustable, in fact, than wood. As recounted in several historical accounts from early exhibitions, nitrate often caught fire during projection and caused both the destruction of theaters and death of viewers.[61] Acetate, however, was introduced as an important safety measure, and its adoption significantly impacted the development and popularization of the filmic medium especially in its first area of application: non-theatrical and educational contexts. As this section will show, without the development of acetate film, the projection and distribution of films within a public context would not have been possible. Early cinematic projection was not only dependent on the flexibility and relative durability of celluloid roll film, but its safe function was made possible though the introduction of celluloid acetate. While other film historians, including Charles Acland, have focused on film gauge size, this section argues for a deeper, previously neglected level of specificity: it shifts attention squarely onto acetate film materials and suggests that moving images of cellular life could not be safely stored nor publicly shown without acetate safety stock.

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[60] Cartwright, "The Hands of the Projectionist," 460.

[61] For a comprehensive listing and description of significant theatre fires caused by the projection of nitrate film — including "the most tragic" fire at the Paris Charity Bazaar o May 4, 1897 — see "Early Years and the Museum of Modern Art." *Nitrate Wont Wait: A History of Film Preservation in the United States*. Ed. Anthony Slide. Jefferson: McFarland & Company, 1992. 9-24.

While projection was an essential part of showing moving images on a mass scale, it was also a volatile and even potentially dangerous activity for the viewing audience. However, as stated in an early advertisement for the Victor projector company, the projector process could never be made fully safe as long as nitrate film was being projected: “No amount of mechanical cleverness in making a projector can take the ‘flam’ out of the inflammable film,” the ad stated and “[e]very projector — no matter how many fire shutters it may have, no matter how small and innocent it may appear — is a menace to your safety if it employs standard [nitrate] theatre film.”[62] Cinematic projection could only be turned into a safe and viable endeavor, especially for lay users, through the invention of non-flammable film. Acetate safety film was thus developed to extinguishing the unavoidable threats posed by nitrate projection, and to finally “knock the ‘flam’ out of film and the booth out of the projection equipment.”[63] A little known fact overlooked in current histories of film materials is that acetate was also used to reduce cinema fires even before the invention of safety stock. Preceding its use as a stock, the Lumière brothers reduced the threat of projection fire by placing a water condenser between the arc lamp and lens. Importantly, the Lumière’s enriched the water with acetic acid — the same acetic acid that comprises the base of cellulose acetate. Thus, even when nitrate film was still in use, acetate materials were already implemented as a way to bring about cinema’s safe projection and its successful public application.

Popular press articles vocally attested to acetate film’s central role in fire projection. The *New York Tribune* noted in an early 1914 article, for example, that the Pathéscope projector was

[62] Victor, “The Standard That Knocked the “Flam” out of Film and the Booth of Out Projection Equipment,” 32; note that in the parlance of the time, flammable film stock was referred to “inflammable” and non-flammable or flame-resistance stock was referred to as “non-inflammable.” For contemporary clarity, however, I use non-flammable and flammable designations.

[63] *ibid.*

the only safe motion picture machine in the world, not because of the projector itself but because it ran acetate safety stock instead of nitrate film.[64] Pathé's own advertisements also used acetate as a selling point and emphasized its safety features in their marketing for projectors. One such ad, placed in the debut January 1919 issue of the *Education Film Magazine*, described how Pathé projectors worked in tandem with new, slow burning safety film to ensure the enjoyment of educational films within public, non-theatrical settings.[65] The ad prominently featured both the projector unit and the film stock, and detail how Pathé's new portable projector and small-gage acetate stocks were approved as the "new safety standard" by the Society of Motion Picture Engineers. These products were especially designed for schoolroom use without the need for special site-specific projection booths, professional operators, or exorbitant fire insurance coverage. Acetate safety film also instigated the revision of several restrictive safety legislations originally enacted to protect film spectators from the hazards of nitrate. Before the introduction of acetate, schools were restricted from showing nitrate prints and theaters were subjected to large fines and Federal safety restrictions. However, as noted in *The Educational Screen*, acetate's introduction lead to state and Federal safety law amendments, allowing schools and other non-theatrical institutions to show acetate films materials.[66]

Safety was a serious overarching concern, for distributors, exhibitors, and consumers during the early decades of the twentieth century, especially after the devastating losses imposed by WWI. Playing-into this rhetoric of safety, desires for protection, and demands for

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[64] "Motion Pictures for 20 Schools," 9.

[65] The Pathéscope Co. of America, Inc. "The New Premier Pathéscope" advertisement. *Educational Film Magazine* 1.1 (January 1919): 1.

[66] see Dean McClusky, "A Survey of Visual Instruction (Editorial Note)." *The Educational* Screen (March 1930): 85; James G. Sigman, "Gradual Growth of Motion Pictures in Education." *The Educational Screen* (January 1931): 4-5; 13.

preservation, several film companies and other material producers marketed acetate products as ensuring their user's safety and providing a preservative function. With this, acetate products ranging from film stocks to plastic containers were sold to the public through public discourses that pandered to cultural obsessions.[67] One especially heavy-handed article, published in the March 1920 issue of *Educational Film Magazine*, valorized acetate for safeguarding thousands of human lives and even elevated safe film projection to a moral and civic responsibility.[68] Tugging on every conceivable heartstring, the article concluded by stating that the mental well-being and physical lives of viewers (and school-aged children, especially) depended upon acetate. Other companies even exaggeratively boasted that cinematic instruction would preserve the delicate eyesight of young students.[69] Amidst all this marketing hot air was a residing, prevailing belief that nitrate equalled dangerous/bad, and acetate equalled safe/good. Whereas nitrate stock was characterized in popular and trade press outlets as a "vampire [that] may be beautiful to look upon (...) [but] in her heart is a black menace to all weak men," acetate emerged within public opinion as a trustworthy, life-saving and life-giving alternative.[70] Acetate's association with safety did not stop at its material level, but also influenced the subject matter ad types of films that were made. An entire branch of the educational films, for example, focused on promoting safe working practices; thanks so acetate safety stock, these films about safety could also be safely shown in factories and other dangerous workplace settings like underground mines were nitrate film projection would have been especially ill-advised.

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[67] see James R. Cameron, "The Law Says: 'Safeguard Life and Property' — America's Slogan is 'Safety First!' *Educational Film Magazine* 3.3 (March 1920): 24.

[68] "SAFETY FIRST!," 5.

[69] "Motion Pictures and the Eyes," 297-298.

[70] "SAFETY FIRST!," 5.

Replacing film's original nitrate base with acetate undoubtedly marked a pivotal moment in film history, mostly because acetate made the distribution and exhibition of film a viable reality within non-theatrical contexts and venues other than motion picture theaters. Before the widespread switch over to acetate, the dangers of nitrate required special projection booth designs, professionally trained projections, and other safety measures that were only feasible for large cinemas and certain not smaller, non-for-profit public institutions including schools. Reacting to this, the *New York Times* concluded that "[p]erhaps nothing is more important to the wide extension of the use of motion pictures in schools, halls, and homes than the production of non-inflammable film."[71] This opened new outlets for cinema, and enabled film to become a popular, educational tool as well. None of this would have been possible without the advances offered by acetate plastic.[72]

Educational Science Films: From Room to Room and Used Where Desired

While much has already been written about educational films and the use of cinema to present scientific materials as popular entertainment, this section intervenes to place a new focus on the crucial role played by celluloid acetate film. Specifically, it focuses on educational science films featuring microcinematic images of moving cells, which were captured on acetate and successfully moved into public consumption through safety stock distribution. Charles R. Acland and Hadie Wasson's recent anthology, *Useful Cinema*, and Devin Orgeron, Marsha Orgeron, and Dan Streible's *Learning with the Lights off: Educational Film in the United States,* both provide rich and wide-ranging discussions of visual education, industrial films, the history of scientific

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[71] "Non-Inflammable Film."

[72] "A New Non-Inflammable Film For America," 22-23.

films, and significance of small gauge film technology.[73] Crucially absent from these compilations, however, is a recognition acetate's popularization as a safe, truth-worthy material and how this discourse allowed for scientific images of cellular life to enter the public sphere. Acetate film materials prioritized "movement" in a number of ways: acetate film technology captured moving images of cellular life, and these revolutionary images were then moved into the public sphere through education science film distribution. Consequently, these moving images shaped how the general public understood the nature of life. As a new contribution to the existent scholarship, this section places acetate at the center and reclaims it as an overlooked though vitally important aspect of scientific visuality and educational film history.

While different types of films comprise the large educational film genre — including history, geography, and hygiene movies — science films proved especially popular throughout the twentieth century. Using Michaelis' working definition, science films result "from the application of cinematography to the systematic search for new knowledge in the sciences," they are "motion pictures made in the laboratory, or during the course of field work, which aid directly in the discovery of new knowledge (...) a research film."[74] Educational science film are essentially as old as cinema itself: Muybridge and Marey's early experiments in filmmaking encompassed the scientific analysis of bodily locomotion. Even in the contemporary era, moving cinematic images are still used to educate and entertain viewers, even though they are no longer produced or projected in the film format. Educational science films can also cover a wide array of topics, including biopics that focus on the lives and work of individual scientists or research

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[73] Specifically, Gregor Waller's essay, "Projecting the Promise of 16mm, 1935-45," and Ronald Greene's essay, "Pastoral Exhibition: The YMCA Motion Picture Bureau and the Transition to 16mm, 1928-39," both in *Useful CInema,* consider how 16mm film and projector formats influenced a national network of non-theatrical film distribution and exhibition.

[74] *ibid*, ix, 1.

films that represent actual experiments and laboratory tests. While the topics and subject matter tackled by educational films are indeed vast, the following sections focus on films produced within labs and that depict experiments with cellular movement; these film, in particular, relied upon acetate film materials and microcinematic techniques to visually define the basis of life as well as export these images to lay viewers.

Everyday movie fans enthusiastically embraced these films, and their spectacular "attractions" as both a form of entertainment as well as intellectual engagement. As chronicled in the May 1914 edition of the *Motion Picture Magazine*, Arthur Lenox from Washington, D.C. marveled how "[m]odern science, as represented by the Movies, actually out rivals Aladdin's lamp, Jules Verne's fancy, and opens new worlds of enjoyment to all."[75] Cinematic and scientific technology joined forces to performed magically seeming feats, and reveal the wonders of life in an easy to understand and even enjoyable visual experience. The popularity of educational science films also spurred the development of trade magazines, such as *Educational Screen* and *Educational Film Magazine,* which will be frequently referenced in this section. In these magazines, educators discussed trends and innovations in cinematic teaching methods, and commercial companies used them as forums to promote their own products. These print outlets further solidified the industry and served as vital public venues for educators, commercial companies, and the lay public to discuss the wonders of cinematic technology and acetate materials, especially. Importantly, the marketing tactics used in these magazines frequently featured positive descriptions of acetate film materials, which contributed to the mass, popular

[75] Arthur Lenox, "A Modern Miracle." *Motion Picture Magazine* VII.4 (May 1941): 90.

appreciation for acetate as a safe, cheap, durable, and all-around superior alternative to other imaging materials.

Leaving the Laboratory and Entering the Public

In his influential writing on the popularization of scientific images, Thierry Lefebvre claimed that film shared an influential, mutually constituting relationship with the sciences: film was, after all, pioneered by scientific inventors and researchers and many of the earliest films focused on bodily mechanics and physiology.[76] The intersection between the sciences and cinema, however, is perhaps best embodied in the form of popular sciences films which illustrate principles of the natural, biological sciences in an easy to understand visual (and eventually aural) format. Intended for lay audiences, these films utilized the accessible nature of images and populous cinematic medium to disseminates scientific knowledge. In an act of popular democratization, these films allowed lay viewers to access scientific secrets and knowledge about the nature of life, which were previously restricted to the privileged purview of professional scientists.[77]

While educational films where not part of the commercial Hollywood film industry per se, they were nevertheless extremely popular and influential within the early cinema landscape. Many of these early films aimed to educate or reform a diverse set of viewers ranging from promiscuous schoolgirls to inefficient assembly line workers, wartime military trainees to post-

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[76] see Thierry Lefebvre, "Science Film: Europe." *Encyclopedia of Early Cinema*. Ed. Richard Abel. New York: Routledge, 2005: 568-72. For more on scientific imaging and medical visuality, see also: Caroline A. Jones, Peter Galison, and Amy E. Slaton. *Picturing Science, Producing Art.* New York: Routledge, 1998; and Kirsten Ostherr, *Medical Visions: Producing the Patient Through Film, Television, and Imaging Technologies.* Oxford: Oxford University Press, 2013.

[77] Acetate technology would similarly bring about a "democratization" of filmmaking through the introduction of cheap, safe, and easily accessible amateur stocks.

war immigrants "needing to be Americanized."[78] In each of these cases, educational films served as shaping tools that, intersecting with Michel Foucault's theories of visual control and biopower, used imaging technologies to produce knowledge, mold minds, and even reshape the bodies of its viewers.[79]

The popularization of scientific images was also enthusiastically supported by the scientific community. Dresden-based biologist, Martin Weiser, for example praised microcinematic films and specifically those produced on acetate for their ability to travel between the lab and public sphere, disseminating scientific knowledge amongst the masses. Acetate materials, as Weiser keyed into, made the public circulation of scientific images possible thanks to their decreased flammability and safer, cheaper transportability. These features appealed to the producers and distributors of these films, which were often the same entity. Most of the leading educational film producers — including Kodak, Pathé, Bausch & Lomb, Coronet, and the Ford Motor Company to name a few — were responsible for manufacturing film equipment (stocks, projectors, lenses), film titles and series, as well as selling and shipping all of these products.[80] Often, the scientific films produced by a company would feature their products and forge a positive association between the company, modern progress, and the very fabric of life. Bausch & Lomb, for example, produced films touting the benefits of microscopic analysis and studying

[78] The *Educational Film Magazine*, for example, published a startlingly large number of articles and advertisements through the 1920s on how to "Americanize" immigrants, foreigner workers, and even young American students through cinematic viewership.

[79] see Michel Foucault, *The History of Sexuality.* New York: Pantheon Books, 1978.

[80] for more on the industrial histories of educational film see: Victoria Cain, "'An Indirect Influence upon Industry': Rockefeller Philanthropies and the Development of Educational Film in the United States, 1935–1953," in *Learning with the Lights Off: Educational Film in the United States*. Devin Orgeron, Marsha Orgeron, and Dan Streible, Eds. New York: Oxford University Press, 2012: 230-48; Lee Grieveson, "The Work of Film in the Age of Fordist Mechanization," *Cinema Journal* 51.3 (2012): 25-51; Heide Solbrig, "Dr. ERPI Finds His Voice: Electrical Research Products and the Educational Film Market, 1927–1937," in *Learning with the Lights Off: Educational Film in the United States*. Devin Orgeron, Marsha Orgeron, and Dan Streible, Eds. New York: Oxford University Press, 2012: 193-214.

biologic phenomena through microscopes, which were of course equipped with Bausch & Lomb optical lenses.[81] Educational films and the companies behind them ultimately grew into their own self-sufficient and largely self-promoting industry, and produced hybrid images of scientific knowledge mixed with marketing propaganda that served to shaped the public's understanding of biologic life as well as new technological innovation and visual materials.

Organizations outside of the commercial sector also facilitated the production, collection, and circulation of educational acetate film titles. In 1920, the Educational Museum of the Cleveland Public Schools began a project called the "The Ford Educational Library," which provided motion pictures and accompanying teacher guides to hundreds of schools cover various topics from heath to history.[82] The St. Paul Institute/Science Museum in Minnesota also established a free lending library for educational films circa 1921. Preservationist Dino Everett and film scholar Jennifer Peterson have noted in their recent work on educational films that several other universities and public libraries also distributed and produced their own 16mm educational film.[83] This systematized sharing fulfilled the needs of educators and other non-theatrical exhibitors who demanded a stead stream of new titles to keep their viewer's attention and show off the latest, up-to-date scientific discoveries. Public schools not only rented educational films from lending libraries, but also circulated them amongst themselves. Homer Croy noted in his writing for *Educational Film Magazine* that scientific education depended upon this type of free circulation and exchange: "[s]cience especially will be taught," he claimed, "by means of motion pictures traveling [between schools] (...) A film illustrating the action and

[81] see *Corrective Spectacles: To Greater Vision* (produced by Bausch & Lomb, 1944).

[82] Flory, 17.

[83] see Dino Everett and Jennifer Peterson, "When Film Went to College: A Brief History of the USC Hugh M. Hefner Moving Image Archive." *The Moving Image* 13.1 (Spring 2013): 33-65.

reaction of certain gas will be shown in one high school, to be sent from there to another, until it has completed its round of schools of that grade."[84] These circulation processes influentially contributed to the birth, growth, and success of the entire educational film industry, and were made possible through the specific properties of acetate film.

What Acetate's Got to Do With it, or: Why Acetate Matters

While other film historians, such as Oliver Gaycken, have written about the circulation of scientific images within the public sphere, they have collectively overlooked the underlying factor that initially this possible: the advent and use of acetate safety stock. Acetate materials not only made images of moving cells possible within the lab, but allowed these images to publicly circulate through domestic distribution and projection. If not for acetate, these new images of life could not have been captured by scientists in the first place, nor safely shared with lay audiences or used for public educational purposes. In a full-page advertisement that reads like an official laboratory report, the Kodak company praised acetate film stocks and their Frozen Section Stripping Film, in particular, by highlighted their vital role in microscopic cellular imaging. [85] Appearing as the first page of *Science News Letter*, the ad details a variety of acetate film uses: bovine pregnancy testing, data-recording, and microtome cross-sectioning. A number of researchers, cytologists, and microcinematographers also confirmed Kodak's claims and acetate's importance. C. G. Lefeber and E. J. Ambrose, for example, wrote in *Cinematography in Cell Biology* that acetate stocks were highly successful imaging mediums that reliably captured cinematic records of cellular movement and supported the laboratory creation of biologic

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[84] Croy, 6-7.

[85] Eastman Kodak, 129.

specimen cross-samples. Thus, scientific practitioners valued acetate film for its unique material features and relied upon its ability to render filmic representations of biologic life.[86]

Referencing Vannevar Bush's latest microtome process, the ad describes how acetate-based film invaluably aided in the creation of hybrid, biologic specimen that were turned into moving image pictures. The Frozen Stripping Film used in Bush's microtome machine was specially designed without an emulsion layer that that the strip was completely comprised of an impressionable acetate surface. In effect, Bush's cellular imaging method re-engineered the entire process of photographic imaging making: rather than using emulsion to create and store the image, Bush's images were produced and kept within the acetate itself.

In his report on the evolution of educational motion pictures, John Flory specifically singled out the important role played by acetate technology within educational contexts. While the cinematic medium was envisioned as an educational medium from its inception, the material composition of early film hamstrung the fulfillment of this vision. "The earliest film stock," Flory lamented, "was made on nitrate base. It was highly flammable and could only be shown in fireproof projection booths. Hardly the kind of accessibility that educators are demanding today!"[87] Acetate emerged to improve film's accessibility in a number of ways, ranging from increased safety assurance to decreased shipping and distribution costs.

In terms of cost, acetate improved the accessibility of films by offering a cheaper, less demanding alternative. Unlike nitrate, acetate could be manufactured in a smaller, lighter gauge size, which meant it could be produced and shipped at a reduced cost. Acetate was also cheaper

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[86] see C.G. Lefeber, "Modular Design for Time-Lapse Cinematography." *Cinemicrography in Cell Biology*. ed. George Rose. New York: Academic Press, 1963: 3-26; E.J. Ambrose, "The Use of the Interference Microscope for the Study of Cell Movements and the Quantitative Analysis of Changes in Growing Cells." *Cinemicrography in Cell Biology*. ed. George Rose. New York: Academic Press, 1963: 123-142.

[87] Flory, 17.

and safer to distribute via the postal system, and was thus supported as the preferred material for (non-theatrical and eventually commercial) film distribution. Acetate stock also helped to make projection more of a mobile endeavor: small gauge films could be easily carried along with small-scale acetate projector units. As Cartwright described, the projector unit and entire method of acetate film projection was intended to service the needs of portable display and presentations: with their films and projectors in tow, researchers traveled like cinematic sideshow exhibitors; they moved between laboratories, lectures, and classrooms circulating their work and amazing audience with awe-inspiring images of moving life. Thanks to its small gauge format and fire resistance, acetate films and the means to project them were made portable and safe to use within the public sphere. Regional newspapers also promoted acetate's portability. Writing for the Philadelphia-based *Evening Public Ledger*, Chas E. Duryea noted that the need for projection apparatuses in schools was met by "small machines using films of acetate of cellulose instead of [nitrate] celluloid (...) [which could] be moved from room to room and used where desired."[88] Acetate could thus be projected in any room, without the need for special fireproof booths or specialist projectionists.

While its small size and portability facilitated economic introduction of moving pictures into public schoolrooms and civic venues, acetate's main improvement and most heralded achievement was undoubtedly its decreased flammability. By improving the fire resistance of the stock base, acetate films could be projected and manipulated with greater ease and success in non-theatrical venues. Whereas nitrate film quickly caught fire and could catastrophically self-destructed under the intense heat of prolonged projection, acetate fared better under multiple

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[88] Duryea, 24.

runs, fast-forwarding, looping, and even freeze frame pausing under hot projector lamps. Rather than imploding, acetate would remain stable or, at worse, slowly bubble and burn in a self-contained manner under the projector's heat. Popular press especially played up safety rhetoric to sell acetate, and championed its fire resistance; print articles and advertisement through the 1920s especially exploited public fears of nitrate as well as ambivalent desires to still have cinema within schools and other public venues. For example, Pathé published a number of ads proclaiming that acetate film materials ensured their viewer's safety: "[our] pictures combine instruction with safe entertainment," as one ad stated.[89] Another two-page spread proudly announced how Pathé to be the alleged "inventor" of slow burning film, "which has made it possible for you to enjoy SAFE MOTION PICTURES" (emphasis original).[90] The ad continues its (overly) lofty claims to state that the Pathéscope line of non-theatrical film products were the recognized leader in safety standards and that school boards had already adopted their products as safe for schoolroom use. Other companies, such as Spencer Lens Company, also used safety encoded language in their advertisements, peppering choice buzz words like "unbreakable" in describing their acetate film products.[91]

One specific application of acetate's safety features and reduced flammability was that it allowed motion pictures to be paused in the projector and be turned back into static images. Ironically, acetate film importantly enabled motion pictures to be stilled and stopped for static scrutiny. With this, acetate extinguished the initial shortcomings of nitrate stock and moving

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[89] Pathé, "A Forceful Aid in Teaching - A Pleasant Way To Learn" advertisement. *The Educational Screen* 6.10 (December 1927): 483.

[90] Pathé, "Pathéscope" advertisements. *Educational Film Magazine* 3.4 (April 1920): 30-31.

[91] Spencer Lens Company, "Spencer Filmslide Service," advertisement. *The Educational Screen 6.4* (April 1927): 210.

image instruction: films printed on safety stock could be re-stilled in the projector without combusting like nitrate, thereby creating a stilled filmic image that teachers and students could inspect in closer detail. As Henry Macmahon noted in his writing for *Education Film Magazine*, repeat screenings and freeze frames were especially helpful tools for scientific researchers and classroom instructors. Before acetate safety stock, he noted, a "minor pedagogical difficulty of motion pictures has always lain in the fact that it is a 'flash,' (...) [t]he film story needs to be told, and twice, told, and retold many times over."[92] An article in *The School World* further emphasize this point, claiming that "[b]esides the danger of fire, there is another objection to the use of [nitrate-based] kinematograph methods: one is hurried along from scene to scene; if a stop occurs the heat of the lantern at once causes the gelatin films to blaze up; one is never allowed to stop and analyze situations."[93] By contrast, slow-burning acetate allowed for moving images to be stilled and turned back into immobile, stagnate images, thereby improving the learning processes and enabling the viewer to acquire knowledge and understanding. A later advertisement for Bell & Howell educational film projectors also confirmed that it could run acetate stock "forward or backward, or it may be stopped on a single frame for protracted discussion without damage. [The safety stock and projector's] precision and all round dependability insure long life under all conditions of use."[94] Acetate was thus championed as a new material that could save the life of both the film strip and its viewers. This emphasis on safety and livelihood became the prevailing advertisement rhetoric and popular discourse around acetate film materials. As an alternative to nitrate, acetate was ultimately singled out as a superior imaging and educational material, one

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[92] Macmahon, 11.

[93] "Items of Interest: General," 429.

[94] Bell & Howell, "Filmo School Projector Conquers Time and Space," 65.

which promised to be uniquely valuable in both scientific practice and instructional application for its ability to represent motion as well as be safely turned back into a stilled image.

Permanence also become a selling point for acetate motion pictures. Capturing cells on acetate promised to supply "a broad array of data on tissues and cells derived from permanent records of film strips."[95] In addition to motion, cinematic images and the film stock itself, were pitched and valued for their presumed ability to last as permanent records; as Michaelis notes, many believed acetate materials could be "preserved for any length of time in place of the cellulose nitrate."[96] Ostensibly, acetate filmed strips could be re-projected over an indefinite amount of time, lasting longer than nitrate and even the lifespan of original specimen. Writing for *Educational Film Magazine,* Lawrence Augustus Averill claimed that part of the filmic record's strength resided in this able to reproduce and replace the original specimen: filmic "reproductions of things, people or places past or present," he wrote, and "are limitless in their scope."[97] Whereas the original specimen sample is bound by its natural form and biologic materials, transforming it into an alternative, image-based form and materials like acetate motion picture stock would in theory grant the specimen increased longevity and manipulability.

The educational sector specially valued acetate science films for their qualities of permanence. In addition to the films themselves lasting "forever," educators claimed their lessons and insights would leave indelible impressions upon students. "The movements of centuries will be brought out in an hour," *Educational Film Magazine* proclaimed in their April 1919 issue, "and will be more vivid and permanent in their lasting effects on the students' mind

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[95] Rose, vii.

[96] Michaelis, 30-31.

[97] Averill, 12.

than the same material covered from textbooks in a semester's course."[98] Anthony Michaelis further claimed that cinematic records were permanently re-playable and, therefore, extremely valuable because they afforded researchers a greater ability to scrutinize their test processes discover all of the intricacies that might have evaded their initial observation. Echoing this sentiment, biologist Arthur T. Brice claimed that filming his experiments allowed him simultaneously review his work at leisure as well as scrupulously analyze it.[99] Through the looped projection of his acetate films, Brice could continuously re-watch his cellular experiments either in their entirety or as isolated, repeated segments.[100] Acetate, in short, was believed to offer both an increased lifespan and improved permanence — at least initially. Although this belief was eventual shattered in the 1990s by its confirmed failure as a long-lasting, durable medium, acetate was widely celebrated as an ideal recording and projection medium; during the first half of the twentieth century, it was indeed entrusted to introduce scientific images and views of biological life into the public sphere.

The Importance of Cinematic Visuality in Public Education

Film scholars including early Soviet filmmaker, Dziga Vertov, and German film theorist, Siegfried Kracauer, importantly theorized that one of the essential strengths of the cinematic medium is its ability to augment natural vision and function as a visual prosthetic.[101] Vertov termed this type of cinematically aided vision the "kino-eye," or camera-eye. According to

[98] *Educational Film Magazine* 1.4 (April 1919): 6.

[99] Arthur T. Brice, "Instrumentation for Cinemicrography from a General Purpose Viewpoint," *Cinemicrography in Cell Biology*. George Rose, ed. (New York: Academic Press, 1963): 53-72.

[100] Ironically, this same act of loop projection was also used as a technique within Materialist filmmaking to bring the acetate stock to its point of death and material destruction. This paradoxical use of acetate loop project will be returned to in the Coda.

[101] see Siegfried Kracauer, *Theory of Film: The Redemption of Physical Reality*. Princeton: Princeton University Press, 1997.

Vertov, the kino-eye functions as a more perfect type of mechanical human eye; it can gather and record visual phenomena without being restricted by the physical limits of natural perception or memory. In short, the cinematic eye affords an improved type of visuality by making use of cinematic techniques — such as accelerated motion or microcinematography — to reveal aspects of the natural world.[102] Echoing Vertov, Kracauer later theorized in the 1960s that motion pictures were uniquely able to "acquaint us with normally imperceptible or otherwise non-duplicable movements — flash-like transformations of matter, the slow growth of plants, etc."[103] In other words, cinematic technology uniquely enabled filmmakers and/or scientific imagists to capture motion and manipulate movement in order to reveal elusive physical phenomena.

Educational films that used microcinematography to visualize cellular life were especially praised and beloved for using cinematic principles; in fact, as Gaycken notes, the first films to become truly popular within classroom and public consumption featured microcinematic views of cells.[104] These films rendered invisible microscopic cellular functions visible, and their producers used such visual feats as marketing fodder. The Scientific Film Corporation, for example, advertised their new educational science film, *A Microscopical View of the Blood Circulation*, as fulfilling the modern age's need to visualize biological phenomena.[105] By watching films like *A Microscopical View of the Blood Circulation*, which featured microcinematic views of blood cells, viewers were given access to previously hidden aspects of

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[102] for more on Vertoz's film theory, see *Kino-Eye: The Writings of Dziga Vertov*. Annette Michelson, Ed. Kevin O'Brien, Trans. Los Angeles: University of California Press, 1984.

[103] *ibid*, 28.

[104] see Oliver Gaycken, "'The Swarming of Life': Moving Image, Education, and Views through the Microscope." *Science in Context* 24.3 (2011): 361-380.

[105] see The Scientific Film Corporation, "Biological Motion Pictures for Schools, Universities and Learned Societies." *Educational Film Magazine* 3.1 (January 1920): 2.

the natural world as well as their own bodies. Additional advertisements also played upon such promises of seeing and understanding life better through cinematic mediation. Bell & Howell's ads for their Filmo acetate projectors, for example, claimed to provide realistic cinematic mediations that were even more effective at revealing life than "life at first hand."[106] Writing for *Motion Picture Magazine,* Leon C. Kelley further claimed that film afforded "a perfect means" of recording and representing the natural world, and that "[s]urely, all previous methods are incomparable to this one."[107] Playing up the nature and value of cinematic visuality, film producers promised to reveal the smallest of details and most fleeting of experiences and share them with a general viewing audience.

Visualizing inaccessible or impossible sights was, indeed, a central draw of the cinematic medium — a draw that even transcended science films and influenced other genres as well. Travelogues and fantasy features, for example, became popular early film genres for this very reason: they allowed viewers to see and experience things outside of their natural perception or physical/geographic limits. Viewers could be transported to magical-seeming lands and visually inhabit foreign countries, fantasy-scapes, or even interior regions of the body through cinema. Writing for a regional Iowa magazine, George Mallinson and Waldemar Gjerde claimed that educational science films were especially useful in this regard, because they "[gave] students experiences of visiting otherwise inaccessible places;" through techniques like microcinematography and materials like acetate safety stock, they made "visible action that is

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[106] see Bell & Howell. "Life at First hand with Film School Projector" advertisement. *The Educational Screen* (April 1930): 97; Bell & Howell. "Education is Life: Visualize Life with Filmo School Projectors" advertisement. *The Educational Screen* (February 1930): 33; Bell & Howell. "Modern Means for Modern Methods!" advertisement. *The Educational Screen* (June 1930): 161.

[107] Kelley, 116.

ordinarily not visible to the human eye."[108] With this, the cinematic medium and acetate films materials functioned to provide the general public previously unobtainable sights, knowledge, entertainment, and viewing pleasure.

The popularity of educational science films also reflects a larger trend towards visuality within early twentieth century pedagogy and learning. An overarching move towards visual representations and technologies ushered in a cultural, popular, and institutional veneration of the eye. Vision became privileged amongst all other senses, and was elevated above other tactile or auditory ways of acquiring knowledge. In the medical sciences, for example, cinematic imaging replaced physical dissection and autopsy practices; in the educational sector, learning was increasingly fostered through visual instruction and exposure to images rather than through more traditional hands-on or aural instructional methods. Thomas Alva Edison, inventor of the first kinetoscope projector, also championed this emergent era of cinematic education even at the devaluing expense of flesh-and-blood teachers. He happily predicted that educational films would replace antiquated things like textbooks and teachers in modern schools of the future; while "today the teacher explains on the blackboard," he proclaimed, "in the school of tomorrow all explanations will be made on the motion picture screen."[109] Pathé similarly called upon educators to "Reach the Mind Through the Eye!" in their advertisements, and in his later reportage on the state of education John Flory went so far as to proclaim that "the eye outranks all other sensory organs put together as a pathway to the brain."[110] Undoubtedly, many of these advertisements and publicity statements were motivated by sensationalistic and even

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[108] Mallinson and Gjerde, 2.

[109] qtd. in "One of the Greatest Things in the World," 8.

[110] Pathé, "Reach the Mind Through the Eye!," 147.; Flory, 5.

unsubstantiated marketing exaggeration. Nonetheless, they do reveal a trend within popular culture towards visual technologies and teaching methods, as well as show show how acetate materials and the cinematic medium were being positively sold and positioned within public discourse.

Collectively, these marketing strategies reveal a cultural shift that lead away from other sensory learning methods and towards cinematic visuality. While sound would eventually be revalued as an important teaching aid and element needed to really bring films "to life," the visual elements of a film were initially considered the most useful and important.[111] Early educational films were, in fact, without audio soundtracks until the 1930s. They were also without color until this period, when new acetate stock formats such as Kodachrome, which will be discussed in Chapter four, were introduced with the ability to support imbedded sound tracks and record color images.[112] Before these inclusions, educational films relied upon black-and-white representation with intertitles and, occasionally, teacher/presenter narration to describe the images.

As early as 1914, the popular pressed called for the integration motion picture technology in schools, in order to turn them into modern institutions capable of appealing to "modern" students. The *New York Tribune*, for example, claimed that "education by visualization is the

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[111] While much of the initial discourse surrounding educational science film focused on their visual qualities, the introduction of sound technology ca. the 1930s lead to a reclaiming of sound as an equally vital element. Auditory stimulation and communication remerged from the shadows cast by vision; now, hearing films were just as important as seeing their images. For more see: Western Electric. "Natural Science Taught More Effectively by Talking Pictures" advertisement. *The Educational Screen* (October 1931): 245 and "On *Sound Films,* it Comes to LIFE..." advertisement. *The Educational Screen* (April 1931): 127; and Charles R. Thomas, "Preparing Sound Film Strips." *The Educational Screen* (October 1938): 254-6.

[112] In keeping with previous discussion of color in early chapters, scientists utilized color film and imaging technologies to both increased verisimilitude and, in some case, help them to identify certain physical features.

latest and greatest medium for teaching."[113] Other advertisements placed by Pathé in trade magazines confirmed that "[t]he use of visual aids through the medium of motion picture film constitutes a momentous advance in modern instructional methods."[114] This desire for modern, cinematic instructional methods sparked an overreaching reform movement within education, culminating in the "Visual Education" movement of the 1920s-1950s.[115] During this time, in both Europe and the United States, progressive schools began integrating motion picture technology into their curricula. As such, the entire education process became increasingly modernized and revamped through the integration of cinematic visuality. Spurred by the public veneration of cinema, schools began to utilize education science films and especially those that made use of cinema's unique, unprecedented ability to see microscopic life processes and represent them in motion.

Circulation and Movement in a Dual Sense

Movement and circulation emerged as essential features of educational science films: these films captured cellular motion and emphasize the moving processes of life, and utilized acetate safety stock to circulated these images within the educational sector. In a literal sense, acetate-based microcinematic films visually represented the moving processes of living organisms, with a particular emphasis on the circulation of blood and other vital fluids. Several of the earliest science films printed on acetate and circulated throughout schools depicted either the microscopic movements of cells or the circulation of blood. This favored theme suggests that

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113 "Motion Pictures for 20 Schools," 9.

114 Pathé, "The EYE Remembers what the EAR forgets," 85; this ads also fatuously promised that modern moving picture technology could fix short attention spans and stop wandering minds, which were often described as negatively side effects of modern living, technology, and too much visual stimulation.

115 see Joanna Barbousas, "The Visual Education Movement: The Emergence of Visual Technology in Education." *International Journal of Learning* 16.10 (December 2009): 169-180.

movement was indeed a point of particular emphasis and importance within educational films — something that reflects in their literal subject matter as well as the large conceptual importance of using acetate film to disseminate knowledge and circulate scientific images within the public sphere.

George E. Stone, a biologist from UC Berkeley, was an early educational filmmaker who utilized microcinematography to bring the minute movements of various organisms into visible, living motion. Stone released the silent, intertitled film, *The Living World* (also known as *How Life Begins*), in 1920 though he captured much of the footage between 1916-18. The film begins by looking closely at a seemingly innocuous, lifeless drop of water. However, once looked at through a microscope and as moving cinematic images, the water comes alive to reveal a swarming mass of cellular life. Existing only as cells, these invisible inhabitants evaded natural sight and public understanding until microcinematic imaging revealed them. *The Living World* proceeded to extrapolate from these unicellular organisms and map their basic life functions onto higher order specimen and subjects. With this, Stone created a visual parallel that connected even the most advanced and evolved organisms to simple, unicellular amoeba; in both cases, cellular material and functions comprise the core of natural existence. Upon its release, *The Living World* circulated amongst schools, colleges, museums, and even military training camps. It remained popular throughout the 1920s and, as *The Social Hygiene Bulletin* noted, reached a large, diverse set of viewers; it aroused "a remarkable amount of appreciation" from school children as well as "rousing threes cheers" and demands for repeat screenings from military base officers.[116]

[116] "George E. Stone Finds Exhibition of Biological Film, 'How Life Begins,' Interesting Work," 8.

On the heels of Stone's popularity, Charles F. Herm produced a four reel film, *A Microscopical View of the Blood Circulation* (ca. 1920). Reel 1, "The Anatomical Structure of the Heart" covered the history of circulation and the anatomical structures of mammalian hearts; reel 2, The Heart Our living Pump," depicted the heart's functions; reel 3, "A Microscopial View of the Blood Circulation" represented circulation processes in a living chick embryo in unprecedented detail; reel 4, "The Blood and Its Ingredients" focused on the function of red and white blood cells, in particular.[117] Similar to Stone's previous work, Herm's film emphasized moving life processes, and featured new, microcinematic views of pulsating blood flow and real-time close-ups of a beating human heart.[118] These images were novel images providing radical revelations for lay viewers: this would be the first time many, if not all, would see a beating heart within a live patient. With this, the general public gained access to internal, living, moving biological process, which shaped their understandings of the body and basis of life. Lay viewers saw the body anew and as a compilation of small, moving parts thanks to microcinematic visualization. Through the projection and public distribution of these images, new understandings of biologic life emerged, which essentially established a unifying cellular basis for all organism. This, in turn, lead to an important epistemic shift: visualizations of cellular life gave birth to new ways of seeing all life as connected through their biologic foundations found in cellular material and their basic, life-sustaining functions.

Educational Film Magazine as well as the public at large heralded Herm's film as "the greatest of all motion picture studies of the human body" due in large part to its ability to see

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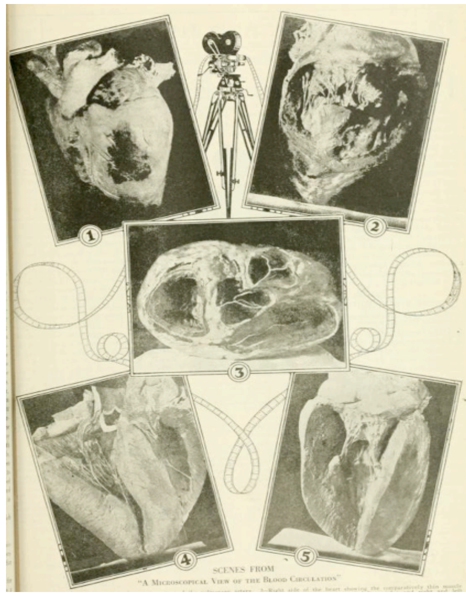
[117] Motion Picture Age Chicago, 124.

[118] The heart, blood, and circulation were first identified as the foundation or seat of life by William Harvey in the mid-seventeenth century. For more on Harvey's seminal theorization of blood flow and the functional structures of the heart, see "On the Motion of the Heart and Blood" (1628).

inside veins and arteries, and follow the moving stream of life through real-time, live imaging. With this, viewers experienced what Leon C. Kelley described in *Motion Picture Magazine* as seeing through the camera's eye to "every stratum of the world's tide of life."[119] While the camera's eye helped to see the movement of blood, acetate film stock made moving images of its circulation possible as well as its circulating distribution. In other words, acetate not only allowed for images of literal circulation to be projected in motion and understood as a moving process, but also proved to be a vital element in the distribution of these film objects. An article intended to promote *A Microscopical View of the Blood Circulation* visually accentuates this parallel by depicting acetate film as a type of circulatory system.[120] Published in the October 1920 issue of *Educational Film Magazine*, the feature includes a full-page illustration with closeup snapshots of an anatomical human heart. Positioned amongst and intersecting with the heart images is a cartoon film camera with a ribbon of safety stock flowing out of it in unfurling arabesques [Fig. 3.7]. In this illustrated rendition, the acetate film functions as a literal conduit: similar to veins and arteries, pulsating with movement, the film strip is depicted as flowing through the projector and bringing life to the still cardiac photographs. A number of films produced by leadings production/distribution companies, namely Kodak and Pathé, also privileged representations of cellular movement. Utilizing acetate imaging technology, these films demystified the previously inaccessible mysteries of life for the viewing public, and revealed cellular movements as the basis of all living organisms.

[119] Kelly, 116.

[120] see Dolph Eastman, "*A Microscopical View of the Blood Circulation*." *Educational Film Magazine* 4.4 (October 1920): 14-15; 28.



[Fig. 3.7] Eastman, Dolph. "A Microscopical View of the Blood Circulation." *Educational Film Magazine* 4.4 (October 1920): 15.

Making Science Public with the Films of Pathé and Kodak

Pathé spearheaded the educational film industry in Europe starting in the early 1900s, and Kodak dominated the US market with their own film productions as well as film technology developments. As noted in the 1913 edition of *The Moving Picture,* Pathé held an especially strong foothold in the British scientific film industry; compared to other rivals production companies like Eclair, Pathé employed French biologist/filmmaker, Jean Comandon, to conduct microscopic cellular research and produce a number of films chronicling his experiments.[121] Working in conjunction with Pathé, Comandon was the first to apply film technology to the study of living tissue cultures. He used microcinematography to produced research films of cellular movement and other biological life process, which were distributed by Pathé amongst public viewers, schools, and other non-profit societies in the form of educational science films.

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[121] Pathé also funded a large newsreel production division, which utilized acetate-based stock and filmmaking technology to document the event of World War I, in particular. ; see "The Film In France." *The Moving Picture World* 17 (1913): 180 and Ratisbonne, Edmond. "Educational Films from a French Viewpoint." *Educational Film Magazine* 1.4 (April 1919): 8.

As Gaycken has noted, Comandon believed cinematic technology could be used as a serious scientific research tool as well as a means to popularize science and share its secret knowledge about cellular life.[122] The New York-based Scientific Film Corporation made these same claims in 1920. In a full page ad-cum-article, they echoed Comandon's sentiments by claiming students could only grasp and understand biological phenomena through motion picture images.[123] Comandon's early Pathé films thus instituted a popular demand for science films, that influenced both European and US educational film production at the turn of the 1910s. His collaboration with Pathé marked a important moment in the coming together of science and early cinema: it established cinema as a means to popularize scientific images and birthed a new film genre, production industry, and instructional method which Kodak continued to develop within the United States.

The 1920s-30s were an especially generative period for educational science film production. Between 1922-1933, Pathé ran the popular "Secrets of Nature" series featuring biological science and research films, and in 1923 Kodak formed the Eastman Teaching Films division to enlivened the educational film market in America with their own series of scientific research films printed and distributed on their newly released 16mm acetate film stock. While the Ford Motor Company was the first to produce business-sponsored educational films for American classrooms — including the "Ford Educational Weekly" series (1916-1920), which covered topics in agriculture, civics, and history — Kodak's establishment of Eastman Teaching Films in the 1930s marked an important period in educational science film production. In one of

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[122] Oliver Gaycken, "'The Swarming of Life': Moving Image, Education, and Views through the Microscope." *Science in Context* 24.3 (2011): 361-380.

[123] The Scientific Film Corporation, 3.

the few studies dedicated to Kodak's educational film work, John Flory notes that the Eastman Teaching Films project was one of Kodak's largest ventures and grew out of George Eastman's own experimental studies on the value of visually-based classroom instructional methods.[124] Between 1928-1932, roughly the same years Pathé produced their "Secrets of Nature" series, Eastman Teaching Films produced approximately 250 silent educational titles, covering topics ranging from hygiene to geography to cellular biology.[125] This last genre, in particular, utilized microcinematography techniques to locate the basis of life in moving cells and their motive activities. While Kodak's educational film experiments greatly influenced their research and development throughout the first half of the twentieth century, the resultant innovations from this project have gone largely understudied and un-theorized.[126] In their strategic introduction of film products, including a smaller16mm acetate stock in 1923 and sound film in the 1930s, Kodak equipped several public schools throughout the United States with projectors and an array of film titles, mostly focusing on health, the biological sciences, and microcellular movements.[127] The findings from this experiment revealed that the strategic use of film and acetate products were indeed useful teaching aids, especially when it came to illustrating cellular life processes and biologic phenomena defined by movement. Only through moving images could such moving

[124] see John Flory, "Films for Learning: Some Observations on the Present, Past, and Future Role of the Educational Motion Picture." Eastman Kodak Company, 1968.

[125] Saettler, 103.

[126] for one of the few accounts on the Eastman Teaching Film division, see Eastman Kodak Company,*The Story of Eastman Classroom Films.* Rochester: Eastman Teaching Films, Inc: 1929.

[127] Aside from educational classroom films, Eastman Teaching Films also produced films for the medical community on surgical procedures and anatomical structures. In addition to revealing natural phenomena, these films also promoted health care and hygiene practices, which were seen as essential elements for advanced civilizations and modern human progress. For more see: Anthony Slide, *Before Video: A History of the Non-Theatrical Film.* New York: Greenwood Press, 1992.

processes be seen, Eastman concluded, and therefore it was necessary to integrate moving picture technology into educational contexts.

All of these microcinematic, educational science films promised to reveal a hidden, microscopic world that cinematic images defined as full of frenetic activity and whirring motion. Beginning at the turn of the twentieth century in Western countries, bustling movements and fast-paced living were also identified as defining aspects of modern, technologically-advanced civilization. Whereas an ability to still life and arrest motion defined "modern" progress and technological superiority during the nineteenth century, a shift occurred in the twentieth century; now, speed and movement became synonymous with progressive modernity.[128] Preoccupations with movement pervaded educational science films, which favored images of moving organisms and physiology especially on a microscopic scale. One particularly interesting visualization of microscopic movement and cellular life functions appears in Pathé's 1927 production, *Penetrating the Stream of Life*.[129] In this film, cellular life is visually conflated with the same kind of whirling, frenetic livelihood found in films such as Vertov's 1929 *Man With a Movie Camera* or King Vidor's 1928 narrative American film, *The Crowd*.[130]

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[128] for more on theories of modernity and its intersections with cinema, see *Cinema and the Invention of Modern Life.* Leo Charney and Vanessa R. Schwartz, eds. Berkeley: University of California Press, 1995; James Lastra, *Sound Technology and the American Cinema: Perception, Representation, Modernity.* New York: Columbia University Press, 2000; Ben Singer, *Melodrama and Modernity: Early Sensational Cinema and Its Contexts.* New York: Columbia University Press, 2001; *Post-War Cinema and Modernity: A Film Reader*. John Orr and Olga Taxidou, eds. New York: NYU Press, 2001; Mary Ann Doane, *The Emergence of Cinematic Time: Modernity, Contingency, the Archive*. Cambridge: Harvard University Press, 2002; Murray Pomerance, *Cinema and Modernity.* New Brunswick: Rutgers University Press, 2006; Kristen Whissel, *Picturing American Modernity: Traffic, Technology, and the Silent Cinema*. Durham: Duke University Press, 2008.

[129] Pathé's produced this title as part of a 9.5mm newsreel, which was circulated throughout Europe as well as the United States.

[130] *The Crowd* also depicted modern, urban culture as obsessed with speed and cheap thrills; Tom Gunning further theorized how these fast-paced experiences similarly characterized modernity and an early cinema of attractions. For more see: "The Cinema of Attractions: Early Film, Its Spectator and the Avant-Garde." *Wide Angle* 8.3-4 (Fall 1986); "An Aesthetic of Astonishment: Early Film and the (In)Credulous Spectator." *Art and Text* (Fall 1989); "Modernity and Cinema: A Culture of Shocks and Flows." *Cinema and Modernity.* Murray Pomerance, ed. (New Brunswick: Rutgers University Press, 2006), 297-315.

Penetrating the Stream of Life begins as a typical scientific research film, focusing on the cellular basis and features of organic life. It starts with a familiar inter-title declaration establishing the supremacy of scientific imaging — "With the microscope, science has conquered the mysteries of the blood" — can continues to use microscopic filming and fast-forwarded projection reveal an entire world of surging action and movement beneath the static seeming surface. While blood corpuscles appear as a muddy, inert mass to the natural eye, microcinematography and motion picture technology reveals it to be frenzied, vivacious swirl of activity. From this point, the film diverges from other typical titles within the genre and proceeds to extrapolate its microscopic images of cellular movement into a broader visual comparison with of modernity and rumination of "modern" living. *Penetrating the Stream of Life* essentially represented and visually equated blood corpuscles as "work-men [in] a surging mob." A match cut primarily served to establish this relationship between: the camera cuts from an extreme microcinematic closeup of streaming blood cells to an overhead, extreme long shot looking down at a swarming mass of people who visually mirror a crowd of moving cells. From this dehumanizing distance, the crowd appears as a faceless mob of scurrying dots and dizzied movements, much like the flowing corpuscles swept away by their own unstoppable movements. A mixture of excitement and anxiety characterized the underlying sentiment of these scenes — similar to how modernization, urbanization, and technological advancement were ambivalently embraced and disavowed during the early decades of the twentieth century.

As also noted in Chapter one, the negative ramifications of World War I led to reevaluation of technological progress, leading some to even question whether rapid advancement and fast-paced living would ultimately destroy natural life and human civilization.

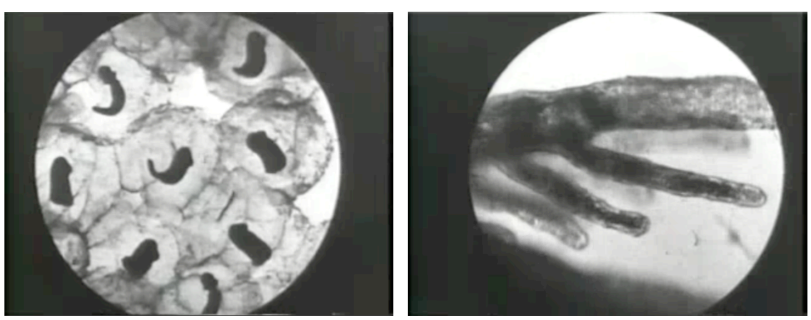
As Yuri Tsivian noted in his essay on scientific visuality, educational science and research films played upon this ambiguous relationship between modern technological advancement and the preservation of natural life. Images such as those found in *Penetrating the Stream of Life*, for example, depicted a terrifying vision of microorganisms that for some functioned as an existential metaphor for the difficulties of modern society (including those depicted in *The Crowd*). When confronted with these images, Russian journalist Nikolai Shebuev, exclaimed in exasperation: "Look at the typhoid fever bacilli (...) they gallop in a whirlwind. Blood is alive, and it runs like mad."[131] Filmic mediations of cellular life thus played upon ambivalences and anxieties generated by technological advancement and the proliferation of war, even to the existent of representing movement as a potentially dehumanizing and pathological.

Blood flow, vessels, and corpuscles existed as a repeating theme and especially favored subject matter within Pathé films, as well as Kodak's titles. Pathé *Chick-Chick-Chick-Chicken* (1931), for example, emphasized cell division and blood circulation (in this particular case, in fetal chick samples maintained in live culture). Several Kodak titles also also captured and represent movement-based life processes, with a particular emphasis on fantastical views of internal circulation. *Frogs, Toads and Salamanders* (1932), for example, intercut microscopic views of multiplying cells and circulating blood with field footage depicting living amphibious subjects [Fig. 3.8].[132] Similar to Herm's *A Microscopical View of the Blood Circulation*, both of these films utilized real-time moving images, shot through a microscope and captured on acetate film, to represent the foundations of life: namely, cell division and circulation re-enacted through

[131] qtd. in Tsivian, 85.

[132] Jennifer Peterson also discusses this title in her article on nature films. See: Peterson, Jennifer. "Glimpses of Animal Life: Nature FIlms and the Emergence of Classroom Cinema." *Learning with the Lights off: Educational Film in the United States.* Devin Orgeron, Marsha Orgeron, and Dan Streible, eds. New York: Oxford University Press, 2012: 145-167.

the animating illusions of projection. The prominent iris masking around the microscopic views confirmed the veracity and authenticity of these images; they were indeed laboratory produced views, accessed through the microscope, and now made publicly viewable as acetate motion pictures. Microscopes were already a staple within American classrooms, and students were generally well versed in seeing specimen through microscopic visualization. However, as Bell & Howell suggest in an 1930 advertisement for their Filmo projector, the traditional use of microscopes had its limitations: a classroom of thirty or more students would often struggle with having only one microscope; this left students with only "a moment's glimpse at the turbulent world of living things."[133] By projecting microcinematic films, however, every student could now see onscreen, collective as a class, and for as long as desired what they previously could only see through the microscope. Even though these claims were tailored to sell the benefits of Bell & Howell projectors, this advertisement does speak to the importance of microscopic visuality, its privileged place within scientific education, and its improvement through cinematic technology.



[Fig. 3.8] *Frogs, Toads and Salamanders* (Eastman Teaching Films, 1932, 16mm acetate motion picture film).

These moving images provided unprecedented insights, which Pathé claimed would reveal things that otherwise "cannot be seen with the naked eye." For example, *Secrets of*

[133] Bell & Howel, "Filmo School Projector Conquers Time and Space," 65.

Nature: Seed-Time (1926) and *Secrets of Nature: Mighty Atoms* (1930) utilized stop-motion photography, X-ray, real-time microcinematography, and acetate film projection to depict the slow growth of plants and minute movements of microscopic organisms. In other Pathé films, including *Secrets of Nature: The Frog* (1930), *The Magic Eye: The Life Stream* (1930), *Micro Marvels* (1933), and *Micro Nature* (1938), the film camera transversed the barriers of skin, flesh, and bone to reach the innermost circulation system. *Micro Marvels*, in particular, claimed to access an "invisible wonderland" through microscopic and cinematic mediation. The film begins with an inter-title card, promising to provide a "study of the minute by the aid of the microscope, and to "take you into the world of the infinitely small" by aid of cinematic technology. The camera proceeds to double as the viewer's physical eyes, and pushes into a close-up shot held hovering above the scope's eyepiece. A jump cut reveals an extreme close-up of cells. With this, the film creates the illusion of looking through a microscope and entering into a new microscopic world. We have now traveled into an unseen, invisible wonderland, as the voice-over narrator continues to describes; this is thanks to the penetrating eye of the microscope and representational capabilities of cinema. As the film progresses, we travel through the vegetable and animal kingdom, and into the cellular depths of various organisms occupying different rungs on the evolutionary ladder. From bladderworts to bullfrogs, unicellular amoeba to embryonic chicks, microcinematic imaging united them by focusing on their shared cellular and circulatory functions. Each organism, regardless of its complexity, was depicted as "beating with the mysterious rhythm of life" and as kept alive by the same fundamental cellular movements. *Micro Marvels* concluded its journey into the mysteries of life with an excited exclamation that many viewers also shared: "it is an amazing achievement of science that we are able to watch this life process actually taking place before our very eyes." *Micro Marvels* and nearly all of the films in Pathé's "Secrets of Nature" series utilized moving picture technology to tap into the pulsing, flowing stream of life and visually present them through flowing, moving pictures. Only through cinematic images could these cellular bodies and circulatory processes be seen in motion. As such, scientific investigators and public viewers relied upon motion pictures and acetate films, in particular, to reveal the nature of these essential, moving processes as well as to make them understandable as the essence of life.

Even thought the "Secrets of Nature" series was produced in Britain, they were also intended for and consumed by international audiences, and vice-versa for Kodak's American produced films. By printing their films on acetate stock, the companies and others like them ensured that their films could be safely and economically shipped throughout Europe, the United States, and the globe. As chronicled in the US-based *Popular Science* magazine, American viewers welcomed these British films, and especially valued their depictions of moving life functions. In their December 1929 issue, for example, *Popular Science* called the "Secrets of Nature" a remarkable collection of films that revealed how plant cells work and function like breathing organs or "lungs."[134] With this, educational science films transcended national borders and even cultural divisions; regardless of their country of origin, these films traded in a universal currency: cinematic images and moving signs that newly define biologic life. While other educational films on politics or civics were indeed influenced by nationalistic ideologies and messages — some American titles, for example, even attempted to instruct, or indoctrinate, immigrants on how be "good" American citizens — scientific films tended to reflect a unifying

[134] see "'Lungs' of Leaf Reveled in Motion Pictures." *Popular Science* (December 1929): 73.

view of life with an emphasis its cellular foundations. Life on microcellular level would essentially look the same and carry the same basic information about the "life" whether the film was produced by British Pathé, American Kodak, or the Soviet Studio for Popular-Scientific Film. While this largely held true during the interwar period, nationalistic propaganda did begin to infuse seemingly "objective" scientific films, especially those produced by the emergent Nazi order beginning in the 1930s. With the 1934 establishment of the Reich Office for Teaching Films, educational science films were redeployed as propaganda vehicles; rather than focusing on how all biologic life was similar and unified through the same base cellular material, Nazi produced films searched for demonizing pathologies, aberrations, and other points of difference as part of their effort to generate publicly support and evidence for eugenics and other forms of Nazi medical intervention.[135] In this case, cinematic visualizations and manipulations of life were used to shape public opinion and understandings of life for political reasons rather than for purely educational purposes or intellectual enrichment.

Aside from films and motion picture products, acetate made the circulation of educational materials a plausible reality within the United States in a broader sense as well. Just as Eastman Teaching Films relied upon the stability, durability and portability of acetate to disseminated their film titles through school institutions, other institutions such as the Chicago Field Museum used acetate materials to create stable, shippable replicas and traveling taxidermic displays.[136] As

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[135] for more on Nazi medical films, see Ulf Schmidt, *Medical Film, Ethics and Euthanasia in Nazi Germany: The History of Medical Research and Teaching Films of the Reich Office for Educational Films/ Reich Institute for Films in Science and Education, 1933-1945.* Husum: Matthiesen, 2002.

[136] see *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1933* X.1 (January 1934); *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1935.* X.3 (January 1936); *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1936* XI.3 (January 1937).

detailed in Chapter one, taxidermists used the same cellulose acetate formula at the base of safety film to create artificial skins and replicas of biologic materials. Leon L. Walters perfected this technique at the Chicago Field Museum between the 1920s-1930s, and used it to create durable taxidermic pieces that could withstand the demands of traveling exhibition. Matching the progressive, up-to-dateness of the modern education system and tenets of the "Visual Education" movement, the Field Museum proudly described their mobile acetate displays as representing advanced exhibition methods. "Durning these twenty-five years," they claimed, "Museum preparation and exhibition methods have advanced markedly (...) [and] this Department has kept pace with the improvements in technique, the most important of which are the development of the cellulose-acetate method for reproducing perishable specimens and accessories, [including] the use of sheet celluloid."[137] In their internal reports, The Field Museum noted how their N.W. Harris Public School Extension program specifically relied upon acetate materials and Walters' method. The Extension program collected, prepared, and installed acetate replicas in portable cases and circulated them amongst public schools and other educational institutions throughout Chicago. They used acetate reproductions in large part because they could withstand the wear-and-tear of travel and serve as lasting, realistic visual displays. In order to succeed in both entertaining and educating students, these traveling displays needed be true to nature, visually engaging, durable enough to withstand frequent handling by children, and light enough to be shipped. Acetate provided the ideal compositional properties for all of these needs.

The Field Museum's traveling boxes also bore an uncanny visual resemblance to film strips. At the center of the box, a large cell contained the acetate replicas pressed between even

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[137] *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1936*, 79.

more layers of acetate film. Smaller text boxes flanked the image on both sides, ultimately resembling sprocket holes [Fig. 3.9]. Ultimately, acetate proved essential in the Museum's efforts to reach young minds through "moving," visual instruction. Even though these displays were stagnant and unmoving, they nonetheless mimicked the visual appearance of motion picture film strips; furthermore, they were set into motion through acetate materials and essentially became mobile, circulating images that just like educational films. In both cases, acetate materials were used to disseminate knowledge and understandings about the natural world through portable, sharable images.

[Fig. 3.9] Top: *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1935.* X.3 (January 1936), 356.
Bottom: *Field Museum of Natural History, Chicago Report Series: Annual Report of the Director to the Board of Trustees for the Year 1936* XI.1 (January 1937), 108-9.

Conclusion

Ironically, the only existent copy of Pathé's *The Magic Eye: The Life Stream* (1930) has fallen victim to the Vinegar Syndrome and begun to chemically decompose.[138] Whereas *The Magic Eye* once pictured the thriving, supportive materials of life through acetate, it now reveals the material death and decay processes of film's supportive materials. In this copy, the death signs of acetate overshadow the vital signs of life: blistering, circular marks made by the

[138] When the plastic acetate base begins to decompose and chemically denature, it releases acetic acid and a pungent vinegar odor, which further infects and corrodes the entire stock. This autocatalytic decay process has become known as the Vinegar Syndrome.

decomposing plastic mar the surface of the film, creating an eerie, perverse parallel to the original shapes of lively, pulsing blood cells. When acetate fails, the pigment and chemical components held within the emulsion layers bleed through to the surface ad bubbling mess. Just as blood rushes out of the body when the skin is compromised, emulsion flows out of the films stock once the acetate "skin" fails. Captured, thus, in *The Magic Eye: The Life Stream* is both the life of cellular bodies and the death of a cinematic body, and each is made visible through the material properties of acetate.

Even though acetate was originally marketed and popularly accepted as the ideal material to replace nitrate and save its internal contents, it was eventually phased-out and replaced itself by even newer materials: non-celluloid based polyester film and eventually non-filmic digital formats. Touting the same promised benefits that were originally associated with acetate — including superior distribution capabilities — digital formats have stet the new standard for how media information is shared and accessed. Even though most archivists agree that access and distribution via digital streaming channels or high definition Blu-rays do not conform to old standards of archival preservation, the mass access they provide is nevertheless considered more valuable in today's visual economy, which ultimately spells doom for analog film.[139] "When we eventually reach the point where digital distribution of commercial releases is widespread," James White, a British film restorer claims, "economics will dictate that many of those works will never be converted to film or video.[140] Access has taken over and, in some damanging ideological ways, done away with preservation.

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[139] Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White" *Some Came Running: Enthusiasms and Expostulations* (March 12, 2013) Access 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

[140] *ibid.*

Before these shifts, acetate safety stock revolutionized how the medical sciences and lay public saw and visually accessed the foundations of biological life. Departing from static images of dead cells kept barricaded behind the closed doors of laboratories, new microcinematography imaging techniques coupled with new safety film stocks brought sights of moving cells streaming into public circulation. Importantly, these functions could only be truly understood through moving cinematic projection, and printing them on non-flammable and portable acetate safety stocks allowed these images to freely circulate amongst lay viewers and within the public sphere as a form of modern entertainment and education. As this chapter has argued, acetate imaging technology lead to a redefinition of life within scientific and public spheres as well as a redefinition of what the cinematic medium should ultimately provide: public access. In many ways, this continues to influence the prevailing discourse around the purpose and future life of media with "preservation" efforts: namely, that these images should continue to flow into the public and before their eyes while remaining accessible for future generations.

CHAPTER 4

Store Them in Cans for the Future: Microfilm, Photo-Albums, Home Movie Reels, and Safety Repositories

In the November 1936 edition of *Scientific American*, the President of Oglethorpe University and "father of the modern time capsule," Dr. Thornwell Jacobs, described an apocalyptic future in which all the earth's inhabitants and artifacts are reduced to a graveyard of dust.[1] To combat this bleak future, Jacobs called for the creation of an indestructible archive. Dubbed the "Crypt of Civilization," this bunker would save civilization by keeping a lasting record of humanity in the form of microfilms, photographs, motion pictures, and sound recordings that entrusted America's cultural heritage to celluloid acetate substrates. In the shadow of World War II and its mounting threats to literally "bury our civilization" under a cloud of nuclear war, a collective faith and hopeful discourse was invested into acetate records as an insurance policy for the future. Acetate products promised to keep civilization alive, safe, and everlasting for thousands of years through discourses and marketing campaigns that described them as the protectors of our memories, our cultural heritage, our children, our homes, our very lives and limbs. "Barring accident," Jacobs promised, time capsules like the Crypt of Civilization that had been stockpiled with acetate artifacts would "found in perfect condition after sixty centuries."[2] While this was the hope and promise, however, acetate's own susceptibility to decay and failure as a "immutable" preservation agent would be revealed before the turn of the next century.

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[1] Thornwell Jacobs, "Today—Tomorrow: Archeology in A.D. 8113." *Scientific American* (November 1936).

[2] "Preserving Our History In A Tomb: 'Crypt of Civilization' Will Re-create Our Daily Life for People of 8113 A.D." *Popular Science* 133.6 (Dec 1938): 111;113.

During World War II and into the Cold War, American citizens faced immense social upheaval, economic downturn, and unprecedented threats of global destruction. In response to this climate of fear, the desire for preservation and safety reached a new height. New safety materials, survival methods, and even governmental sponsored initiatives emerged throughout the 1930s-60s, all aimed at ensuring the future survival of what were considered those most in danger and the pinnacle of American civilization: the nuclear home and its children, especially. This chapter interrogates the discourses and methods of preservation as they came to be practiced in archiving (institutional microfilm duplication and the widespread building of time capsules), home imaging technologies (photographs, home movies), and domestic safety measures (backyard bomb shelters and gas masks). The argument put forth is that throughout the 1930s-1960s, preservation efforts based in acetate plastic materials narrowed their focus onto children and, in doing so, established a prevailing rhetoric that promoted the figure of "The Child" and notion of "The Future" as the prized figures whose safekeeping was both the goal and justification for preservation interventions.

Technology, in and of itself, is heavily steeped in notions of "futurity": there is a perennial push toward the next, new and forthcoming innovation that will not only be better than what came before, but that will improve, advance, or save the future existence of human civilization. In many ways, technology itself embodies and is elevated to represent "the future." Intersecting with this overarching aura around technology, rhetorical calls to "save the children" and the cultural frenzy for preservation emerged during the mid-twentieth century; a rhetoric that has continued to influence preservation as it is thought of and practiced today. Importantly, the conversation around preservation was directed towards the nuclear family and the future of their children, while suggesting that saving them was vital to the Nation as a whole. In his article, "We Must Protect the Children!," U.S. Army Major, Robert D. Walk, implored that government officials were beholden to protect the nation's children, which "after all, [are] the future of any nation."[3] Major Walk continued to describe how new military technologies, wielded by the enemy, had to be met with new innovations in protective technology. Acetate plastics emerged as once such innovation in the form of microfilm stuffed time capsules, gas masks, and bomb shelters stuffed families. Many of these products where marketed not only to families for use in their domestic homes, but specifically for protecting children and infants who required innovative protection strategies due to their smaller size, constantly changing "body compositions" (as Walk termed it), and difficult containment. Discursively, these same concerns and descriptions would also be used to "sell" the project of saving acetate film objects in the twentieth-century. The same parlance of saving "children" is still being strategically used to drum up support for saving endangered film objects, often referred to as "orphans" or a national "heritage" that needs to be kept in good stewardship for future generations, as are the methods of preservation (namely that containment, technological intervention, and artificial material substitutions). As this chapter shall reveal, the discourse that first placed acetate as the protector of children would be flipped to position acetate film objects as metaphorical "children" whose unruly, changing, (d)evolving physical composition needed to be contained, protected, and kept safe through Government sponsored interventions.

All of these figures and notions — "The Child," "The Future," "orphans," and "heritage" — are rhetorical constructions that have been marshaled to advance varying agendas during

[3] Major Robert D. Walk, "We Must Protect the Children!" Accessed 10 Jan 2015 <http://www.gasmasklexikon.com/Page/USA-Mil-Children.htm>.

different historical moments of crisis. In her book, *Figurations: Child, Bodies, Worlds*, Claudia Castañeda argues that "The Child" is a cultural construction whose inherent incompleteness and malleability position it as a useful cipher for addressing and shaping larger social concerns.[4] In the 1930s-60s, and especially during World War II, military and commercial groups co-opted the figure of The Child and used it as a figurehead to justify national security, domestic safety, and use preservation interventions both in a literal sense, as in the case of child gas masks, as well as more metaphorically as in the case of photo-cinematic imaging technologies. Coupled with this emphasis on The Child, the related notion of heritage and futurity have also fueled the frenzy for future-proofing devices like time capsules and microfilm duplication. Importantly, what was established in the twentieth century continued into the next century as well: preservation rhetoric still focuses on the need to save our endangered film heritage for future generations through duplication and archival storage. Behind all of these interventions is a belief that the goal of preservation should be to ensure that future generations can inherit the accomplishments of the past. In her writing on film preservation practices, Caroline Frick demonstrates how discourses on futurity and a rhetoric of "saving our national film heritage" has been marshaled to fuel contemporary preservation initiatives.[5] By elevating the content of decaying film objects to the level of a national treasure that needs to be protected like a precious heirloom, the goal is to generate public and Governmental support for their duplication and re-containment.

Taking a slightly different stance in this debate, however, are those who champion the cause of non-commercial films including home movies, educational films (as discussed in Chapter 3), and other cinematic works made on small-gauge film who don't have a specific

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[4] Claudia Castañeda, *Figurations: Child, Bodies, Worlds* (Durham: Duke University Press, 2002).

[5] Caroline Frick, *Saving Cinema: The Politics of Preservation* (New York: Oxford University Press, 2010).

creator or studio behind their production. Within preservation parlance, these objects are defined as “orphans” who need to be saved from abandoned neglect like a poor, parentless child incapable of protecting themselves. Though the origin of the term “orphan film” has a bit of a contentious history — Paolo Cherchi Usai notes that the term was first used in 1950 rather than 1992 — what has become clear is the image it conjures and maps onto analog and, increasingly acetate, film objects: that of a work abandoned by its owner/parent and that has begun to suffer neglect.[6] Importantly, advocates for saving orphan films tend to focus more on saving the actual film bodies and keeping the original strip forms rather than just extracting their contents. Film scholars and preservationists have also used orphan films to make a case for treating film objects as artifacts of cultural heritage.[7] Orphan films can function as containers of meaning and portals back to see the actual people and cultural happenings outside of mass entertainment constructions. In many ways, these film bodies exist as a form of patrimony: not only are orphan films a type of inherited property that are often passed on generationally within the same family (home movies, for example), but they have also been elevated to a National patrimonial artifact that contains valuable historical information and and cultural significance for.[8] Playing upon these associations with patrimony, contemporary preservation movements have called upon the U.S. Government and Library of Congress to save these important, orphaned films. Underwriting

[6] Paolo Cherchi Usai, “Are All (Analog) Films ‘Orphans’?: A Predigital Appraisal,” *Moving Image* 9.1 (Spring 2009): 1-18.

[7] see Caroline Frick, “Beyond Hollywood: Enhancing Heritage with the ‘Orphan’ Film,” *International Journal of Heritage Studies* 14.4 (July 2008): 319-331; Emily Cohen, “Orphanista Manifesto: Orphan Films and the Politics of Reproduction,” *American Anthropologist* 106.4 (December 2004): 719-731.

[8] In her chapters, “The Home Movie Movement: Excavations, Artifacts, Minings” and “Morphing History into Histories: From Amateur Film to the Archive of the Future,” Patricia R. Zimmermann argues that home movies are indeed containers of significant cultural history and heritage. For more, see *Mining the Home Movie: Excavations in Histories and Memories*, Karen I. Ishizuka and Patricia R. Zimmermann, eds. (Berkeley: University of California Press, 2007).

this discourse is an unseen residual anchoring in the rhetoric used during the early twentieth century to encourage parents and the government to intervene with acetate plastic safety materials and save literally endangered children.

While there is a strong cadre that support keeping the original film formats and materials, there is also a move within contemporary preservation practice to save orphan films by transferring their contents onto new digital formats through reproductive and duplicative interventions. Ironically, children themselves are by definition the products of (physical/sexual) reproduction and are in some ways duplicative replacements for their parents. In a telling way, then, referring to film objects as "children" grounds the solutions for saving film in the original method use to create them: reproduction and duplication. Essentially an equation is presented that suggests the best, perhaps only, way to save something is to reproduce it. Not only was this the prevailing logic of the 1930s-60s, as manifest in widespread obsessions to translate priceless artifacts into acetate microfilm copies and bury them within protective shelters-*cum*-catacombs, but it continues to inform preservation initiatives today, whose mission is to translate old acetate media contents into newer, alternative formats which provide the (false) illusion of secured future access.

Whether used to build family photo-albums, microfilm archives, or backyard bomb shelters, acetate plastics were positioned throughout World War II and into the Cold War as positive "safety" materials that could establish safe storehouses. As has been shown throughout the preceding chapters, acetate was defined from its point of invention as a "safety" material, beginning with its first use as both a fire-resistant imaging material as well as a fire-proof lacquer covering that literally preserved allied aircraft during the first World War.[9] Now, in the second World War, acetate was again called upon to function as a mechanism of safety, protection, and preservation. National heritage and real, flesh-and-blood children became the targets for preservation during the Depression, WWII, and Cold War moments, which gave birth to a prevailing rhetoric that defined preservation through children, future heritage, and heterosexual reproduction,. Feeding into this discourse, commercial manufactures pitched acetate-based products to the public as ways to improve safety and ensure survival. In sum, acetate became synonymous with "safety," security, and protection within public consciousness and and consumer practice. Cultural historian David Nye has argued that even more important than the actual technologies or products themselves is how consuming and engaging with them makes users feel: in the case of these acetate products, it was even more important that using them made institutions and laymen alike feel like they were doing everything possible to save and keep their precious items or loved ones or from irreversible loss.[10] While this was their promise at the time, by the mid-1950s acetate plastics would begin to fail and decay, leading to the rhetoric to shift and recast it as an untrustworthy, failed material that needing to be saved from its own vices or outright replaced. As this chapter will show, the prevailing rhetoric around acetate might have appealed to everyone's prayers for protection and preservation at the time, but its greatest success was not preservation: rather, the galvanized of certain ideologies surrounding "preservation" that have have outlived acetate itself.

Microfilm:
Mighty Midgets of Filmdom

[9] Blaine B. Kuist, "An Old Plastic with New Uses: Cellulose Acetate," *The Michigan Technic* Vol. 59-60 (May 1941): 12-14.

[10] see David Nye, *American Technological Sublime* (Cambridge: MIT Press, 1994).

In Louis L. Snyder's 1942 *Handbook of Civilian Protection*, he implored Governmental agencies, business firms, schools, museums, and even civilians to act quickly and decisively in order to insure against the destruction historical records; the best way to do this, according to Snyder, was through microfilm duplication.[11] Microfilm, also commonly referred to as "microphotographs," are "films bearing a photographic record on a reduced scale of printed or other graphic matter" and "compressed recordings used to preserve vital records or documents on strips of high contrast, high resolution, safety film."[12] John Benjamin Dancer, an English imagist and optical instrument manufacturer, first began experimenting with microfilm technology in 1839. His early designs and applications took the form of miniature text novelties viewed through microscopic magnification. In these early experiments, Dancer combined microscopic optics with photographic materials — essentially establishing an early prototype for the microcinematography apparatuses discussed in the previous chapter. By 1928, Kodak began marketing their own microfilm products under their newly launched Recordak Division. At this point, nitrate film was already being phased out in favor of acetate safety film and, as such, Kodak and other companies predominately manufactured microfilm on acetate.

Manufactures like Kodak aggressively pitched acetate microfilm as an improved replacement for paper documentation and as an improvement upon current record-keeping methods. Microfilm's plastic composition, they argued, provided a number of pertinent benefits: it would last far longer than most paper products, even up to 500 years if correctly stored and handled; would reduce storage needs and overhead; and it could generate numerous

[11] Louis L. Snyder, *Handbook of Civilian Protection* (New York: McGraw-Hill Book Co, 1942).

[12] "What is Microfilm?" *MicrofilmWorld* (2011). 11 Dec 2013. Accessed 21 November 2014 <http://www.microfilmworld.com/whatismicrofilm.aspx>; Ralph De Sola, *Microfilming.* New York: Essential Books, 1944.

reproductions and reprints.[13] As such, new acetate microfilm was positioned as an improved alternative to old materials like paper, and would be embraced as inventive, novel solution to various crises — some real, some invented.[14] Rather ironically, paper was first used to "preserve" film in the nineteenth century. In response to vagaries in copyright law concerning wether or not it included new cinematic images, films were translated into paper printed photographs which did qualify for copyright protection and were stored in the Library of Congress. Paper, thus, preserved both the legal rights and the contents of early motion picture works.[15] However, this would change in the twentieth century, and acetate microfilm would return to take the place of paper as an archive medium.

As previously allude to, part of the motivational logic the material shift to acetate microfilm and the phasing out of paper, is an inherently problematic and even flawed ideological core at the root of technology. In short, there is a commonly held faith in new technologies and a belief, even if unfounded, that they are always, automatically "better" than what came before, and that they represent "the future" in terms of both providing progressive innovation as well as promising a brighter, better tomorrow for its users. And yet, these ideologies are undercut by profit-driven models of planned obsolescence, which communicate contradictory (though accepted) messages that technically is necessary for a secure and better future, though because it is always changing and "improving" with new models, upgrades, and replacements it is also the

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[13] "What is Microfilm?"

[14] Following the useful distinction made by Anthony Seger and Shubha Chaudhrui, archives and libraries differ in two significant ways within the context of this chapter: first, archives often collect unpublished and/or non-officially, "amateur" materials in addition to official, published items, and archives tend to place a stronger emphasis on preserving their holds whereas libraries tend to focus making their collections accessible to the public. For more, see *Archives for the Future: Global Perspectives on Audiovisual Archives in the 21st Century.* Anthony Seeger and Shubha Chaudhuri, eds. (Calcutta: Seagull Books, 2004).

[15] Ken Weissman, "The Library of Congress Unlocks The Ultimate Archive System," *CreativeCOW.net* (2010) Accessed 4 July 2015 <https://library.creativecow.net/weissman_ken/library_of_congress/1>.

literal antithesis of a permanent, stable future.[16] It is impossible for new technologies to promise future survival and access when they themselves might not be around or accessible after the next upgrade. So have infamously proven the case with floppy disks that can no longer be read, and this might very well turn out to be true for today's digital formats. Interestingly, though microfilm may not have proven to be long lasting materially, it has proven to be remarkably resilent in terms of format access. Like paper before it, microfilm remains a relatively "low-tech preservation solution," at least according to Baird and Schaffner; more specifically, it has remained a relatively usable access medium into a technological future that does not include many analog outlets.

Problems with Paper

Microfilm's popularity increased throughout the 1930s, at the same time numerous library institutions faced a crossroads: a large portion of their original printed materials — books, periodicals, newspapers — appeared to be at risk, either due to paper's own natural decomposition processes (dubbed a "brittle book crisis," ironically similar to the "Vinegar Syndrome" phenomena that would befall acetate materials) or the mounting threats of wartime destruction. This was the decade, after all, of literal military assaults on paper as Hitler lead his Nazi supporters to burn thousands of books in the streets of Berlin.[17] Several American libraries indirectly responded to these cases of natural and imposed decay with a backlash against paper materials. Essentially, paper had become a problem — a perspective that even continues today, as

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[16] for a discussion of planned obsolescence as a market strategy within the automotive industry, see Bruce A. Blonigen, *Keeping it Fresh: Strategic Product Redesigns and Welfare* (Cambridge: National Bureau of Economic Research, 2013).

[17] Guy Stern, "The Burning of Books in Nazi German, 1933: The American Response" *Museum of Tolerance Online* 2.5 (1997) Accessed 21 January 2015 <http://motlc.wiesenthal.com/site/pp.asp?c=gvKVLcMVIuG&b=395007>.

Lisa Gitelman notes, in our proudly "paper-less" society.[18] In order to solve the problems with paper, numerous policy shifts were instituted that would forever change the face of library practices. By 1938, the Library of Congress microfilmed more than three million pages of books and manuscripts; special government-funded committees formed to conduct further microfilm research/development; and the American Library Association officially endorsed microfilm as its archival material of choice. Since the primary goal of libraries, in contrast to archives, is to preserve content and ensure its public accessibility, it was decided that all paper holdings — books, magazines, documents, records, newspapers — should be be turned into microfilm reproductions. With this, the informational content was be given priority over the paper format. Paper books and newsprint had officially fallen out of favor, and microfilm had arisen to take their place.

Importantly, these shifts were instituted to primarily service circulation and access — key features that would come to set libraries apart from archives as well as set the course for future preservation work — rather than protection and preservation.[19] Rather than couching preservation in terms of keeping pristine, locked away copies (as is often the practice in archival libraries that work with paper holdings), the logic behind acetate formats like microfilm is that they can "preserve" their contents while still offering a useable form and medium that can be reproduced/replaced at will to keep the contents safely renewed. This brings into focus a key

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[18] Lisa Gitelman, *Paper Knowledge: Toward a Media History of Documents* (Durham: Duke University Press, 2014).

[19] For more on the shift to microfilm reproductions within library sciences and archival practice, see Nicholson Baker's critical exposé, *Double Fold: Libraries and the Assault on Paper* (New York: Random House, 2001). In contrast to the early praise afforded acetate microfilm, Baker counter argues that microfilm copies required additional, complicated technology to access and read its contents, lacked the color and quality of original paper illustrations, and still deteriorated with age. Ironically, Baker's argument in defense of paper mirrors the same rhetoric used to reclaim acetate from its later analogue and, ultimately, digital media replacements.

difference at the core of acetate preservation: that it is, in fact, a completely different take on what preservation is and how it can be accomplished. In its practical application, acetate plastics offered to extend the longevity of various objects by reproducing them through an alternative material format. While acetate was frequently marketed and touted as lasting forever, it was also sold as being effective because it could be easily reproduced. As time and use mandated, acetate mediations could simply be re-produced in order to be maintained. The same process of logic of scanning and reproducing content as a new format continues today in the form of digital reproductions and restorations; as British preservationist James White summarizes, "These days (...) if someone embarks on a new restoration, they will almost always begin by scanning the best existing film materials and working in digital throughout the entire process."[20] One of the clearest manifestations of this particular philosophy of preserving through microfilm reproduction is found in the example of time capsules, which were increasingly with microfilm reproductions and not just original artifacts.

Filling Time Capsules with Microfilm

At the same time libraries were putting their precious collections into acetate materials, the public began putting their collective faith in microfilm, and popular culture became overrun with the idea of stuffing time capsules full of acetate microfilm in order to outlive their current era and last for generations to come. The first "time capsule" prototype, termed "The Century Safe," officially debuted in 1876 at the Philadelphia World's Fair, yet the idea that time capsules could serve as miniature preservation devices reached its apex in the 1930s. A number of world events occurring between WWI and II set the stage for these amplified interests in time capsules

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[20] Glenn Kenny, "Film Restoration in the Digital Domain: A Chat with James White," *Some Came Running: Enthusiasms and Expostulations* (March 12, 2013) Accessed 4 July 2015 <http://somecamerunning.typepad.com/some_came_running/2013/03/film-restoration-in-the-digital-domain-a-chat-with-james-white.html>.

and the need to preserve a lasting record of civilization. In 1923, the archaeological discovery of King Tut's Tomb ignited worldwide interests in ancient Egyptian culture and how they succeeding in preserving it for centuries.[21] In contrast, that same year the deviating Great Kano Earthquake leveled Tokyo, Japan, killing over 150,000 thousand people, wiping out the city's recent modernization efforts, and essentially showing the fragile nature of current civilization. To ensure American civilization would become the next Egypt instead of the next Tokyo, numerous commercial companies, institutions, and even individuals began filling time capsules with priceless artifacts, irreplaceable memorabilia, and miles of acetate microfilm. Cultural historian William E. Jarvis has argued that during this "rise of the modern time capsule," the goal was to create a lasting record of civilization in a shape or form that would last long into the future, and twentieth century time capsule preparers turned to microfilm records and acetate reproductions to accomplish this. The Westinghouse Electric & Manufacturing Company, for example, filled their 1939 "Capsule of Cupaloy" with materials that they specifically "selected for permanence and have been treated, so far as possible, to give them resistance to time." For Westinghouse, acetate microfilm seemed to offer the best permanence and temporal resistance; "[m]aterial which would ordinarily be published in books," they described, "have been photographed on acetate microfilm; a method that not only promises permanence but also makes possible the concentration of much information in small space."[22]

Many of the time capsules produced in this period, including the "Capsule of Cupaloy" and Jacobs' "Crypt of Civilization," also included the latest in technological developments and

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[21] William E. Jarvis, *Time Capsules: A Cultural History* (Jefferson: McFarland & Company, 2003).

[22] Westinghouse Electric & Manufacturing Company, "The Book of Record of the Time Capsule of Cupaloy." (January 1, 1938): 8.

scientific accomplishments from the current period. Plastics, which were considered the latest in "wonderful," "man-made" substances, occupied an entire wing in Jacob's crypt.[23] In addition to microfilm reels, other acetate plastic goods including Rayon fabrics and even artificial prosthetics were included to give a sense of new plastics' possibilities. Even though plastic was not as precious nor unique as other natural materials like gold or ivory, it was nonetheless considered an important emblem of technological progress and contemporary life that deserved a spot within the time capsule, not just as a container for other information but as a worthy relic itself.[24] Material culture scholars, including Bill Brown and Daniel Miller, have argued that a culture's material products and popular regard for them reveal a great deal about the culture in question.[25] The fact that plastic products, including acetate plastics, were included in these crypts as both artifacts/objects as well as containers for other artifacts confesses the significant place acetate held within popular culture as well as these preservation initiatives at the time.

As described earlier, Jacobs strategically planned to save history through his Crypt of Civilization and with microfilm, in particular. He was so keen on using microfilm for this task, in fact, that he hired T.K. Peters, a motion picture technician, to devise a way to turn literary texts, historical speeches, and fine artworks into acetate reproductions. In an article for the *Journal of the the Society of Motion Picture Engineers*, Peters described how acetate impressed him as the

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[23] T.K. Peters, "The Preservation of History in the Crypt of Civilization." *Journal of the Society of Motion Picture Engineers* XXXIV (February 1940): 210.

[24] *ibid.*

[25] see Bill Brown, "Materiality" in *Critical Terms for Media Studies,* W.J.T. Mitchell and Mark Hansen, eds. (Chicago: University of Chicago Press, 2010); Daniel Miller, *Material Cultures: Why Some Things Matter* (London: UCL Press, 1998) and "Materiality: An Introduction" in *Materiality (Politics, History, and Culture)*, Daniel Miller ed. (Durham: Duke University Press, 2005).

ideal material to use in this endeavor, in part because it seemed on par with the materials ancient Egyptians used in their successful embalming attempts. He reasoned, that:

> Knowing that our new cellulose acetate film had a life span equivalent to that of rag paper, and knowing that the ancient Egyptians papyri were nothing more than rag paper and that one of them, the Papyrus of Nu, is now nearly 4000 years old, it was but a step in reasoning to assume that cellulose acetate if properly prepared and finished would, under the scientific method we should adopt, be preserved in splendid shape.[26]

Ironically, Peters saw acetate as a positive peer to paper. Moreover, he also saw it as a more than a mere replacement materials, but also a fortifying agent that could be used to sure-up and conserve original objects. In other words, Peters maintain a rather unique perspective that diverged from the prevailing "preservation through replacement" rhetoric. He believed that acetate could be applied as a strengthening support rather than just as a replacement measure. Other materials, Peters reasoned "can be further protected by a coating of cellulose acetate and should last ten thousand years when protected in the same manner as the cellulose film."[27] With this, Peters put forth a more nuanced approach to "preservation" — one that attempted to not just keep the informational content of a source and discard its material form, but an approach closer to conservation practices which attempt to save original sources *and* their original container form/format with the supportive aid of new technologies and materials.[28]

While such distinctions between "conserving" original materials verses simply "preserving" their contents are often overlooked within popular discourse, there were some instances where acetate products were in fact used in a conservatory fashion. In "Sealing History Away for Keeps," an article published in the December 1940 edition of *Popular Mechanics*,

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[26] Peters, 208.

[27] *ibid,* 209.

[28] for more on conservation versus preservation, particular with an emphasis on audio archiving, see: Referat von George List, "Archiving Sound Recording," *Phonetica* 6 (1961): 18-31.

acetate lamination was presented as a conservation method that could protect or even mend historical documents printed on paper.[29] By sealing or "sandwiching" the original documents between layers of acetate, conservation experts claimed that the "danger of decay or insect attack [was] minimized, and aging tests indicate this laminating process makes the historical record as permanent as it is possible to make any paper record."[30] A later 1942 article further claimed that old, neglected paper documents could be revitalized and given a new lease on life through acetate reinforcement. In a process likened to "toasting," paper documents were fused together with acetate sheaths, essentially transforming them into a longer-lasting, plasticized hybrids that were part paper, part plastic. These laminations still hinged upon suppositions that acetate was superior to paper, yet they also offered an alternative way to retain the original document. Unlike other microfilming methods and the discourses surrounding them, which largely discredited and discarded paper originals, plastic lamination conserved them while still providing the superior protective power of acetate.[31]

The culture and rhetoric established around acetate microfilm aligned with the logic and core principles undergirded Leon L. Walters' acetate taxidermy processes. As discussed in Chapter 1, Walters' method replaced organic skins with acetate-based replicas in order to produce what was believed to be a longer-lasting, more preservable semblance of the original animal specimen. Just as Walters threw away the skin and saved the copy, the microfilm reproduction process also threw away paper in favor of acetate film strips. Evident in these cases

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[29] "Sealing History Away for Keeps." *Popular Mechanics* 74.6 (December 1940): 878; Bourdon Scribner, *Protection of Documents with Cellulose Acetate Sheeting* (Washington, DC: Government Printing Office, 1941); Pete Edwards, "Take Care of the Maps." *Boys' Life* (March 1962): 66.

[30] "Sealing History Away for Keeps." *Popular Mechanics* 74.6 (December 1940): 878.

[31] "'Toasting' Old Records to Save Them." *Popular Science* 140.3 (March 1942): 61.

is a residing proclivity for artificial materials, reproductions, and replacing of older, organic materials (skin and paper, in these cases) with what was deemed to be a new and thus improved technological alternative (acetate coverings and microfilm containers). The same points used to sell the wonders of microfilm — namely, its efficiency and speediness — were also used for other acetate products, such as the medical casts and braces analyzed in Chapter 1. Microfilm and medical apparatuses were both advertised as modern improvements upon old techniques or materials, and were marketed as particularly valuable because they could provide reliable, fast, and efficient function — things that were especially valued and desired in the throes of World War II. A 1943 advertisement for Recordak epitomizes how the benefits of microfilm were presented as particularly beneficial, if not essential, for the war effort and survival of American civilization. Entitled "Miracles of Swift Repair," this article-length ad highlighted microfilm's small format and duplicative nature as essential for American military success and citizen survival.[32] Advertisements like this undoubtedly took many liberties in promoting their products and aggrandizing their importance — it is a bit grandiose to think that microfilm will win the war and save America — yet these lofty promises do reveal what features of acetate products were considered important and marketable to their consuming audience. Namely, speed was pitched as a vital feature of acetate microfilm, which forecasts the ways in technology would increasingly be promoted through a rhetoric of rapid change, speedy upgrades, and the fast consumption.

Preserving Space while Reproducing Copies

Microfilm's compact format also promised to save storage space which became increasingly valuable as an influx of records steadily increased while the resources to actually

[32] Recordak, "Miracles of Swift Repair" advertisement (1943).

manage them dwindled.[33] In his 1945 book, *The Scholar and the Future of the Research Library*, Fremont Rider calculated that the storage needs of research libraries were growing at unsupportable rate.[34] Executive director of the American Library Association, David H. Clift, similarly feared a storage "crisis" within institutions: "The scientist and research worker can no longer keep up with (...) the published materials in his field," he claimed, and thus advocated for the use of microfilm technology to help with present storage and future retrieval.[35] Even more pressing than the deterioration of paper holdings and the (over)hyped "brittle book crisis" were structural issues within the institutions themselves: namely, the rapid deterioration of actual storage and shelf-space within the Nation's libraries. This became the real issue which microfilm's miniature format seemed to solve.

As such, microfilm was given an aggrandized position as a powerful, "mighty midget" that could preform the Herculean tasks of turning voluminous paper holdings into space-saving, easily accessible miniature photographic collections.[36] In addition to these intuitional uses, the U.S. military also relied upon the space-saving size of V-Mail microfilm correspondence, and even domestic users incorporated microfilm technology as a space-saving solution in their daily,

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[33] For more on microfilm's advertised role during the Baby Boom, see; "How Recordak Microfilming Helped Simplifying The Biggest Bookkeeping Job in the World" advertisement (ca. 1952); "More People...More Records...More Need for Recordak Microfilming!" advertisement. *The American City* (April 1963): 171. And for more on the surplus of digital data during the Information Age, see Alexander Stille's "Are We Losing Our Memory?" from *Future of the Past* (New York: Farrar, Straus and Giroux, 2002).

[34] see "Microfilm Copying Outfits: Miniature Camera Used with Homemade Equipment Makes Permanent Photo Records." *Popular Science* 142.5 (May 1943): HW 158-161 and Fremont Rider, *The Scholar and the Future of the Research Library: A Problem and Its Solution* (New York: Hadham press, 1944). The crisis of library space also continued after the war, as chronicled in the 1951 British Pathé short documentary, *Microfilm Newspapers* (http://www.britishpathe.com/video/micro-film-newspapers/query/microfilm)

[35] Joseph N. Bell, "CRISIS! How Can We Store Human Knowledge?" *Popular Mechanics* (Nov 1962): 104-110; 224.

[36] "Mighty Midgets of Filmdom." *Popular Mechanics* 78.6 (December 1942): 72-76, 168-169.

home record-keeping efforts.[37] In all of these applications, the goal was not simply to retain content but, even more importantly, to do so in a way that preserved shelf-space, storage overhead, and/or low shipping costs. This all came at its own cost, though; in order fit information into the microfilm format, several features of the document such as its original shape, scale, and even content (as in the case of color images) had to be eliminated. An advertisement for Recordak, brazenly entitled "Kodak's Recordak System Safeguards the Vital Records of Everyone's Life," further illustrates how microfilm remediation ultimately destroyed aspects of the very documents it intended to save. The ad features a halo of personal documents swirling around the disembodied head of a man, who puns his "career is in films."[38] Bank statements, checks, census records, hospital bills, and a number of other sensitive personal documents are all represented in their original forms, variegated shapes and sizes, and colorful printing. They are given second placement, however, and behind uniform, colorless strips of microfilm which have come to replace and overshadow the originals.[39] While these small strips with their roll film format will indeed save space compared bulky paper documents, they have already lost a number of features and characteristics of the originals.

Microfilm's roll film format not only helped to compress volumes of information and save storage space but also allowed for the easy and cheap reproduction of numerous copies — a

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[37] see Eastman Kodak. "Kodak created, U.S. Government adopts 'V-MAIL"...For Communication with Our Men on Distant Fronts" advertisement (ca. 1942) reprinted in Lynn Heidelbaugh, "Advertisement for Kodak." *Argo: People, Postage & The Post* (Washington, DC: Smithsonian National Postal Museum). Accessed 1 Jan 2014 <http://arago.si.edu/index.asp?cmd=1&con=2&id=181795> and "Microscopic Mailbag." *Popular Science* 142.1 (Jan 1943): 100-101. See also, Tracy Diers, "Hobbyist Microfilms His Records to Save Storage Space." *Popular Mechanics* 110.5 (Nov 1958): 194-95 and "Microfilm Copying Outfits: Miniature Camera Used with Homemade Equipment Makes Permanent Photo Records." *Popular Science* 142.5 (May 1943): HW 158-161.

[38] Recordak, "Kodak's Recordak System Safeguards the Vital Records of Everyone's Life" (ca. 1957).

[39] See Lisa Gitelman's, *Paper Knowledge: Toward a Media History of Documents*, for a compelling discussion of how paper documents, their tangible "paper-ness," and materials hallmarks (embossed seals, watermarks, etc.) have been used to ensure the authenticity of such official documents and personal records.

feature that, rather ironically, would actually generate more and more copies of things that would further tax actual storage capabilities. The microfilm format and acetate medium allowed for an excess of information production — a phenomena that would continue and become even more amplified with the production of pictures and, eventually, digital images or information. This posses a catch-twenty-two, however, within actually preservation practices: while the discourse surrounding microfilm suggested that it was preferable to save materials by reproducing them as lots of copies, this excess makes it logistically more difficult to actually preserve anything. The ability to store, care for, and actually retrieve anything from the excess becomes nearly impossible, thus undermining some of the fundamental purposes of preservation.

Regardless of this inherent paradox, microfilm's reproducibility still became one of its most valued features and contributions, which gained further support from cultural shifts that defined the 1950s as a time of consumer excess and heightened mass production. In an era marked by ever evolving mass production technologies, balanced mounting threats of utter nuclear annihilation, rare images and irreplaceable objects became liabilities and subject to irretrievable, devastating loss. Having a format that could easily produce multiple copies as needed conversely provided a sense of security; nothing is be lost forever if there is another copy or version of it to take its place. As such, a certain culture developed around acetate that valued it as a reproducible and therefor safety-providing format even despite the paradoxical problems this actually posed to practice preservation efforts. In contrast to other design and aesthetic movements that, as Jeffrey L. Meikle discusses in *American Plastic,* privileged craftsmanship or the uniqueness of one-of-a-kind originals, another culture developed around acetate plastics and microfilm that valued having things in an easy to copy format because it promised a greater chance for long-term survival.[40] Microfilm both played into and depended upon this very rhetoric, and encouraged library institution as well as domestic consumers to embrace the logic that safety is to be found in reproduced numbers.

An ad for Recordak's Reliant microfilming machine, for example, featured a happy microfilmist proudly holding up duplicate reels of microfilm while claiming that extra copies provided extra protection because they could be kept across several locations.[41] Echoing the same logic behind using acetate safety film to produce and circulate copies of educational sciences films, discussed in Chapter 3, acetate microfilm was praised for its ability to be cheaply mass-reproduced and distributed throughout the public. Singular paper-based documents posed a dilemma to libraries, especially: while their primary responsibility is to make knowledge sources accessible to the public, this is also a risky endeavor. Allowing the public to use and interact with irreplaceable documents jeopardizes their material integrity, can speed up their decay, and lead to their destruction.[42] Thus, an impasse is created where access can result in irrecoverable loss. Microfilm reproduction, however, offered a solution: originals could be turned into multiple, sturdy duplicates and put into public circulation across multiple library branches. Several advertisement campaigns highlighted these features of reproducibility, further suggesting this was a main selling point and positively regarded attribute of this new technology.

Acetate's plastic composition made it and cheap and easy to reproduce which, ironically, made it quite valuable: original sources could be kept safe and preserved in restricted, less-

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[40] see Jeffrey L. Meikle, *American Plastic: A Cultural History* (New Brunswick: Rutgers University Press, 1995).

[41] Recordak, "Introducing...the Recordak Reliant" advertisement (ca. 1955).

[42] for more on this impasse between preservation and access, especially in the case of home movies, see Snowden Becker, "See and Save: Balancing Access and Preservation for Ephemeral Moving Images," Special Issue *Spectator* 27.1 (Spring 2007): 21-28.

accessible archives, while an army of cheap reproduction could be released to the public and easily replaced as needed. While some historians, including Meikle, have suggested this lead to a disregard and devaluing of plastic, the public discourse and marketing tactics surrounding acetate microfilm during WWII, especially, suggested the exact opposite. In the previously detailed "Miracles of Swift Repair" advertisement, for example, one of the main selling points for acetate microfilm was its reproducibility. The ad proudly detailed how Recordak turned the priceless holdings of the British Museum and invaluable financial records from the great British banking houses into "miniature duplicates," whose acetate composition placed it beyond the reach of bombs and microfilm format provided "a way to condense and perpetuate culture."

Problems with Microfilm Preservation

Many promoted and embraced microfilm as a welcomed solution, but it inevitably caused as many problems, if not more, than it intended to solve. The first evidence of acetate's failure arose in the 1950s, when microfilmed government documents stored in India began showing signs of decomposition. On the heals of this, *Popular Science* ran a feature in their "Science Newsfront" section claiming that microfilm records across the U.S. were suffering from what appeared to be a mysterious manifestation of "measles."[43] Strange spots and blemishes were erupting on microfilm no more than 30 years old, leaving archivists and manufactures desperate to find both the cause and the cure for this alignment. Following the classic tale of new technologies causing more problems than providing solutions, acetate film was in fact impermanent and quite vulnerable to decay, aging, and loss. Even the chief of New York Public Library's Microforms Division, Thomas A. Bourke, ended up comparing acetate to asbestos —

[43] Wallace Cloud, "Science Newsfront" *Popular Science* (July 1964): 15-16;18.

which was originally hailed as a beneficial fire-retardant, only to later be re-discovered as an extremely hazardous material — and ultimately declared acetate microfilm to a "malady produced by a self-inflicted cure for the problem(s) caused by cellulose nitrate," paper, and other older materials that came before it.[44]

In the end, acetate plastic did not prove to be as long-lasting or indestructible as advertises suggested or its supporters initially believed. In fact, the first signs of decay began appearing less than eighty years after the development of celluloid acetate plastic. Paper, on the other hand, has lasted for centuries even though it was characterized as weaker and inferior to acetate. In light of its manifested short-comings, archivist have grown increasing wary of microfilm and acetate as a preservation container, even despite the continuation of consumer marketing that into the 1970s still touted both as tenable products. Advertisements from microfilm manufactures continued to fuel this backlash against paper, even into the 1960s. In one particularly inflammatory ad from Recordak, a reel of microfilm stands triumphant in front of a crumpled mess of paper documents while a typewritten caption calls upon libraries to "save the facts...and throw away the paper" [Fig. 4.1].[45] Even thirty years after microfilm first entered into library practice, it was still being positioned as the triumphant solution to destructible, disposable paper. This entire institutional shift, as well as this particular ad, reflect a divergent perspective on medium specificity and the sanctity of original forms or artifacts. Rather than echoing McLuhan's position that the "medium is the message" — or, that the original format of media objects like paper-based book are as important as their informational contents — this ad and the

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[44] Bourke, "The Curse of Acetate; Or, a Base Conundrum Confronted," *Microfilm Review* 23.1 (Winter 1994): 15-17. 15.

[45] Eastman Kodak, "Save the Facts...And Throw Away the Paper" advertisement (ca. 1965).

discourse at large suggested the exact opposite: that older, seemingly weaker containers like books should be thrown away and their contents should be redeposited into a safer, seemingly stronger container like acetate microfilm.

[Fig. 4.1] Eastman Kodak, "Save the Facts...and Throw Away the Paper" advertisement (ca. 1965).

Replacing paper collections with acetate microfilm managed to still continue even past the heyday of acetate plastics. In 1971, *Popular Science* teamed up with Xerox to endorse their own transition from paper archives to microfilmed backups and back issues.[46] Essentially, they positioned microfilm (and Xerox's University Microfilm products, in particular) as superior to paper because it offered the best chance for past issues to be accessed by future generations. This rhetoric established a distinction between mere collecting (like the kind down by collectors, who value and trade in rarity, authenticity, and restricted access) versus future access and retrieval: paper texts could be collected, but only acetate microfilm could truly offer access and a useful, retrievable record. What acetate microfilm offered, essentially and a bit ironically, was a

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[46] Xerox University Microfilms. "Xerox Announces a Plan for Saving Popular Science" advertisement. *Popular Science* 199.5 (Nov 1971): 39.

prototype for digital data bases and a vision for information storage/access that would ultimately evolve into the World Wide Web.

In practical application, though, microfilm proved to be much less effective and user-friendly especially over time and as it aged. The process of using microfilm and accessing its contents is extremely taxing — both for the film material as well as for the users. In order to see these miniaturized photographs, the film has to be threaded through a viewing machine; scrolling through the reel to view often requires a lot of imprecise fast-forwarding and rewinding. This process can leave users dizzy and disorientated while subjecting the film to a considerable amount of tension and friction. After enough scrolling, users (or at least, this user) often find themselves lost and alienated amongst non-contextualized snippets on a glaring screen, while the film is scratched and weakened in this trying retrieval/viewing process. Central to McLuhan's writing on mediation as well as Baker's defense of original print and paper-based documents is the claim that form and format significantly effect a users' experience, interaction, and ability to access informational content. Flipping through a magazine by hand, for example, is fundamentally different than using knobs to mechanically scroll through a microfilm reproduction. As Baker further observers, the screen displays on microfilm viewers flatten print documents, leveling out any textures or elevations in the paper and print, while restricting the users' ability to interact with the document — to rotate from portrait to landscape orientation, for example, or properly view centerfold images that require a viewer to see two pages simultaneously. In all of these cases, the remediated microfilm limits the type of information captured as well as the ways in which users can access and engage with whatever remains. Such side-effects should be minimized and not actually caused by a preservation medium.

In addition to these nuisances, microfilm has also shown itself to be an unreliable reproduction material. Rephotographing or making reproductions from microfilm are rarely legible due to finicky light balance and contrast levels. Perhaps even more egregious, all of these reproductions and re-reproductions are stripped of their original color images since they were either economically rendered in black-and-white or, in the rare cases where color is kept, microfilm does suffer from significant fading and pigment loss over time and usage.[47] All of this culminates in the actual users of microfilm tending to dislike the format, even though institutions, manufactures, and even the public at large favored microfilm at the time. An interesting tension is found in this point of disjunction between what institutions deem important or necessary for future "preservation" and what users experience in their present usage. In short, the continued investment in microfilm is not in response to user support nor with the usability preferences of today's users in mind; rather, microfilm was turned to as an investment in the future and the imagined accessibility of tomorrow's users. With this, we pull back the mask that is claims and promises of preservation, to reveal that microfilm and acetate media, at large, are ultimately access materials. With access, the goal is not to remain pristine or to achieve perfect fidelity to the original, but rather to provide other functions of mass distribution and future information retrieval, which actually place the materials at risk for damage, disrepair, and undermine conservation and retention.

Once again, and made ever so clear in this case, acetate media were not necessarily offering preservation, thought they claimed, but ultimately the promise of future access which is

[47] Even though acetate film was capable of producing color reproductions, microfilm records were largely rendered in black-and-white. This practice was in-part motivated and counterintuitively favored by some microfilm archivist. While rendering color images in black-and-white limits what can be saved and fundamentally changes the nature and overall effect of the original, black-and-white reproductions were more economic to produce and were conceived as easier to preserve compared to color copies or even color originals, which were seen as more prone to color fading, degradation, and informational loss.

in some cases in opposition to the actual retention, protection, and saving (as in the case of color). However, herein lies another rub that harkens back to the underlying logic of all technologies: planned obsolescence and the fact that microfilm manufactures have a vested interest in their product eventually wearing out and needing to be replaced by new, institutionally purchased reels. The true goal then, and a goal that microfilm actually succeeds in accomplishing when it appears to “fail,” is to last only until the next upgraded and renewal on it future lease on life. Indeed, multiple agendas are driving this, and truly all technological processes of preservation: on the one hand, institutional and personal desires for safety and assured preservation of their precious materials, and on the other hand, market desires for products that met these desires but only up to a certain point — that point being when their “failure” can be turned into a new source of profit.

Paralleling the institutional efforts to “save” our collective history, amateur users also turned to acetate recording materials. In these familial contexts, acetate products were used to amass personal archives full of family photographs and home movies, as well as literal protect family members with gas masks and bomb shelter “containers.” As shall be turned to next, these domestic uses continued to perpetuate much of the same rhetoric that surrounded microfilm and carried the ultimate message that acetate materials could preserved life.

Photo-Albums and Home Movie Reels:
Forever Just as They are Today, As They Never Will Be Again

Photography and film, family snapshots and home movies, are of course different media technologies with unique features. While not overlooking the critical differences between still and moving imaging, this section follows Richard Chalfen’s method of seeing snapshot photography and home moviemaking as connected imaging expressions.[48] Rather than considering these mediums separately, this section will focus on their points of intersection, both materially (they both utilized acetate roll film) as well as rhetorically (they both promised lasting permanence in the form of miniature images). While the existent literature on home photography and home movie technology is indeed comprehensive, a new material-centric perspective will be offered in the following sections with the focus on how these technologies used acetate safety film to enter American homes and offer its domestic users a safe, seemingly permanent way to create and keep pieces of their loved ones. Acetate film, more than nitrate before or even polyester after, was positioned as a the paragon of safety and preservative. As discussed in Chapter three, acetate photosensitive film was specifically marketed as "safety film" and capitalized on the Progressive Era's rhetoric of safety reformation to position acetate products as ideal for non-professional use. Adding to this discourse of acetate film products providing safety, advertisements also began to pitch photographic and home movie technologies as allowing users to permanently capture a moment or loved one and keep them forever in a miniature, crystalized form.[49] These mediations promised to "fix" memories, experiences, and loved ones into permanent, undying visual forms as well as "fix" the problems of unavoidable aging, fading colors, dimming memories, and even physical death.

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[48] see Richard Chalfen, *Snapshot Versions of Life*. (Bowling Green: Bowling Green State University Popular Press, 1987). And for more on photography, particult in relation to film, see: David Green and Joanna Lowry, *Stillness and Time: Photography and the Moving Image* (Brighton: Photoworks/Photoforum, 2006); Laura Mulvey, *Death 24x a Second: Stillness and the Moving Image* (London: Reaktion Books, 2006); David Campany, *Photography and Cinema* (London: Reaktion, 2008); *Still Moving: Between Cinema and Photography*. Karen R. Beckman and Jean Ma, eds. (Durham: Duke University Press, 2008); *Between Still and Moving Images*. Laurent Guido and Olivier Lugon. eds. (New Barnet: John Libbey Pub. Ltd, 2012).

[49] Next to footage of children and pets, which home movie developers cited as the most popular, travelogues were a favored subject matter for those who desired to make a permanent record ephemeral incidents of vacation or travel. Still, the subject mater and driving motivation at the heart home photography and movies record in permanent form the ways of small children.

Importantly, these photo-cinematic home mediums differ from microfilm in that they function more as "recording" agents. Even though microfilm was conceive of as a record-keeping device, it did not actually record information or events as they happened; rather, they reproduced copies of already existing records and remediated them into another format. Photography and home movies, on the other hand, document moments, experiences, people, and memories as they play out before the lens, in real life, and in real, evanescent time. The act of "recording" is thus a complex process that, in the end, is driven by desires for futurity. Essentially, one is only interested in recording the present so it can still be remembered into the future. Once again, the future is evoked and seen as the ultimate telos behind the making and keeping of all records.

Photographs and home movies may seem to offer a sense of "preservation" but, like microfilm, they also diverge from preserving the object as it exists now in order to ensure future access. All of these formats are intended to be retrieved and used again in the future. When one records something with a photograph or as a home movie, they intend to play these recordings back and access their contents at various points in the future in order to relive the past. Additionally, just as some preserved artifacts are actually harmed or even destroyed through access, home movies and photographs can also suffer from prolonged use and frequent playback. However, part of acetate film's intended contribution was to circumvent such effects and offer a longer-lasting, safe, and nearly-permanent type of recording and play-back material. At least, these were the initial promises and hopes surrounding acetate recording film, though their actual ramifications shall be interrogated in the sections that follow.

Beginnings of Home Photography

Even though photographs are often thought of and experienced as paper-based prints, original transparencies, slides, and even photographic “paper” where in fact all made of celluloid acetate. Before the invention of resin-coated paper (RC paper) in the late 1960s and the eventual switch to polyester plastic in the 1980s, acetate plastic used as the base support for photographic prints.[50] In the case of Polaroid instantaneous photographs, introduced in 1948, the final photographic image and printing material were in fact one in the same — the film used to print and develop the image was also the final print.[51] Of course, photographic images can also be collected and saved as film-based negatives (similar to microfilm), and other RC paper photographs are frequently protected and displayed between acetate plastic sheets in photo albums.

The introduction of plastic roll film fundamentally changed the nature of photographic imaging making, namely by democratizing photography and allowing layman amateurs to create image reproductions of their daily lives. Before film-based photography, the earliest 19th century photographs were printed on tin, copper, paper, and other non-film base materials.[52] In 1889, a new era in photographic possibility began when Kodak released the first flexible, plastic roll film

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[50] Henry Wilhelm and Carol Brower, *The Permanence and Care of Color Photographs: Traditional and Digital Color Prints, Color Negatives, Slides and Motion Pictures* (Grinnell: Preservation Publishing Company, 1993).

[51] For more on the history of Polaroid, see: Polaroid Corporation, *Storing, Handling, and Preserving Polaroid Photographs: A Guide* (Cambridge: Polaroid Corp, 1983); Alan R. Earls, Nasrin Rohani, and Marie Cosindas. *Polaroid* (Charleston: Arcadia, 2005); Christopher Bonanos, *Instant: The Story of Polaroid* (New York: Princeton Architectural Press, 2012).

[52] In 1834, Henry Fox Talbot developed the calotype process, which unlike irreproducible copper Daguerrotypes, created paper negative from which positive reproductions could be indefinitely duplicated.

produced on celluloid nitrate and eventually celluloid acetate by the 1920s.[53] Plastic film was in fact the key technology behind Kodak's groundbreaking Brownie amateur camera system. These cameras could be purchased cheaply and used by anyone especially since they came preloaded with roll film that contained all the necessary chemicals for taking photographic snapshots. All users had to do, according to Kodak's own infamous slogan, was push the camera's button, mail in their camera, and Kodak would "do the rest" to develop their prints.

Thanks to plastic roll film, photography became a cheap and easy possibility for amateur users and gave birth to an entire world of domestic image-making possibilities: the snapshot, tourist photography and travelogues, Polaroid, and eventually motion picture film technology which depended upon flexible roll film.[54] The easy to use, easy to print roll film format thus helped to establish a "snapshot culture," in which using cameras, taking pictures, and visually documenting everything or anything became something everyone could/should do as part of their daily lives. More pictures meant greater chances of keeping a lasting record, and the introduction of acetate roll film products made the mass proliferation of photographic images possible. Similar to microfilm, the prevailing logic here is that there is safety in numbers and that preservation can be ensured through replication and the reproduction of multiple copies. Rather than placing value in rareness or exclusiveness, a different value system that valued reproducibility as a feature to find comforting against the backdrop of fear, war, and loss. The

[53] While there are numerous manuscripts dedicated to the history of photography, the following texts offer social, historical, theoretical, and technological considerations of domestic and snapshot photography: Michel F. Braive and Michel Frizot, *The Photograph: A Social History* (New York: McGraw-Hill, 1966); Brian Coe and Paul Gates, *The Snapshot Photograph: The Rise of Popular Photography, 1888-1939* (London : Ash & Grant, 1977); Thierry de Duve, "Time Exposure and Snapshot: The Photograph as Paradox," *October* 5 (Summer 1978): 113-125; Colin Ford and Karl Steinorth, *You Press the Button We Do the Rest: The Birth of Snapshot Photography* (London: Nishen, 1988); Kenneth P. Czech, *Snapshot: America Discovers the Camera* (Minneapolis: Lerner Publications, 1996); Douglas Nickel, "Roland Barthes and the Snapshot," *History of Photography* 24.3 (2000): 232-35; and Catherine Zuromskis, *Snapshot Photography: The Lives of Images* (Cambridge: MIT Press, 2013).

[54] Thomas Edison's first motion picture camera, developed in 1891, used Kodak roll film.

loss of something is less devastating so long as there is another to take its place, and acetate plastics provided the ability to keep reproducing replacements.

Beginnings of Home Movies

While nitrate roll film made the first motion picture recordings possible at the turn of the nineteenth century, the replacement of nitrate with acetate made motion pictures a safe possibility for home users and provided them unprecedented access to cinematic technology. The first versions of acetate-based motion picture film were available in the early 1900s, mostly for the home projection of existent film titles. In Europe, Pathé introduced their "Pathé Baby" system of projectors that brought 9.5mm acetate safety copies of films into European homes. However, as Gerald McKee notes, "9.5mm was intended primarily as a home entertainer and educator rather than as an amateur movie-making medium — a fundamental principle that was exactly the opposite of Kodak's 16mm gauge [which was] basically intended for shooting films at a moderate cost."[55] Historians of amateur film and home movie technologies, including Alan Kattelle and Patricia Zimmerman, mark Kodak's 1923 introduction of 16mm direct reversal safety film as the birth of home movie making.[56] As Kattelle further notes, this lead to a watershed moment in the history of film: 16mm acetate safety stock "swept away every other amateur format and scheme that had been essayed since 1894."[57] Kodak especially marketed

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[55] Gerald McKee, *Film Collecting* (South Brunswick: A.S. Barnes, 1978): 73.

[56] Both Kattelle and Zimmermann have chronicled the technological as well as social development acetate motion pictures; yet both Kattelle and Zimmermann primarily focus on camera technology, equipment developments, and Amateur Ciné Clubs rather than the film stocks themselves, which will be the focus here. See: Alan Kattelle, "The Evolution of Amateur Motion Picture Equipment 1895-1965." *Journal of Film and Video* 38 (1986): 47-57 and *Home Movies: A History of the American Industry, 1897-1979*. (Nashua: Transition Pub, 2000); Patricia R. Zimmermann, "Trading Down: Amateur Film Technology in Fifties America." *Screen* 29.2 (1988): 40-51; *Reel Families: A Social History of Amateur Film*. (Bloomington: Indiana University Press, 1995); *Mining the Home Movie: Excavations in Histories and Memorie*s. Karen L. Ishizuka and Patricia R. Zimmermann, eds. (Berkeley: University of California Press, 2008).

[57] Kattelle, *Home Movies: A History of the American Industry, 1897-1979*, 68.

their 16mm film products to everyday laymen; they played up acetate's new safety features and its user-friendly accessibility, thus turning motion pictures into a newly "democratized" medium available to the mass public.[58]

Part of 16mm film's success came from its user-friendly, easy to use nature, which popular press articles and advertisements compared to taking snapshots with Brownie still cameras.[59] In addition to ease, 16mm motion picture film also offered cheapness, and this vital cost effectiveness stemmed directly from the properties of acetate plastic film. Because it was more stable and fire-resistant than nitrate, acetate film could be manufactured in much smaller gauge sizes than the standard format of 35mm.[60] Smaller gauge size meant manufactures could cut materials and production to 1/5 the cost of 35mm nitrate. While home movie technology was still not inexpensive — a complete outfit including camera, film, projector, tripod, and screen cost around $335 in 1924, and just the film sold for $6 per 100-foot in the 1930s — acetate's small-gauge format opened the possibility of a non-professional market and made home movie-making a safe and accessible pastime for many American households who were instructed to use such products to create lasting records of their family lives.[61]

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[58] In *Reel Families*, Zimmerman make the useful distinction between "amateur" film existing as "a covering term for the complex power relations defining amateur filmmaking," versus "home movies" which "is a descriptive term for actual films produced by families."[49] Following Zimmerman, I make the same distinction here.

[59] see "Keep this Priceless Record of heir Childhood Days... in a Wonderful Movie that you make Yourself." *Popular Science* (April 1928): 85; Kodak, "The Wonderful Story of Growing Up" advertisement. *Popular Science* 121.4 (Oct 1932): 75.

[60] Prior to 1950s, virtually all theatrical, major motion films were printed, distributed, and projected on 35mm celluloid nitrate stock which still surpassed acetate in terms of image quality, even if not fire safety.

[61] Eastman Kodak, "Motion Picture the Kodak Way" advertisement. *Country Life* (June 1924): 99; Robert E. Martin, "Home Movies — 1930 Family Album." *Popular Science* (Jan 1930): 27; 130; Eastman Kodak, "From 9 A.M. to 5 P.M. Daily A Special Exhibition of Home Movies in Full Color" advertisement (1930); Eastman Kodak, "Add Motion to this Picture" advertisement (1933).

A second cost-saving aspect of 16mm acetate film and unique feature of acetate film stock was its direct reversal development process. With direct reversal films, only one step is needed to develop the film rather than the usual two: the film strip can be directly rendered into a projectable, positive image without having to first produce a negative print. While this reduced the time, labor, and money associated with film development, direct reversal printing also left users with only a singular, original print and no reproducible negatives. Though this offered a more cost effective alternative, it also stood in contrast to the preservation discourse established around other acetate materials, such as microfilm, which relied upon reproductions and copies to ensure the survival of records. In an interesting reversal from microfilming methods, photographic roll film, or even taxidermic skin casting techniques which used acetate to create infinitely reproducible negatives, 16mm motion picture technology produced original filmic renditions and singular copies.

Beyond being an interesting technical fact, 16mm film's original object status also effected the way it was described and understood within mass culture and public discourse. As *Popular Science* described in an early article on home movie technology, 16mm film images were by-in-large considered to be "originals" and not mechanical reproductions or copies like microfilm.[62] The same discourse also applied to Polaroid's line of instantaneous photographs, which provided cheap, immediate positive images printed on photosensitive paper encased with either an acetate or polyester plastic backing.[63] And yet, this lack of backup copies and inability to generate new prints did not factor into how home movies were conceptualized or marketed as

[62] "Novel Ideas." *Popular Science* 134.3 (March 1939): 140.

[63] Some Polaroid films, including the 43 and 53 lines both manufactured in the 1950s, could produce acetate-based negative prints and generate additional prints if desired. The discourse surrounding Polaroid did not center around the virtues of acetate in the same way that it did centrally figure in the advertisement campaigns for other photo-cinematic products; as such, it is not centrally discussed in this chapter.

preservation mediums. Under the logic established by microfilm, which equated survival and safety with numbers, 16mm home movies would have been poor preservation options. Nonetheless, marketing buzz and public opinion still invested their money and entrusted their family memories into 16mm home movies.

Miniatures Keepsakes, Kept Safe

While still photographs and motion pictures are obviously different in how they capture subjects — the first in frozen status, the second in flowing motion — they nonetheless offered a similar miniaturizing process and small-sized imaging method. Just as previously discussed with microfilm, these film-based recording modes relied upon miniaturization to capture, contain, and keep their subjects as safe. Miniaturization was also consciously presented to the public as a key feature of home photographic and cinematic technology — both in terms of the cameras themselves (see, for instance, Kodak's line of miniature cameras) as well as the film gauge and final images.[64] In fact, in 1941 Kodak's introduced a especial line of "Minicolor" Kodachrome prints. These miniature mementos had rounded corners, were printed on acetate-based paper, and were marketed as the perfect shape, size, and material to mail to distant loved ones or keep close to the heart in a pocket and safe in one's wallet.[65]

A number of media and literary theorists have also attested to the importance of miniaturization, as a conceptual framework for understanding how photographic imaging can offer both control and preservation. In *On Longing: Narratives of the Miniature, the Gigantic, the Souvenir, the Collection*, Susan Stewart theorizes that part of the miniature's appeal is that it

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[64] Sylvania. "The Great Moments in History..." advertisement. *Popular Science* (Dec 1964): 13; "Miniature Kodaks for Speed." *Popular Science* 126.5 (May 1935): 69.

[65] see Kodak, "Kodak Minicolor Prints...Make a Big Hit Over There," advertisement (1944); Henry Wilhelm and Carol Brower, *The Permanence and Care of Color Photographs: Traditional and Digital Color Prints, Color Negatives, Slides and Motion Pictures*.

seems to offer an alternative plane of existence that can reman set-apart, uncontaminated, and untouched by normal time.[66] Furthering Stewart's claim that miniature objects provide a type of escape from natural temporality and its negative effects, Carol Mavor has suggested that by creating miniaturize objects or images (namely, photographs of children) one attempts to control time, change, and loss.[67] Mavor's claim also echos Christian Metz's suggestion that the photograph offers a kind of "safe" harbor in which "a tiny piece of time brutally and forever escapes its ordinary fate, and thus is protected against its own loss."[68] In this same spirit, it is not only the photographic miniature that exists as a form of preservation, but also the child itself. Essentially, children function along the same paradigms as acetate mediums: they are literally miniature "reproductions" of their parents that are valued because they will carry their family name and bloodline into the future. Just as acetate medium provided an extended lease on life for its remediated objects, so too do children theoretically allow for a piece of their parents to live on into the future even after the parent's own natural lifespan has ended. Transcendence from the limits of nature and a preserved afterlife, therefor, are found both in acetate reproduction as well as the reproduction of children.

Several press advertisements for early home movie film and cameras picked upon these associations between children and preservation, and played upon fears of small children growing up or getting big too quickly as well as desires to lock them into a small, containable, and protected form. One such ad for Kodascope 16mm film, published in the April 1928 edition of

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[66] Susan Stewart, *On Longing: Narratives of the Miniature, the Gigantic, the Souvenir, the Collection* (Durham: Duke University Press, 1993).

[67] Carol Mavor, *Pleasures Taken* (Durham: Duke University Press, 1995).

[68] see Walter Benjamin, "A Short History on Photography" and Christian Metz, ""Photography and Fetish." *October* 34 (1985), 81-90.

Popular Science, employed both visual as well as rhetorical allusions to how time and nature could be controlled by creating miniature images of children.[69] Above a central headline, which implored parents to "Keep this Priceless Record of their Childhood Days," a series of still snapshots and strips of roll film appear imprinted with the small-scaled face of a young toddler. The text below further described how his and every mother faced the problem: that this little boy will soon be hurried along an unstoppable, terrible aging process from babyhood to childhood to adolescence to then be "gone forever." Photo-cinematic images, however, offered a solution: they could intervene to stop this flow and capture "every little motion there is (...) every gesture, every smile, every flash of personality" within a "thin strip of film" and keep them crystalized in a permanent image form, "forever just as they are today, as they never will be again."[70] When, of course, these promises were more metaphorical than literal, home photography and movie-making were pitched as control mechanisms that parents could use o gain some semblance of power over time and their child's natural growth. By reproducing their bodies as small photographs, film slides, or moving images, parent's could cataloged and keep their children, or at least their visual likenesses, as if they were unchanging, taxidermic butterflies pined behind glass (or, preferable still, acetate safety glass).[71]

Desires to arrest the ephemeral smallness of children spiked in intensity during the Great Depression and continued throughout the tumultuous years during/after World War II. Upheavals caused by the Depression, World War II, and post-war recovery had a profound impact on the

[69] Eastman Kodak. "Keep this Priceless Record of Their Childhood Days... in a wonderful movie that you make yourself" advertisement. *Popular Science* (April 1928): 85.

[70] *ibid.*

[71] For more on the formal composition of such family photographs and how a "familial gaze" shaped the final photographic record, see Marianne Hirsch, *Family Frames: Photography, Narrative, and Postmemory* (Cambridge: Harvard University Press, 1997) and *The Familial Gaze* (Hanover: Dartmouth College, 1999).

configuration, cohesion, and conduct of the traditionally conceived American nuclear family. Marriage, divorce, and birth rates fluctuated wildly; scores of families were separated as a result of lost livelihoods and/or lives; and American homes were increasingly seen as vulnerable targets for enemy infiltration. In the midst of severe economic depression, many American families were faced with losing their property, homes, and children to poverty, disease, starvation, or governmental seizure.[72] Families were forced to concentrate both on the survival of their nuclear unit as well as the welfare of their dependent children.[73] This period was also characterized by preoccupations with "time" itself and anxieties over its passage, leading many historians to call a decade of "standstill" when "everybody and everything marked time" and were obsessed with documenting or accounting for everything.[74] Speaking to these fears and desires, home photo-cinematic technologies promised to crystalize time in the form of immortal s images that offered a form of protection and permanence during an especially vulnerable time for American families.

As discussed in Chapter 3, there was also an established discourse connecting school-aged children's safety to both the miniaturized small-gauge safety film format as well as its fire-resistant acetate plastic materiality. Within the context of the educational classroom, children's physical safety and intellectual growth was also assured through the replacement of nitrate audio-visual films with acetate ones. Acetate continued to carry this association with safety and

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[72] see Tracy B. Collins, *Living Through the Great Depression* (San Diego: Greenhaven Press, 2004).

[73] According to Hawes and Hiner, The trauma of the Depression led to a decade that focused heavily on child welfare which included a host of cultural and social landmarks: the public recognition of the special needs, rights and place of children; the formation of the American Academy of Pediatrics in 1930 ; provisions for dependent and crippled children; new child labor laws; and growth of public child care facilities, to name but a few. For more, see: *American Childhood: A Research Guide and Historical Handbook*. J. Hawes and N. Hiner, eds. (Westport: Greenwood Press, 1985).

[74] see "Social Trends in the 1930s: Overview." *DISCovering U.S. History*, online edition (16 Dec. 2007). Accessed 25 Jan 2014 <http://find.galegroup.com/servlet/src>, and Gitelman, *Paper Knowledge: Toward a Media History of Documents*.

protect outside of the classroom setting and into public discussions on how children, families, and the home could be made safer by replacing various household items with resilient plastics. Articles found in *Woman's Home Companion*, *Life*, *Good Housekeeping,* and *Parents* magazine urged homeowners to safety-proof their home's with plastics: windows were retrofitted with acetate safety glass, kitchens were restocked with protective plastic containers and packaged foods, toys were made of "durable, play-safe" acetate, and even protective plastic masks were added to fragile glass television screens.[75] American homes were becoming increasingly "plasticized," not just in the typical, well-known ways like Tupperware in the kitchen or plastic covers on the sofa, but in ways that extended to an extreme level of "safety-mongering" during and after World War II. As shall be turned to at the end of this chapter, American home and families would continue be draped in acetate safety plastics, in the form of backyard bomb shelters, eye goggles, and gas mask.

Protecting Children from Pictorial Neglect

New parenting philosophies also emerged hand-in-hand with such ads, as well as governmental protection programs and laws aimed at ensuring the future survival of the nation's children.[76] A renewed focus on children grew out of earlier nineteenth century transformations in the sentimental meaning and value of of children, as well as early twentieth century governmental interventions keen on conserving child's lives and protecting them from the new

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[75] see Celanese, "Lumarith Windows: Attract...Protect...Persuade" advertisement (1946) and "Good Taste: It's in the Package Too" advertisement (1947); Allen Raymond, "Scientific Torture makes Your Home Safer." *Popular Science* (May 1951): 1133-39.; Celanese, "Quality Toys are Made of Acetate" advertisement (1953) and "Celanese Plastics Give Toys Play-Safe Toughness" advertisement. *Good Housekeeping* (Dec 1953): 30.

[76] Several private and government sponsored child protective programs emerged during this time — including the Societies for the Prevention of Cruelty to Children — fueled by the belief that the nation's children were in danger and needed to be saved. For more on the child protection interventions staged during this period, see: John E.B. Myers, *The History of Child Protection in America* (Sacramento: University of the Pacific, McGeorge School of Law, 2010).

dangers of deadly automobiles, street traffic, and transportation technologies. As Viviana Zelizer notes in her historical account of the changing value (sentimental and fiscal) of The Child in American culture, a number of social programs emerged in the early twentieth century with the goal of keeping children safe (including the 1912 establishment of the United States Children's Bureau, and the Stepphard-Towner Act of 1921). In response to growing public demands for increased governmental intervention during the Depression, Roosevelt's New Deal agenda placed the U.S. government in a newly active role as sort of "parent" to American parents; new legislation against child labor, for example, along with increased assistance programs for destitute families and children attempt to make sure the Nation's children were being raised and protected properly, as seen in the eyes of the National Government. These government sponsored safety measures would continue into World War II, taking on the shape of Civil Defense programs and other recourse focused on the safekeeping of the American home and family unit.

Indeed, driving all of these interventions is a shift that elevated The Child into a figure larger than itself: an emblem standing in for the nation's future and and symbol of hope for human civilization itself. If The Child could be protected and saved then, by extension, "the Future" could also be ensured. Contemporary feminist and queer theorists have continued to trace this (over)valuation of The Child as a continued force that directs national as well as social discourse. In *The Queen of America Goes to Washington City,* Lauren Berlant argues that American citizenship and social laws are bent to privilege The Child and heterosexual, nuclear family reproduction. These discourses contributed towards an obligatory cultural "life drive," as Lee Edelman argues, were we "intend to secure the survival of the social in the Imaginary form of the Child."[77] In contrast, Edelman places a twenty-first century call in *No Future: Queer Theory and the Death Drive* for a counter, queer resistance to the hegemonic value placed in The Child as a figural embodiment of life, reproductive futurity, and survival.[78] Edelman's project speak to (and against) some of the cores issues established in the early decades of the twentieth century: that the future can be "saved" through the saving of other token stand-ins, from paper documents to children themselves.

The Child became a national concern within American culture, and its survival a top moral, governmental, and parental responsibility. Though the Government took an increasingly active role as a protective Father figure, individual parents where still the primary targets of blame and shame if some calamity did befall their children. The Child may have become a national symbol, but children's parents were still called upon to practice good protective parenting — which would eventually include photo-cinematic documentation. Celia Stendler, historian and child psychologist, noted that throughout the Great Depression and World War II, parenting practices shifted to focus on careful physical care and maintenance: parents were expected to carefully measure their children's calories and nutrition as well as watchfully monitor their physical development and chart their bodily changes. Scientific interests in the growing child's body also included the use of various technological instruments — for example, as discussed in Chapter 2, Dr. T. Wingate Todd attempted to chart juvenile growth by collecting X-ray photographs of their developing bones. Safety film technology was also used during the progressive "Visual Education" movement, discussed in Chapter 3, to facilitate the growth of

[77] Edelman, *No Future: Queer Theory and the Death Drive,* 14.

[78] see Lauren Berlant, *The Queen of American Goes to Washington City: Essays on Sex and Citizenship* (Durham: Duke University Press, 1997) and Lee Edelman, *No Future: Queer Theory and the Death Drive* (Durham: Duke University Press, 2004).

children's minds and ensure their safe mental development. Along side these practices, home recording technologies were similarly marketed as good parenting techniques and necessary instruments to both chronicle as well as protect one's growing child.[79]

A curious advertisement trend spearheaded by Kodak in 1935 even went so far as to characterize the act of *not* taking photos or home movies as a form of child abuse or neglect. Even though this odd trend was clearly sensationalistic and can be written off as yet another hyper-exaggerative marketing scare tactic, it nonetheless offers a provocative glimpse into the mindset of the time period, public consciousness, and their infatuation with domestic photo-cinematic technologies as "saving" interventions. One 1935 Kodak ad, entitled "Lost Record of a Young Man with a Future," channeled this new parenting ethos to describe how even the most seemingly ideal guardians, who monitor their son's calories and vitamins, are still neglectful failures if they do not also make home movies of him [Fig. 4.2]. Under this commercial rhetoric, home movies were as essential to healthy, successful growth as proper diet and nutrition.

[Fig. 4.2] Eastman Kodak, "Lost Record of a Young Man with a Future" advertisement (1935).

[79] Similar to Todd, visual anthropologists Gregory Bateson and Margaret Mead also used still photography recording techniques as well as 16mm motion picture film to chart the development of children in Bali and New Guinea. For more on their work, see: Ira Jacknis, "Margaret Mead and Gregory Bateson in Bali: Their Use of Photography and Film," *Cultural Anthropology* 2.3 (May 1988): 160-77.

In “Lost Biography of a Lively Lady,” another example from this series, the language suggests that while the well-kept, smiling child pictured in the ad is “the focal point of interest for a family clan that is both numerous and devoted,” she is still “a neglected child” because “no one thinks to make movies of her.” Even though the results of this neglect would not lead to visible bruises or signs of abuse, their ramifications were no less severe: this poor girl would lack a lasting record of her youth; she would be deprived of keepsakes immortalizing her “best chapters.” “Lost records are a family tragedy,” yet another ad within this series claimed, and missing the opportunity to capture and keep one’s child in lasting visual way was placed within the realm of child abuse and tragedy — both very real and feared issues facing American families.[80] In short, to not take photographs or record home movies was tantamount to harming one’s child, which was a heightened concern during this time when so much social emphasis was placed on doing everything — scientifically, educationally, governmentally, domestically, and even consumptively — to intervene and protect the future survival of the Nation, its children, and both of their futures.

This last aspect — consumption — emerged as a particularly odd though emphasized way in which parents could, and should, intervene to help save their children. Ads like the ones discussed above reveal how marketing discourses played upon existent fears of familial loss by emphasizing that one must take action to stop the loss of time and memories, and that this action should take the form of purchasing cameras and 16mm recording products. Like most marketing strategies, this created a self-feeding circuit where the ad introduced a problem (the natural

[80] These sentiments of loss would be further exasperated when the acetate film supply was restricted during World War II, leaving many family without the means to record home movies. In response, a number of post-war advertisements urged buyers to “make up for lost time” and this imposed loss of family records. See: Eastman Kodak, “Ciné-Kodak Film is on the Way!” advertisement (1945) and “Make up for Lost Time...and Lost Movies” advertisement (1946).

progression of time, aging, forgetting, and death), to then provide the solution in the form of its product (acetate materials that could preserve a record). Paralleling the marketing of other acetate materials such as non-flammable safety film, advertisements for photo-cinematic film filled public discourse with problems that only their products could adequately solve.

Preservation Has a Price Tag

While these advertisements claimed every family had the obligation to serve and protect their children by taking photo-cinematic records of them, they also offered a complex, bordering on contradictory, position as to whether or not home movie technologies were actually an accessible and affordable possibility for the average American household. In fact, much of the imagery used within the advertisements themselves seemed to address a privileged class demographic even while the language suggested home movies were an activity that every family could, and must, participate.[81] The previously mentioned "Lost Record of a Young Man with a Future" ad, for example, features a male infant with a literal silver spoon in hand sitting in front of an overly-large plate of food — a luxury even for grown men during the Depression. The flanking text further described this child as "already enrolled in a future class of an exclusive school." The family unit imagined here is clearly from the higher social classes, yet the ad still ends its pitch with a detailed, "modest" cost breakdown of $112.50 for a Ciné-Kodak pre-loaded with 16mm film (or $125, if you also want a carrying-case). While the average American family experienced a 40% decrease in overall earnings during the Depression, bringing their average net income to only $1,500 a year, home movies were nonetheless still marketed as a necessary

[81] Such rhetoric cast home movie equipment as something elite, and to have priceless recordings made of one's self was to proves their value. As Pierre Bourdieu theorized in *Photography: A Middle-Brow Art* (Stanford: Stanford University Press, 1990), photography as well as home movie technology become aspirational commodities and consumer products, through which owners/users could proved their worth and social economic status.

product that, for the good of one's family and children, one had to buy and integrate into their daily lives.[82]

A certain ambivalence is present in ads like these, yet a residing message seems to prevail: that only certain families and individuals are in fact worthy of the tools to preserve their children and provide them with coveted pictorial immortalization. Selectively choosing what to save is an issue shared across preservation discourses and contexts: whether in institutional or domestic applications, lack of resources to save everything does led to difficult decisions regarding what/whom gets the privilege of preservation. In an era influenced by growing Nazi party rhetoric and a resurgence of eugenics, the prevailing sentiment of these advertisements suggest that those from privileged families who already have a future ahead of them are the ones most deserving of preservation.

Interestingly, while domestic photography seemed to privilege the upper echelons, other photography efforts in the 1930s, such as Dorothea Lang's photographs of migrants and Walker Evans work for the Farm Security Administration, focused on documenting those facing economic hardships and left destitute by the Depression.[83] Rather than focusing on privileged families, these socially conscious photographers turned a documentary lens towards families scrapping by in poverty (and, ultimately, turned a dollar for themselves in the process). As an additional almost ironic contrast, Evans immortalized his images of the poor as large format prints made with expensive film stocks and camera equipment. In contrast, the home outfits used

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[82] Prices derived from Kodak's 1939 "Seems as if She Could Walk Right out of the Picture" advertisement for Kodachrome.

[83] for more, see Evans', "Allie Mae Burroughs (aka Migrant Mother" (1935/6), Lang's iconic "Migrant Mother" (1936) and James Agee and Evans' photo exposé, *Let Us Now Praise Famous Men* (1941).

to document elite families were captured with cheaper, small-gauge film and produced as miniature images.

Beyond 16mm film, Kodak attempted to make home movies even more accessible to average American families with their introduction of 8mm motion picture film in 1932. By shrinking down the image size and increasing the number of exposure per film strip, 8mm would further open the amateur market to those not already enrolled at exclusive schools.[84] Kodak's main competitor, Bell & Howell, also released their own economy 8mm system, which sold for $69. By the end of the Depression, home movie equipment prices continued to fall, and the most basic Ciné-Kodak 8 Model 20 could now be purchase for $29.50. Besides opening the market to budget-minded users, the 8mm format would also facilitate the development of Kodak's next revolutionizing inventions: Kodachrome color film, discussed in Chapter one.[85]

Besides commercial advertisements, popular press articles also urged parents to take up amateur photography and home movie-making as another way to protect their family.[86] These useful hobbies would serve the dual role of providing the family with a pleasurable new leisure activity, while ultimately ensuring some aspect of them would last through time.[87] In fact, as

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[84] 8mm film is actually an economically split version of 16mm film: on its first pass through the camera, only half of the 16mm strip is exposed. When the first pass is complete, the users would open the camera and flips the spooled film to expose the opposite, unexposed side of the same strip during a second pass. After the second pass, the entire 16mm strip is splits it down the middle, resulting in two lengths of 8 mm film with one set of perforation on the side. Since each frame is half the size of a 16 mm frame, there are four times as many total frames. The end result is smaller images, but more of them, and for less money.

[85] Perhaps the most infamous amateur home movie in history — the 1963 "Zapruder film," which captured the assignation of President John F. Kennedy — was shot by a private citizen (Abraham Zapruder) on 8mm silent Kodachrome II acetate safety film and a a high-end 414 PD Bell & Howell Zoomatic Director Series camera.

[86] see Kodak, "Keep 'Family History' in Snapshots" advertisement. *Life* 27.15 (10 October 1949): 73. The same issue also contains an editorial piece on the growing threat of nuclear war, the endangered status of American citizens, and the need to keep them safe ("Atomic Control: It is More Necessary and Seeming Less Attainable than Ever," 38).

[87] Just as with time capsules, the itemizes for immortalization in family photographs and home movies have been by-in-large consciousness and carefully selected to only preserve that which is deemed favorable or worthy by the family.

Virginia C. Rylands noted in her *Woman's Home Companion* article, shooting movies is more than just a hobby: "it's even more important. It's our way of remembering...we record our memories in motion and color and store them in film cans for the future."[88] Essentially, the use of acetate-based materials and recording technologies within the home were conceived of as lifesaving interventions akin to time capsules, emergency food pantries, and bomb shelters. Like these other repositories, home movies and photographs also functioned like protective storage containers for embalmed memories and dutifully preserved them for future retrieval.

Kodak Saves The "Orphan" Children

Aside from rhetorically calling upon American parents to "save" their children through the use of Kodak visual imaging products, the Kodak Company also took a literal, active hand in saving European children during WWII. Beginning in 1939, even before the war started, the British government planned for the large scale evacuation of its most vulnerable and at risk citizens, which were primarily school-aged children living in the city center. By the 1940s a number of "child rescue programs," including The United States Committee for the Care of European Children and Federal Children's Bureau, moved thousands of children carrying gas masks and cardboard suitcases to the British countryside or overseas to other countries.[89] In addition to governmental support, American corporations also funded their own privately run evacuations. The Kodak Company took a lead roll by offering to transport and house the refugee children of their British employees, who became known as "Kodakids."[90]

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[88] Rylands, "We Make Movies for Remembering."

[89] Mary Jo Lanphear Barone, "The Kodakids," *Rochester History* LV.4 (Fall 1993): 21-42.

[90] see "British Kodak Evacuees Gives 'Impressions of America," *Kodakery* (21 March 1944); "Orphans of the Storm, *The American Experience*, WGBH Boston, Inc., 1989; and Mary Jo Lanphear Barone, "The Kodakids," *Rochester History* LV.4 (Fall 1993): 21-42.

Providing governmental aid and protection to European children was a contentious issue, as the American public and government did not want to become financial nor politically embroiled in a second World War. And yet, it was impossible to turn away from children in danger and need, leaving President Roosevelt to "walk on eggshells over the refugee child issue" and committee governmental assistance towards their preservation.[91] In this way, the figure of The Child became a tool for security governmental sympathy and, even more importantly, the allocation of funds towards their protection and safekeeping. This same strategy would be taken up by a different set of preservation seekers who similarly used this language of saving "film orphan" as a way to cajole governmental funds and public support for film preservation initiatives. Once again evoking the language of children in peril, Orphan films began to be discussed as "problem children" needing to be tended to and saved from a type of parental neglect. Echoing the same process that played out with concerns over real, flesh and blood children, the government was also called upon to step in and to help protect the continued existence of these pieces of heritage. Our ancestors gave birth to these treasures, and it is now the responsibility of this present generation to rise up as their faithful custodians and to keep their legacy alive for the next generation. Through government subsidized programs, such as the the American Film Institute-National Endowment for the Arts (AFI-NEA) Film Preservation Program, The Library of Congress, and the National Archives Programs. Though the contexts and objects needing preservative protection are of course vastly different, the discursive joke used to rescue from certain doom and provide the future survival of both flesh-and-blood and film-strip "children" were remarkably the same. Saying "no" to a helpless, defenseless child

[91] *ibid*, 24.

would be an unconscionable act, especially for those institutions such as the U.S. Government who are deeply invested in guarding their citizen, as a parent, and overseeing the future continuance of their civilization. In these ways, using language and metaphors that evoke “The Child” and “The Future” serve as powerful agents to ply governmental assistance.

Kodak may have been a shining beacon of stability and safety for children during World War II, but it would face it’s own perils of bankruptcy and company death into the twenty-first century. The advent of digital photography and filmmaking was by all accounts ruinous for Kodak.[92] Overshadowed by the emergence of new, film-less digital technologies, the company plunged into bankruptcy and forgotten obsolescence. By 2012, the company filed for bankruptcy protection and, in a familiar story, called upon the U.S. government to come to its rescue as if they were a defenseless, fledging children facing eminent death. And while the U.S. government has indeed functioned as a benevolent parental-*cum*-savior figure for other financial institutions (including Freddie Mac and Fannie Mae) in order to protect the health and longevity of its citizens and Nation as a whole, it did not extend a the same saving hand to Kodak. Rather, Kodak has been “left for dead” and to rise from its own ashes. As of 2013, they took their first step out of bankruptcy and now are struggling to survive by re-conjuring their past research and development prowess and hoping to rediscover their legacy of innovation.[93] Repeating the same narratives of technology’s ability to save the day, Kodak is once again hanging their hopes and the life on the company on the belief that their next big technological discovery will indeed secure their future survival.

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[92] “Refusing to Give Up on Kodak.” *The New York Times* (March 22, 2015) Accessed 1 June 2015 <http://www.nytimes.com/slideshow/2015/03/22/business/kodak-ss.html?_r=0>.

[93] *ibid*

Safety Repositories:
Lives, Limbs, and Homes Saved by Scientific Safety Engineering

Aside from photo-cinematic applications, acetate plastic was also applied within both European and American homes as a life-saving, protective material that could/should be used to keep families physically safe and alive. When gas attacks threatened British civilians in WWII, this took the form of gas masks, and when nuclear bombing technology became the new threat of the post-WWII period, bomb shelters took over discussions of how to keep American families safe from total annihilation. Each of these safety apparatuses used acetate plastics materials as technologies of preservation and as part of the family's personal arsenal to fight against the technologies of mass destruction.

Gas masks were mass distributed throughout Europe so that by the start of the War, 38 million masks had been given out to British families. The threat of gas attack was a legitimate fear, since British troops were ravaged by chemical and gas assaults in World War I. Now, however, the threat was brought even closer to home and, while a gas attack never did happen, European families were on constant guard with their protective masks at the ready. Parents and school teachers were called upon to have specially designed gas masks for children in their homes and in schools, and children were drilled in how to wear their newly designed masks, which were fitted acetate plastic windows [Fig. 4.3].[94] American magazines also ran stories on these masks, describing them as using the latest rubber and acetate materials to ensure childrens' safety [Fig. 4.4].[95] Often, these ads would show doting parents, without their own protection,

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[94] "First War Baby Gets His Gas Mask." *Daily Herald* [London, England] 13 September 1939. Accessed 26 January 2014 <http://www.nationalmediamuseum.org.uk/collection/photography/dailyheraldarchive/collectionitem.aspx?id=1983-5236/10702>.

[95] "Devise Gas Mask for Baby." *Mechanix Illustrated* (June 1939) and "Hoodlike Gas Mask Protects Babies." *Popular Science* 135.2 (Aug 1939): 65.

sealing their infant children in full-body masks and watching over them through the acetate window. The resounding message was to save the children, even in lieu of saving yourself; their future is more important than the parent's present. As Edelman aptly encapsulates in *No Future*: "the figure of [the] Child seems to shimmer with the iridescent promise of Noah's rainbow, serving like the rainbow as the pledge of a covenant that shields us against the persistent threat of apocalypse now — or later."[96] The Child, therefore, was equated with survival, hope, and futurity so that all focus and resources were directed towards saving them in order to save the future of humankind. In order to bring about Noah's Rainbow, though, a type of Noah's Ark was necessary, and this took the form of gas masks during WWII and bomb shelters into the post-war and Cold War period as bastions of family security and protection.

[Fig. 4.3] Tomlin, Harold. "First War Baby gets his Gas Mask" photograph for the *Daily Herald*, September 1939 held by The National Media Museum <http://www.nationalmediamuseum.org.uk/collection/photography/dailyheraldarchive/collectionitem.aspx?id=1983-5236/10702>.

[96] Edelman, *No Future: Queer Theory and the Death Drive,* 18.

Hoodlike Gas Mask Protects Babies

THREE years of research have solved the grim problem of fitting babies with gas masks, according to the British designer of the model illustrated in use below. Rubberized gasproof fabric completely incloses an infant from the waist up in a capacious hood with a large cellulose acetate window. A hand bellows operated by the parent supplies pure filtered air for the baby to breathe.

Pure air is fed to this infants' gas mask by operating the bellows with the hands

[Fig. 4.4] "Hoodlike Gas Mask Protects Babies." *Popular Science* 135.2 (August 1939): 65.

In her chapter, "The Baby in the Gas Mask: Motherhood, Wartime Technology, and the Gendered Division Between the Fronts During and After the First World War**,"** historian Susan R. Grayzel suggests that images of children in gas masks, which were published thorough European in both the first and second World War, created a sense that innocence was under attack and that the National governments had a moral obligation to protect innocent civilian homes.[97] These images become even more prevalent and provocative in during World War II: photographs appearing in England's *Literary Digest* and scores of other magazines showed entire hospital wards filed with children in protective hoods and lonely children standing in empty, post-

[97] Susan R. Grayzel, "“The Baby in the Gas Mask: Motherhood, Wartime Technology, and the Gendered Division Between the Fronts During and After the First World War," *Gender and the First World War*, Christa Hämmerle, Oswald Überegger, Birgitta Bader-Zaar, eds. (New York: Palgrave Macmillian, 2004): 127-143.

apocalyptic streets clutching a tattered doll in one hand and a miniature gas mask in the other.[98] These multivalent visuals gave face to a genuinely new horror unleashed by this war: they showed how no one was safe, not even the children, and everyone from individual parents to the National government had to intervene to keep their patrimony out of danger. Propaganda posters and other photographic images printed in the popular press in Europe and the United States also used the images of acetate fitted gas mask, and especially children in gas masks, to generate a extreme sense of emergency, doom, and alert. Acting as a double-coded image, the gas mask represented both the peril (poisonous gas) and the protection (life-saving technology) just as Noah's Ark evokes both the saving of Noah's family as well as destruction of the world. In some posters, gas masks were described as "designed for living" [Fig. 4.5], while in other photographs their created a ghastly image of babies stuffed into shroud-like gas masks and entombed into coffin-like hoods. Similar fear mongering tactics would resurface in the 1960s and into the twenty-first century around issues of film preservation. In the 1960s, fears over Nitrate combustion gave birth to the now infamous scare-tactic slogan, "Nitrate Won't Wait!," which channeled the same urgent demand for public awareness and action as found in wartime posters.[99] A different kind of deadly gas attack in the form of the Vinegar Syndrome threatened to eradicate our film heritage and history, and images of crumbling home movie reels were put on display to give face to the enemy while stirring the public and Government to take action.

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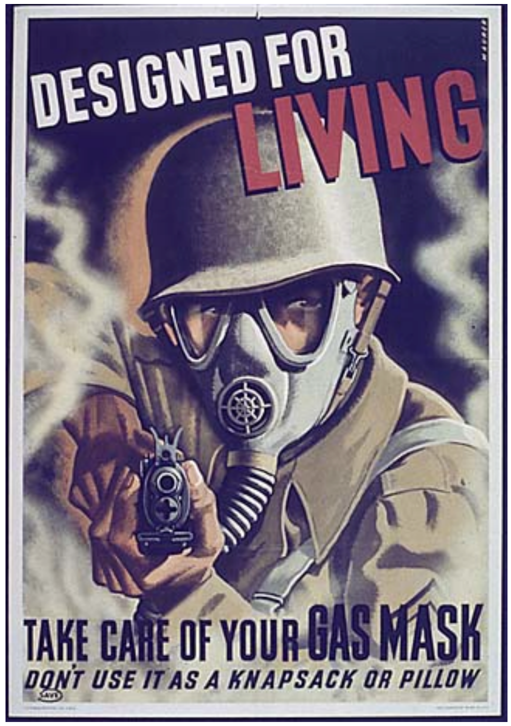
[98] see "Gas Masks for All in the Next War: Europe's Civilians Being Equipped for Air Raids on Great Cities," *Literary Digest* (25 July 1936): 6; 'Gas Masks for All," *Modern Mechanix* (March 1937): 42-5; 142; and "Gas!," *Modern Mechanix* (April 1946): 66-7; 159; 161.

[99] As Anthony Slide describes in *Nitrate Won't Wait: A History of Film Preservation in the United States* (Jefferson: McFarland & Company, 1992), "Nitrate Won't Wait!" has become a rallying cry for raising film preservation consciousness and funds. It was first coined by Sam Kula in the 1960s.



[Fig. 4.5] "Designed for Living, Take Care of Your Gas Mask" U.S. Military Poster, (1941-1945).

Containers and Containment

Intervention, by in large, manifested in the form of containment. Microfilm technology, in particular, was praised for containing, or positively "imprisoning," our time on ribbons of celluloid that could seal "history away for keeps." Home movie reels, photographs, and other domestic products were similarly described as "small snuff boxes" that could safely protect all the vital, invaluable elements of life.[100] Even bomb shelters would be refereed to as "pill boxes" which, similar to time capsules, sealed their contents away from external destruction and attempted to keep families alive by essentially burying them alive in a protective tomb.

[100] *Photographic News* (1859) qtd. in Southern Regional Library Facility, "What is Microfilming?" University of California 11 Dec 2013. <http://www.srlf.ucla.edu/exhibit/text/WhatIs.htm>; "The 'High Spots' of My Life are in Those Reels." *Popular Science* (Sept 1928): 79; "Sealing History Away for Keeps." *Popular Mechanics* 74.6 (December 1940): 878-879; George F. Lewis, *The Time* Capsule. (Bloomington: AuthorHouse, 2007): 108-09.

Popular Science described these acts as part of an overarching obsession and "scheme for 'canning' our civilization." Similar to culinary canning or preserve making, the fruits of human life and civilization were poured into acetate containers — valuable information was crammed into microfilm strips and stuffed into time capsules, while babies were interned into gas masks and tucked into family fallout bunkers.[101] These acetate interventions all functioned as literal and metaphoric containers and "cans for the future." Like other tin or metal cans, these acetate containers were valuable because of the function they provided: they kept their contents safe and secure long into the future.[102] Initially, this perspective may seem to discount the actual container itself and devalue or disregard the external materials of the vessel compared to their precious internal contents. Indeed, this has lead to the importance of medium specificity and the external form, qualities, and materials features of "container technologies" to be overlooked in favor of looking at their interior contents. Acetate had become a protective container in domestic applications that promised to literally keep children safe and alive as the precious content behind acetate screens, which eerily take on the appearance of framed photograph [Fig. 4.6].

[Fig. 4.6] Chema Manufacturing Company, "Gas Mask for Infants (British)," ca. 1930s.

[101] "'Time Capsule' Buried Under World's Fair." *Popular Science* 133.6 (Dec 1938): 112.

[102] Virginia Ryland, "We Make Movies for Remembering." *Woman's Home Companion* (October 1956): 112, 114, 116.

While in some ways it seems counterintuitive to design gas masks with windows and portal holes, it was nevertheless an important feature and even a selling point for both child and adult prototypes.[103] It was important for both parents and children to be able to see while wearing their masks: parents wanted to be able to visually monitor their child's breathing and overall well being, and the child was more likely to keep calm if they could make eye-contact with their parents.[104] For these vital reasons, window were a desirable and necessary element of the masks, which thus required the use of a material that was considered safe and resistant enough to protect eyes and fascinating vision. Acetate safety glass seemed ideally suited for these tasks. As discussed in previous chapters, acetate plastic had a long association with visuality and vision: it was used to maintain the visual appearance of taxidermy mounts, to create medical visual images, and to aid one's ability to see things that evaded natural vision. Here, in the case of gas masks and also with bomb shelters, acetate materials were once again called upon to aid vision and sight as important elements of life that needed to be maintained, protected, and enhanced.

Bomb Shelter During and After the War

The nuclear home and family continued to be seen as something needing additional protection against external as well as internal threats during the post-WWII and Cold War era. Taking on a multitude of forms and applications, acetate plastics were tasked with the singular goal of keeping the family safe and protected. The overarching hope was that "lives, limbs, and homes [would be] saved by scientific safety engineering" and, of course, acetate plastics were elected for the job as the quintessential "safety" plastic.[105] In his *Handbook of Civilian*

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[103] "Full-Vision Gas Mask," *Mechanix Illustrated* (December 1939).

[104] "Gas Mask for Baby," *Modern Mechanix* (June 1939).

[105] Allen Raymond, "Scientific Torture makes Your Home Safer." *Popular Science* (May 1951): 139.

Protection (1942), Louis L. Snyder joins other historians in recognizing that World War II and the attacks on Pearl Harbor, especially, brought the threats of war onto American soil and into American homes.[106] Snyder also notes, though, that rather than just shrinking back in fear, American civilians also took this as a call to domestic arms; instead of picking up offensive weapons, however, they did take up defensive acts of domestic conservation, salvage, and safety-proofing through accessible means. Using basic materials, supercharged with the promises of survival, Americans turned their homes into a "militarized domestic space" and used plastics to accomplish this.

Repeating the same rhetoric found within other "conservation" contexts such as taxidermy, Snyder's manual urged civilians to alleviate wartime shortage by replacing scarce materials with artificial substitutes that could be more easily reproduced.[107] Cellulose acetate plastics, which had already earned their stripes in the first World War and as a conservation material, entering into the domestic consumer market under this wartime rhetoric and to "take their place in national defense" in the form of safety-glass fitted gas masks, bomb shelters, and eye goggles.[108] In an advertisement for the Hercules Powder Company, a prominent producer of acetate products in America, acetate materials were praised for keeping military and naval cargo containers intact and their contents safe during combat [Fig. 4.7].[109] Such battlefront uses also crossed-over to the home-front in the form of new domestic vessels, like plastic kitchen containers, which *Popular Science* writer Arthur C. Miller identified as a new trend in home food

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[106] Louis L. Snyder, *Handbook of Civilian Protection* (New York: McGraw-Hill Book Co, 1942).

[107] *ibid*, 138.

[108] Blaine B. Kuist, "An Old Plastic with New Uses: Cellulose Acetate," *The Michigan Technic* Vol. 59-60 (May 1941): 12.

[109] Hercules Powder Company. "Making it Easy to Make it Tough!" advertisement. 1944.

storage.[110] Thanks to acetate plastics, families were able to stockpile food products, for both short and long term usage, which proved especially desirable as families scurried to prepare emergence supplies and stockpile their acetate fortified bomb shelters. Along side these consumable containers were also human "containers" — full-body gas hoods and bomb shelters — that similarly promised to keep their flesh-and-blood contents safe by encasing them in plastic.[111]

[Fig. 4.7] Hercules Powder Company, "Making it Easy to Make it Tough!" advertisement (1944).

American families were urged to fortifying their homes with strategically marketed "safety" materials, which included acetate plastics.[112] Writing in the May 1941 issue of *Popular Science*, Lieutenant Colonel A.M. Prentiss outlined a military directive and safety plan for

[110] Daniel Miller, 64.

[111] Earl Tupper invented perhaps the most famous domestic plastic container, "Tupperware," in 1947 with polyethylene and not acetate as its main plastic component. For more on Tupperware, see Alison J. Clarke, *Tupperware: The Promise of Plastic in 1950's America*. (Washington, D.C.: Smithsonian Institute Press, 1999).

[112] Despite this ardent urging, however, very few American households did go take on with the hassle and economic burden of building backyard bomb shelters.

American homes that included acetate safety glass.[113] According to Prentiss, citizens should secure their homes and improve their family's chances for surviving an air-raid by building backyard bomb shelter. Instead of using traditional glass windows, Prentiss recommended that families use seal their shelters (and by extension, their family inside of it) with acetate safety glass windows, as did Snyder who advocated for the use non-shattering acetate glass varnishes and transparent window cover materials.[114] In the 1920s, safety glass was still manufactured out of celluloid nitrate; however, a new brand of safety glass made out of acetate plastic hit the consumer market in 1933.[115] Thanks to material engineering advancements, acetate reinforced safety glass promised to be stronger, more resistant to breakage, and offer better visual clarity (a feature that proved especially important for it primary application in car windshields and other types of face masks).

Safety glass not only offered an important safety function, but also spoke to the prevailing visual aesthetics and architectural tastes of the post-WWII time period. As Kenneth Rose notes in his history of bomb shelter design in America, Mid-Century Modern design ideologies were in conflict with safety ideologies, especially in the context of civilian home and school designs.[116] The leading trends in architectural design (as well as theories in child development) advocated for large windows refereed to as 'walls of light' that let in ventilation

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[113] A.M. Prentiss,"How Homes Can be Protected from Air Attack." *Popular Science* 138.5 (May 1941): 77-80; 218. See also: *Chemicals in War: A Treatise on Chemical Warfare* (New York: McGraw-Hill Book Company, Inc, 1937); *Civil Air Defense: A Treatise on the Protection of the Civil Population against Air Attack (*New York: Whittlesey House, McGraw-Hill Book Co, 1941); and *Civil Defense in Modern War: A Text on the Protection of the Civil Population Against A.B.C. Warfare; Atomic, Bacterial, Chemical* (New York: McGraw-Hill, 1951).

[114] Louis L. Snyder, *Handbook of Civilian Protection* (New York: McGraw-Hill Book Co, 1942), 103.

[115] George B. Watkins and Joseph D. Ryan, "Cellulose Acetate Plastic Improves Laminated Safety Glass," *Industrial and Engineering Chemistry* 25.11 (November 1933): 1192-5.

[116] Kenneth Rose, *One National Underground: The Fallout Shelter in American Culture* (New York: NYU PRess, 2001).

and natural light, which experts argued were essential for the vitality and healthy development of children.[117] Naturally, this design philosophy was diametrically opposition to what made for a maximumly effective bomb shelter: namely, closed-off fortification and no windows. Glass windows might have been associated with light and life in previous time periods and in other philosophical contexts, but now in a time when atomic light lead to death, glass was turned into a dangerous liability and potentially deadly material. In numerous safety manuals and films produced by the Civil Defense department, including the famous *Duck and Cover* cartoon series starting Bert the safety-conscious cartoon Turtle, glass was singled out as a hazard and threat. In one cartoon rendering, school children where depicted as under siege by a battalion sharp fragments of glass fragments that came hurdling towards them from a bombed-out classroom window. Glass functioned as an arm of the nuclear bomb, and it was frequently used in visual renderings of atomic attack to illustrate how the bomb could/would harm children. Acetate safety glass, however, could provide a solution and bridge the gap between design form and safety function.[118] It was not completely impervious (especially under a nuclear blast, though no domestically available material really is), but plastic glass reduced the likelihood of breakage and eliminated the threat of flying glass shrapnel. As a compromise, then, home and school shelters could be equipped with acetate windows, as Prentiss advocated for in his *Popular Science* article.

Shifting the Responsibility for Safety in the Post-War Period

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[117] see also Lydnon Welch, "Architecture Design of Protected Areas," *Design for the Nuclear Age* (Washington, DC: National Academy of Sciences — National Research Council, 1962): 53.

[118] In the mid to late 1950s, plastics assumed a complex role within Modern architecture and building design. Architecture critic, Douglas Haskell, likened plastic building to structures that were "all skin" and surface; while the "Monsanto House of the Future" in Disneyland was being erected as a a shining symbol of high Modernity and futurity. For more, on plastic's cultural history within design and architecture, see: Jeffrey L. Meikle, *American Plastic: A Cultural History* (New Brunswick: Rutgers University Press, 1995) and Daniel A. Barber, Michael Ben-Eli, Alan Berman, David Rifkind, Carl Stein, Kevin Bone, Steven Hillyer, and Sunnie Joh, *Lessons from Modernism: Environmental Design Strategies in Architecture, 1925-1970* (New York: The Monacelli Press, 2014).

The American civilian and their home became sites of danger and targets of destruction, as well as the mechanism for safety and protection. Importantly, shifting of safety discourse followed in the wake of the War and into the Cold War period that de-emphasized the government's role in keeping America families safe; now the burden of self-preservation was placed squarely upon the shoulders of civilians themselves. Admonishments to "Dig or die" and "Duck and Cover" took over conversations of home-front security, with individual parents and children being the one's solely responsible for carrying out these lifesaving directives.[119] As discussed previously, this marked a shift from the safety rhetoric of the 1930s and World War II, when the National Government was called upon to take the lead role in protecting their citizenry. Laura McEnaney notes in *Civil Defense Begins At Home: Militarization Meets Everyday Life in the Fifties*, that domestic safety during the Cold War took on the tenor of "self-help," where safety became privatized rather than nationalized and "The Family" become a a medium through which governmental protection was redistributed.[120] McEnaney further notes how this elevation of The Family (narrowly defined through verbal and visual representations as white, upper-middle class, and heteronormative with a bread-winning father, stay-at-home mother, and two opposite-sexed children) also coincided with the ascendance of the family backyard bomb shelter, which were marketed towards home-owning families of some financial means. Perhaps most important is how this shift intersected with cultural shifts in consumer culture as well as discourses concerning how consumer goods made of familiar acetate plastics could be purchased and used by American families to keep themselves alive.

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[119] Howard Simons, "backyard front lines,' *Science News Letter* (16 April 1955): 205.

[120] Laura McEnaney, *Civil Defense Begins At Home: Militarization Meets Everyday Life in the Fifties* (Princeton: Princeton University Press, 2000).

Consumer culture exploded in the 1950s and specifically targeted The Family as a target market capable of spending money on cars, home goods, leisure actives, and security. Essentially, safety was made the citizen's responsibility but also made seemingly accessible as something they could buy and obtain it through their faithful consumption of "safety" products. Acetate safety products continued to flood the domestic market during and after the war with products. [121] A number of products, including goggles, visors, tents, face masks, safety glass windows, screens, and helmets all made out of clear acetate plastics, were brought back from the front-lines and resold within domestic contexts with combat proven, as military grade protection gear.[122] However, as was the case with home movie and photographic modes of recording keeping and image making equipment, these consumer preservation products also can with a price tag and not all families could actually afford them, though it was made their financial and moral responsibility to do so.

Acetate materials also assisted in self-directed safety actions by providing educational training. Throughout the 1950s, the educational films, printed on acetate safety film, flooded schools with didactic information about how to stay alive during a nuclear attack. In this way, acetate plastic was working double-duty: it provided a safe medium through which to teach school children and civilians how to protect themselves. Interestingly, the most famous of these educational films, *Duck and Cover* (written by Raymond J. Mauer, directed by Anthony Rizzo, and produced by Archer Productions in 1951), was inducted to the Library of Congress' Film

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[121] In the August 1947 edition of *Popular Science* magazine, advertisements promoting various war or military surplus items, many of them geared towards safety and production, appeared 21 times over; in the January 1948 issue, this already high number increased to 34 reference to war surplus supplies.

[122] see "Plastic Masks Protect Workers in War Plants." *Popular Science* 142.1 (Jan 1943): 98; "Shields of Clear Plastic Protect War Workers." *Popular Mechanics* 80.1 (July 1943): 87; "Plastic Guard Saves Face" and "Glasses Built into Football Mask." *Popular Science* 155.3 (Sept 1949): 153; "Plastic Suit Stops Radioactive Dust," *Popular Science* 158.5 (May 1951): 93.

Registry as a "historically significant" artifact of Cold War Culture, and will now have Governmental resources directed towards its safekeeping and preservation. The materials once positioned as providing preservation are now in in need of protection and preservation as a new war is waged against the lost of film artifacts.

In this new war, however, acetate has been recast as the problematic cause of decay, and it is being sacrificially lost in favor of newer seeming more decay-resistant technological formats. The meaning surrounding acetate has thus shifted: it is now discussed as a problem needing to be fixed or damaged goods needing to be handled, rather than the solution to the problem and trusted material for keeping things safe from harm.

Beyond the film archive, the public discourse around acetate plastics also began to shift and characterize it as a danger and threat. In the late 1950s, at the same time acetate microfilm collections were beginning to corrode, children began dying at the hands of plastic bags. A rash of infant deaths were caused by accidental suffocation, either from unsupervised play with plastic bags or from ill-advised, hapless parents who intentionally shrouded their children's beds with repurposed plastic bags for waterproofing purposes.[123] By in 1959, cautionary news reports warned that "Transparent plastic bags can be dangerous — frequently fatal," and the first child suffocation warning labels were printed on plastic bags in hopes of alerting parents to their grave threat [Fig. 4.8].[124] Less than fifteen years earlier, these same raw plastic materials were saving

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[123] see "Council Group Urges Ban on Plastic Bags: Must Have Printed Warning if Used," *Chicago Tribune* [Chicago, IL] 18 June 1959: Part 1 - Page 8; "Dangerous to Children: Plastic Bag Warning Law Singed by Brown, in Effect," *Desert Sun* [Coachella, CA] XXXII.247 7 July 1959: 8; and Keller and Heckman, "Plastic Bag Warning Label Requirements," 4 December 2012. Accessed 22 June 2015 <https://www.plasticsindustry.org/files/industry/Plastic%20Bag%20Warning%20Label%20Requirements%202012-12-04%20pdf.pdf>.

[124] Ruth Moss, "Plastic Bags Can Be Dangerous Playthings." *Chicago Tribune* [Chicago, IL] 22 June 1959: Part 3 - Page 1.

children's lives and parents were praised for using them to protect their children in the form of gas mask or protective encasements.

Denise Waltrip, 3, of Wood Dale, has trouble finding her way out of the plastic bag and if she doesn't get help quickly there is danger she will suffocate.

[Fig. 4.8] Moss, Ruth. "Plastic Bags Can Be Dangerous Playthings." *Chicago Tribune* [Chicago, IL] 22 June 1959: Part 3-Page 1.

In yet another ironic and twisted case were technological innovation inevitably brought about more harm than promised good, the safe-keeper of children had now became their killer. Plastic bags remain figures of "death" within various twentieth century cultural contexts, as well. Environmental pundits have launched highly publicized campaigns against plastic bags as agents for pollution and ecological harm, as discussed earlier in the introduction to this chapter. Besides these larger environmental issues, plastic bags have also continued to function as intentional suffocation devises in the hands of suiciding adults. In both popular and official parlance, these plastic bags are refereed to "suicide" or "exit bags" [Fig. 4.9].[125] In a complete and compelling reversal of their historic purpose and use within gas masks in particular, "exit bags" are now used either alone or in combination with deadly gases to terminate life and allow one escape their future existence. In this application, plastic ceases to function as a facilitator of Futurity, and

[125] Robert Meuser, "Fireguard: Suicide Bags AKA "Exit Bags," *FDNY Center for Terrorism & Disaster Preparedness* (20 June 2012): 1-9. Accessed 22 June 2015 <http://www.scfirechiefs.com/Suicide_Bags.pdf>.

instead becomes fuel for a morbid death drive into suicide. A similar iconographic shift accompanies this discursive shift: images of children or adults shrouded in plastic coverings cease being a visual promise of survival, and become visual markers of danger and death. Rather than signaling salvation, their now serve as a warning, quite similar to the ways in which images and displays of acetate media and film strips have transitioned from the centralized savior figure, as seen in Fig. 1, to become poster children of decay and obsolescence when institutions promiscuously pimp images of Vinegar Syndrome afflicts reels in order to raise (digital) restoration and preservation funds.

Suicide Bags AKA "Exit Bags"

[Fig. 4.9] Meuser, Robert. "Fireguard: Suicide Bags AKA "Exit Bags," *FDNY Center for Terrorism & Disaster Preparedness* (20 June 2012): 4. Accessed 22 June 2015 <http://www.scfirechiefs.com/Suicide_Bags.pdf>.

Conclusion

As the 1950s ended, skepticism over the grandiose promises of plastics was steadily growing. At a time when the entire world seemed poised on the brink of self-destruction and total annihilation from atomic war, nothing was certain: the materials once marketed as safety products that would keep you safe were now showing signs of their own decay and impermanence, while incessant duck and cover drills instilled a sense that "we could never quite take for granted that the world we had ben born into was destined to endure."[126] While acetate plastics certainly did not endure nor resist destruction as intended, what has endured is their mark upon our understandings of preservation — what it is, who it is for, and how it is achieved. As this chapter has shown, microfilm, home imaging, and safety devices all responded to cultural currents of fear and distress with a rubric for preservation that equated survival with the creation of multiple copies, replacing originals with plastic duplicates, and calling upon the Government as well as domestic consumers to invest in children, futurity, and heritage as seminal pillars of civilization. In defining *what* should be preserved, a set of ideologies formed to further define *how* this should be accomplished. These patterns of preservation were set by acetate plastics, but did not end with them. Rather, they have continued to live on and are being repeated in supposedly "new and improved" methods and materials that still, nevertheless, reenact the same techniques with the same purpose: to ensure a lasting record of the past and present for future generations "with no end point (...) for your grandchildren's grandchildren's grandchildren and beyond — literally for hundreds of years." [127]

[126] Todd Gitlin, *The Sixties: Years of Hope, Days of Rage* (New York: Bantam, 1987): 23.

[127] Ken Weissman, "The Library of Congress Unlocks The Ultimate Archive System," *CreativeCOW.net* (2010) Accessed 4 July 2015 <https://library.creativecow.net/weissman_ken/library_of_congress/1>.

EPILOGUE

Coda

Music theorist, Charles Burkhart, described codas as performing a vital, sometimes necessary task. After the effortful and climatic main body of a musical score, where all the main ideas are presented and worked through, the coda provides a breather; it provides a moment of extended repose where one can reflect on all that came before, while finding a new sense of balance in an extra after-ending.[1] Figural speaking, codas also function as a set of "crosshairs," (⌖) which signal a navigational break and mark a changing of tone, theme, or focus. Rather than concluding acetate's story with the expected swan song of its decay and failure via the Vinegar Syndrome, this concluding passage will instead function as a coda: the crosshairs will refocus upon few final cases that reflect the contemporary trajectory and future of acetate plastics, while also reflecting back on the discourses and practices of preservation shaped by acetate throughout the twentieth century. In doing so, this coda section does not simply offer a recapitulative rumination, but will show how acetate continues to permeate the notions of preservation and decay, transcendence and obsolescence.

Case 1: Owen Land, Luther Price, and Letting Decay Have Its Day

In their July 1964 "Science Newsfront" section, *Popular Science* ran a rather alarmist feature about acetate microfilm.[2] In a breathless tone, column writer Wallace Cloud warned that microfilm records, some less than thirty years old and all printed on celluloid acetate safety film,

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[1] Charles Burkhart, "The Phrase Rhythm (and willful slurs) of Chopin's A-flat Mazurka, Op. 59, No. 2," *Engaging Music: Essays in Music Analysis*, Deborah Stein, ed .(New York, Oxford University Press: 2005):12.

[2] Wallace Cloud, "Science Newsfront" *Popular Science* (July 1964): 15-16;18.

were beginning to show strange symptoms of a disease. "Microfilm records all over the U.S. — in business, government, and libraries " he lamented, "are threatened by an unexplained outbreak of 'measles.'"[3] These spots and blemishes seemed to suggest that acetate was not nearly as durable as originally promised nor as stable as hoped. Archival institutions and even the Kodak company themselves began scurrying to find a cure for what Thomas A. Bourke, chief of New York Public Library's Microforms Division, went on to confirm was a "malady produced by a self-inflicted cure for the problem(s) caused by cellulose nitrate" and natural, organic materials.[4] Eventually this mysterious malady would become a named, infamous phenomena — the "Vinegar Syndrome" — which forever changed the discourse and understanding around acetate plastics. At the same time microfilm collections caught the measles, doll collectors also began to notice the symptoms of a deadly plastic-borne malady creeping across the visages of holdings. Indeed, just as microfilm and all acetate media products were falling victim to the Vinegar Syndrome, so too were acetate plastic dolls coming down with a case of "Pedigree Doll Disease" (and renamed "Hard Plastic Disease").[5] Once the image of girlie perfection, these infected dolls began to smell of vinegar, lose their colors, develop blisters and cracks, lose limbs and noses (in a perverse twist on the prosthetic appendages discussed in Chapter 1), and literally bleed or weep a putrified, acrid liquid. Needless to say, doll collectors reacted with the same horror and alarm as Bourke and those in the microfilm industry. However, in an important

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[3] *ibid*

[4] Thomas A. Bourke, "The Curse of Acetate; Or, a Base Conundrum Confronted," *Microfilm* Review 23.1 (Winter 1994): 15-17.

[5] see "Hard Plastic Disease (HPD)" *Vintage Doll Repair.* Accessed 4 July 2015 <http://vintagedollrepair.weebly.com/hard-plastic-disease-hpd.html>; "Sad Doll Disease Ends in Tears," *New Scientist* (4 May 1996) Accessed 4 July 2015 <https://www.newscientist.com/article/mg15020282.700-technology--sad-doll-disease-ends-in-tears/>; Geoff Strong, "Dying, Weeping, Oozing, Seeping Living Dolls," *The Sunday Age* (4 May 1996) Accessed 4 July 2015 <http://www.vinyldolls.com.au/news/1996/5/4/dying-weeping-oozing-seeping-living-dolls/>.

departure from media professionals whose solution was to replace microfilm with a newer format, doll collectors refused to abandon or simply dispose of their sick daughters. Rather, their response is one of conservation: to keep the doll in-tact and as-is, even if this means wrapping and storing her like a mummy prepared for indefinite entombment. The same acetate plastic, suffering from the same processes of decay, is nevertheless treated quite differently in media versus non-media contexts.

By the end of the twentieth century, acetate plastics were seen as frail, fallible, and vulnerable to the very things they were meant to defined against: the dreaded ravages of time, aging, death, and organic decay. Yet, in the midst of acetate's downfall and shifting discourse, an alternative perspective was also materializing within avant-garde film practice. Beginning in the 1960s, as has been copiously chronicled by film scholars P. Adam Sitney and Peter Gidal, American experimental filmmakers began to directly engage with the material and structural elements of film in a new genre of artistic practice termed Structural/Materialist filmmaking.[6] Well-known practitioners including Stan Brakhage, Paul Sharits, Hollis Frampton, and Owen Land attempted to reveal the essence of cinema through a return to its filmic materiality and the structural properties of the apparatus, often by destroying or ruining of these materials.

In *Bardo Follies* (1967), Owen Land utilizes acetate's destruction as an opportunity to reveal the hidden material life of the film strip and cinema itself. Land's experiment in decay began as an appropriated16mm home movie printed on acetate plastic film. The original film depicts a Southern beauty queen as she waves to a group of tourists on a pleasure boat ride. Land

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[6] see P. Adam Sitney, *Visionary Film: The American Avant-Garde* (New York: Oxford University Press, 1974), *Visionary Film: The American Avant-Garde.* 2nd ed. (New York: Oxford University Press, 1979), and *Visionary Film: The American Avant-Garde, 1943-2000*. 3rd ed. (New York: Oxford University Press, 2002); Peter Gidal, *Structural Film Anthology* (London: British Film Institute, 1976) and *Materialist Film* (New York: Routledge, 1989).

proceeds to repeatedly loop the film strip through a motion picture projector, subjecting it to intense light and relentless heat, until the individual film cells (to use Hannah Landecker's terminology, introduced in Chapter 2) begin to blister, melt, and decompose before our eyes in an acetate snuff show.[7] This elaborate process utilizes the projector apparatus as well as the methods of optical reprinting and re-photography — techniques that have been historically used to both create special visual effects as its original, primary tasks, as well as preserve analog film objects. Upon the introduction of acetate safety film replacements, optical printers were repurposed to transpose nitrate-based film content onto what was presumed to be a safer, more stable acetate film form. In the case of *Bardo Follies,* however, Land does not use this technology to save nor preserve his film specimen; instead, Land repurposes the optical printer, yet again, and brandishes it as a tool to trigger acetate's decomposition and visual effects of the Vinegar Syndrome.

Most basically described, optical printing works by mechanically linking a film projector to a recording camera. While a film plays through the projector, the linked camera records the projected image, thereby transferring it to another film strip. The projector, as discussed in Chapter 3, is in many ways a "life-giving" technology and apparatus of visuality: it brings film to life by animating the still photographic image. When the projector is attached to another camera and the two are placed into a synchronized, looped dance, it can also be used to create special visual effects. Before the use of digital software and other after-effects editing technology, optical printers were used to create special matting, double-exposures, and other "supernatural" type effects. Playing into the themes discussed in Chapter 1, when used in this fashion the optical

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[7] Hannah Landecker, "Cellular Features: Microcinematography and Film Theory." *Critical Inquiry* 31.4 (2005): 903-937.

printer can be seen as servicing the entrenched desire embedded with nearly all technological interventions: to transcend the physical world and limits of organic materials through artificial, mechanical, and literally super-natural manipulation. In Land's hands, however, the optical printer is not used to transcend the physical properties of the film strip, but rather to bring us back into a grounded interaction with the gritty, visceral nature of the film media. Land also perversely twists the projector into the barer of destruction rather salvation: the very methods used to save film are here, taken to the extreme, and used to destroy the image and the entire film body.

Using the optical printer, Land speaks to many of the contradictory themes wrapped up with preservation that have been grappled with throughout this dissertation: namely, that optics/ visuality can be death-ensuing acts; and that processes of "preservation" ultimately double as processes of destruction. This double-edged sword of visuality and visual preservation has been a recurring theme and resurfacing specter throughout several chapters. As we saw in Chapter 1, taxidermists attempted to create lasting visual representations of life that where simultaneously true-to-nature in their appearances, yet made of artificial materials that could mimic these appearances for longer than original biomatter. A double-standard emerged, then, where in order to create a better visual experience of life, life had to be killed, dismantled, and ultimately discarded so that it could be replaced with plastic stand-ins. Histological practice also ends up undermining and ending life in order to make it visible. As discussed in Chapter 2, histological images of cellular life are created by cross-sectioning, color staining, and using various lacquer solutions to affix cell cultures to slides for microscopic analysis. Historically, these images have been used to see and understand the foundational cellular elements of biologic life, and yet living cells have to be killed in order create these slides. In the pursuit of visuality, then, life is sacrificed. The same dynamic plays out on two levels in *Bardo Follies*. Firstly, the act of animating still images through a projector is revealed to be destructive act against the film strip. Each pass through the projector imparts nicks and cuts, scuffs and scratches to the strip, leaving it with a collection of battle scars referred to as “artifacts” that the film carries with it until it has been rendered non-playable or visible by the scars.

Secondly, Land can only make the material foundations and structural elements of film visible by first “killing” or destroying the film strip. By subjecting the strip to intensified heat and friction from repeatedly forcing it through the projector, Land triggers acetate’s decomposition and turns its materiality into a visible display. As the film degrades and the Vinegar Syndrome takes hold, the image is taken over by a kaleidoscopic parade of bubbling, popping, and disappearing cellular shapes that are visual analogs to pathological cell reproduction (cancer especially comes to mind in here, thanks in part to Land’s segmentation of the film into progressive “stages”) as well as programmed cell death (apoptosis). What is staged here, however, is also more than a death — it is a rebirth and re-visualization of the acetate film base that is found when the occluding surface image is stripped away from the film strip and the underlaying material structure is allowed to literally bubble up to the surface. Only acetate is susceptible to the Vinegar Syndrome, and its slow burning death spectacle of bubbles and bursts is unique unto this plastic formulation. In yet another iteration: visuality and death, visibility via destruction is made manifest through acetate plastics.

In this way, the projector acts like the microscope and Land like a histologist: by channeling the projector’s light, Land is able to bypass the occluding surface layer and reach the inside, unseen structural foundations of the film — its acetate plastic base. Land opens a vein to reveal the life-blood of cinema; he uses the projector to strip away the emulsion and occluding image content held at the surface layer of the film strip to reveal the underlying core, just as a histologist uses a microscope to peer inside to reveal the cellular foundations of organic life. Removing the image to see the substrate is a reversal of the previous scenario discussed in Chapter 3: where histologist and microcinematographers used a form of special acetate stripping fil to turn biological cross-sections into visible images. While on opposites of the spectrum, these processes as still connected through the materiality of acetate and using it to peel away an occluding surface to reveal another foundational base layer. Both the hidden cellular structure of biological life or the plastic substrate underlying motion picture film are brought to the visible foreground through acetate mediation.

In the case of materialist film, the base structure of the film stock is only made visible through the destruction of the filmic image. In traditional restoration and preservation practices, the image takes priority above all as the essential content, and the container film body is manipulated in ways that serve the image even at the expense of film form. In response to acetate film's confirmed decomposition via the Vinegar Syndrome, Kodak readily admitted that the "primary goal is to preserve the irreplaceable image content carried on the film," and not the actual film vessel itself.[8] Once again, desires for the image, representation, and visuality take precedence and all resources and technological interventions are allocated towards its preservation. Conversely, in *Bardo Follies* it is the material essence of the film strip that is privileged above the image suspended within the emulsion layer. Land offers an alternative with

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[8] Robert Breslawski, "Keeping the Legacy of Trust: How to Assure the Longevity of Earlier-Generation Microfilm Images." (Eastman Kodak Company, 2003):1-6.

Bardo Follies by repurposing preservation technology to not serve the image, but rather make the container/base material visible. Rather than remaining the invisible, transparent support structure or container that acetate plastic was "meant" to be, acetate's unique material becomes observable through its death.

Ironically though, Land still clings to some residual notion of preservation. He ends up recording the destruction of his film strip, creating a record that remains preserved at the Art Institute in Chicago, though on another length of 16mm acetate safety film. Departing from Land, twenty-first experimental filmmaker, Luther Price, abandons all claims to longevity and preservation in his similar acts of manipulating, mutilating, and destroying strips of film. Price partakes in what seems to be an emerging ethos for impermanence and embrace of materiality in the form of decay. While Price's oeuvre includes has a range of film practices, including appropriated home movies, and sliced together medical films with hardcore pornography, this section focuses on one particular strain of his work: his 2007 *Inkblot Film, Light Windows,* and *Light Fractures* series. In these materialist works, Price subjects lengths of 16mm and 35mm acetate found footage to chemical alternations and natural elements, including underground burial, to create "incredibly fucked with" unique film objects that cannot be easily projected nor reproduced.[9] Instead of being damaged *by* the projector, Price's films actually inflict damage *to* the projector, and instead have to be predominantly shown as a collection of still image advanced through a slide projector carousel. Price's filmic images are presented thus as stilled image specimen, as if in a histology slide show, to visualize the effects of acetate decay and materiality.

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[9] Andrew Lambert, "Luther Price." *Bomb: Artists in Conversation* (No120, Summer 2012) Accessed 1 April 2015 <http://bombmagazine.org/issues/120>

Decay is celebrated and put on display, here, rather than seen as a plight or disease infecting the film that needs to be cured.

Price's presentation format also evokes traditional art history lectures as well as travelogue slide shows meant to show off one's pilgrimage to distant lands and exotic locations. The similarities to a travelogue are especially poignant in light of the recent fetishization of ruined landscape images, colloquially refereed to as "ruin porn." There is no standing "definition" for ruin porn, in the same way that one only "knows" pornography "when then see it." However, there are common aesthetic themes found within most ruin porn images: decrepit, man-made locations, buildings, and feats of civilization that have fallen into ruin, disarray, and have been overtaken again by overgrown natural foliage or unchecked natural forces. What is desirable in these images, even if abjectly so, is too see, to confront, and to embrace rather ruin than turn away from it or try to correct decay as a sign of "failure." Price's images of acetate decay conjure the same experience; he does not try to intervene or overcome the effects of natural decay, and invites his viewers to partake in the sublime experience of coming face to face with material mortality. Price invites us to worship with him at the altar of corporeality in all its visceral messiness (a theme he continues in his other pornographic and medical film work), and goes one further than Land to completely eschew any attempts to preserve the image. Instead, Price allows and even encourages his images to age, crumble, and eventually pass away into oblivion.

Contemporary experimental filmmaker, Luis Recoder, has called manipulations like Price's and Land's "act[s] of avant-garde vandalism (...) [that] make us aware of the materiality of the medium" and bring us back the bedrock of cinema through its material destruction.[10] More just than revealing something essential about film, though, I further argue that Land's and Price's manipulations also reveal something essential about preservation: namely, that it is a process imbricated with destruction rather than neutrally opposed to it, and that it can actually cause loss and decay through the very methods intended to keep them at bay.

Instead of using duplication and reprinting to extend the lifespan of his film object, Land perversely repurposes these preservation techniques to induce its death and destruction. Taken to the extreme, the techniques typically employed to bring film to life and keep it alive — including motion picture projection and optical duplication — have turned this film strip into a bubbling, putrefying mess akin to other types of corporeal decomposition and death. As in both cancer and apoptosis (or, programmed cell death), there is a perversion of the processes meant to produce and continue life. Projection, reproduction, and duplication are simultaneously used to bring film to life by making cinema a mass-distributable moving image medium. And yet, projection also inflects scratches, burns, and other damage to the film object when it plays, and excessive reproduction and duplication, even when marshaled to save film content, also lead to the film object's demise. Contemporary practices in film preservation (or "restorations," as they are more commonly called today) use reproduction, duplication, optical reprinting, and manipulations manipulations of the film artifact in ways that end up destroying what makes film unique: signs of natural aging, material decomposition, and surface scars picked up from a lifetime of projection. Instead of valuing and protecting these features, as would be the case with antique furniture or even collectible acetate dolls, these artifacts of materiality are recast as visceral flaws

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[10] Luis Recoder, "The Death of Structural Film: Notes Towards A Filmless Cinema." *Spectator*. Special Graduate Conference Edition: "Deaths of Cinema" 27 (2007): 26-30.

needing to be cleaned-up and corrected in the name of image preservation, and advanced technologies, format improvement.

What is lost in this process of "saving film" is the opportunity for a different value system that sees organic decay, imperfections, and even material mortality as things that can make film individual, unique, and even graced with a certain auratic quality departing from Benjaminian associations with soulless, spotless mass-reproduction.[11] The opposite is presented in Land's *Bardo Follies* and Price's collection of "inkblot" and "fractured" films: in each of these cases, it is decay and mortality that are celebrated or that which needs to be preserved and recorded for posteriority. Rather than interrupting the process or trying to correct the visual symptoms, these Materialist filmmakers facilitates acetate's death and embraces the material of film in all its beautiful frailty and impermanence.

Case 2: Instagram, Hipstamatic, and Growing Nostalgic for Analog

Nearly all of the acetate-based media and visual imaging products discussed in this dissertation have been phased out or discontinued from commercial production. Acetate-based photography, taxidermy mounts, x-ray films, motion pictures, and audio recording formats were all forced into the margin of obsolescence by the emergence of newer plastics materials and, eventually, non-plastic formats. Polyester, in particular, emerged in the late 1950s (concomitant with the first signs of acetate's decay) as a new synthetic plastic base for film and videotape. Recycling the same rhetoric used to pitch the benefits of acetate, "new and improved" polyester formats were championed as being stronger, more stable, and a preferable replacement for

[11] Laura Marks also recognizes this *Touch: Sensuous Theory and Multisensory Media* (Minneapolis: Minnesota University Press, 2002). In her writing about analog formats, she notes that "Mechanically reproduced images supposedly lack aura, but as images decay they become unique again: an unhappy film is unhappy after its own fashion. The scratches and unintentional jump cuts on our print of X film are ours alone, and even video decays individually, in response to temperature, humidity, and the idiosyncrasies of playback machines" (94).

tarnished acetate plastics in post-production, exhibition, and archival applications. By the 1970s, polyester had usurped acetate within the amateur market — small gauge film formats like Super8, for example, were replaced by camcorders loaded with video. By the 1990s, polyester further replaced acetate as the standard film format for commercial motion picture prints. The sun would soon set, though, on polyester and all analog forms as newer digital formats began dislodging analog ones and the twenty century gave way to the twenty-first.[12] Even though acetate began its life as a replacement material for nitrate plastics, it too would pass into the shadow of outmoded obsolescence.

Planned or programmed obsolescence is a phenomena that affects all media technologies, including and especially new digital formats. The discourse surrounding acetate plastic technology in the early twentieth century, however, promised that technology was linked with dependable longevity and would provide lasting, long-term survival. This is, however, an impossible promise for ever changing and "evolving" technology to uphold. While technology is still seen as a teleological and progressive endeavor, twenty-first century discourse has also shifted to account for the fact that new technologies become outmoded almost almost soon as they are released. In an interesting reversal, this type of impermanent obsolescence is not feared or seen as a failure of the technology, as was the with acetate in the twentieth century; rather it has become expected and even desirable: technology is supposed to be continually and constantly improving, thereby creating old, lesser formats that are obsolete, unneeded, and needing to be replaced by the next upgraded version. The ethos driving technology is no longer calibrated towards the long-term, but rather the consumptive idea shared by profit-seeking

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[12] In 1998, *The Last Broadcast* became the first feature-length film to be shot, edited, and projected in an entirely digital format. See Marc Graser, "Cannes does digital," *Variety* (29 April 1999) Accessed 1 April 2015 <http://variety.com/1999/more/news/cannes-does-digital-1117499420/>.

producers and novelty-seeking users that frequent upgrades provide the newest, best products, and ofter desirable improvements.

Acetate many have been rendered obsolete by the end of the twentieth century, yet it has made a return from obsolescence in the past decade: it has reemerged from the dust and ashes to become a nostalgic relic and fetishized aesthetic within digital image production and social media circulation. In 2010, the same year that the last independent Kodachrome processing facility, Dwayne's Photo in Kansas, stopped their analog processing services, digital photo sharing applications including Instagram, Hipstamatic, and numerous others emerged within the digital imaging market to revive (and profit off of) analog formats. These applications, designed mostly for mobile smartphones, digitally re-appropriate and recreate the unique aesthetic features of analog media formats: from the vibrant vermilion hues and quirky square shape of Kodachrome photographs; to the dusky faded colors and telltale grain lines of Super8mm motion picture film. As noted on the iTunes page for two of the most recently released digital photo-editing and sharing application, 8mm Vintage Camera (released in 2011 by Nexvio Inc.) and Enlight (released by By Lightricks Ltd. in March 2015), users can apply these analog filters to their images to reproduce the style of classic cameras and vintage films and mimic their tactile, material hallmarks of dust, scratches, age discolorations, flickering, light leaks, and frame shakes. These incidental mistakes and previously perceived shortcomings of analog technology and acetate plastic film materials have now become reproduced as commodities and profitable marketing ploys.

Departing from the discourse and value system that has come to define contemporary preservation, restoration, and even image consumption practices, users are willingly choosing to "degrade" shiny new digital snapshots by applying lo-fi filters and grainy after-effects, which are then shared and circulated through social media platforms as vintage-y cool and chic rather than flawed images that need to be "cleaned-up" or "corrected" back to hi-fi standards. Image circulation and distribution, as discussed in Chapter 3, were foundational practices made possible by the introduction of acetate plastics, and become an important goal within the type of preservation practice it established. Ensuring transportability, multiple copies, and safe, non-flammable distribution were among the main promises and benefits of acetate safety stock and plastics. Acetate-based formats are, in essence and aesthetics, still driving the image circulation practices performed by Instagram-type users. Even after Kodachrome, Super8, and other acetate-based imaging products have been discontinued, it seems some lingering value can still be pillaged from their remains and used to distribute images to a mass viewing and consumer audience.

In her chapter on dying media and "loving a disappearing image," Laura Marks describes how one comes to love the aesthetics of oldness as a way to enact "something like a perpetual mourning, something like melancholia in its refusal to have done with death."[13] While Marks is referring to the aesthetics of faded film and using its visual decay to speak to the corporeal ravages of aging and disease (especially AIDS), the same ethos also applies to the resurrected love now lavished on "old," "dead" media objects including outmoded analog film (which in the case of acetate has also suffered a form of physical, self-destructive "disease" in the form of the Vinegar Syndrome). However, even more than mourning or melancholia, what seems to have taken hold over this generation of hipster Hipstamatic users is what Arjun Appadurai referred to

[13] Laura U. Marks, *Touch: Sensuous Theory and Multisensory Media* (Minneapolis: University of Minnesota Press, 2002), 168.

"imagined nostalgia."[14] Their celebration of archaic media forms like Polaroids or 16mm film does not stem from their own sense of loss or retrieval; rather they are appropriating these forms or, in some cases, merely their appearance and gloss of age, to authenticate their vintage aesthetics, status, and tastes. They miss things they never had and thus never lost, yet nevertheless take them up as a dislodged totem that looks old and thus feels more "real" than their current digital age.

The aesthetics associated with decrepit acetate products — color fading, age spots, scratches, cracks, and crackles — offer a new appeal, antique value, and patina index that departs from the sanitized, clean and pristine world of new digital formats and technologies. The previous flaws of the acetate, especially its fading colors, were decreed as serious problems that preservationists needed to fix. The July 9, 1980 front-page of *Variety*, for example, proclaimed that "Old Pix Don't Die, They Fade Away," which used acetate's color fading as fuel for campaigns (lead in part by Martin Scorsese) to save acetate-based commercial film prints and archive collections from the Vinegar Syndrome. This panic call, however, has mutated within popular visual culture, and these same faded decay marks, or "artifacts" as they are also called, have been re-taken up as signs of an authentic, fetishized "past-tense-ness" and analog "realness" (or valorize ephemerality and "aura of periodization," to use Appadurai's terms) that is returned to in a digital, post-film era.[15] Instead of lamenting faded images as a sign of pictorial death, new digital methods of image creation and circulation seem to proclaim that new pics

[14] Arjun Appadurai, "Consumption, Duration and History," *Stanford Literary Review* 10 (1-2, Spring-Fall 1993): 11-23.

[15] *ibid.*

come alive when you add a faded filter.[16] As Marks aptly phrased it: "[f]aded films, decaying videotapes, projected videos (...) flaunt their tenuous connection to the reality they index"[17] In archaeological, geological, and even art historical discourse, this is precisely the function of an artifact: to reveal something about the past and the past civilization that made it. Artifacts, in this sense, are not mistaken byproducts (though this is also their definition within scientific imaging production), but rather important markers that should be preserved.

A return and revaluing of these aesthetics, Marks claims, can be read as revealing a larger, significant cultural shift. This shift, I claim, is into a "post-preservation" ethos characterized by not about being afraid of or recoiling from "death," but rather acknowledging it and temporal aging/pastness as a new sight/site of value. The turn towards plastics and acetate mediations within the twenty century was marked by the opposite: by a fear of impermanence, death, aging, and loss. Plastic materials promised to fight against these elements and provide a relieving escape route during a period marked by fears of global war, human extinction, and a distrust of the natural world's ability to survive. When acetate plastics failed to make good on these promises, they fell out of favor and their consumers fell "out of love." As we continue into the twenty-first century, however, it seems that a new generation of consumers look back to these passed forms not as failures because they proved to be materially "flawed" and ephemeral, but rather are now valuable for these very reasons. Signs of decay, aging, and material frailty have become unique hallmarks, as in antique furniture; and their ephemeral disappearance has rendered them rare and valuable within a system of obsolescence fetishism. Paolo Cherchi Usai

[16] Interestingly, the latest reactionary turn in digital image sharing has been to adopt a "no filter" policy, literally self-proclaimed with the inclusion of "#nofilter" to images, to make it clear that the images have not been manipulated with the addition of any after-effect filters or lenses to change the colors or appearance of the snapshot.

[17] Marks*,* 168.

theorized that the temporal nature of cinema and even the loss of film was, in fact, not a problem but a necessity: that a history and appreciation of cinema is only possible once it has disappeared or been lost.[18] As photography and cinema cease to be "film" or film-based imaging media practices, analog media objects and their associated aesthetics become endangered, disappearing entities, similar to the endangered animal species identified as instigating the taxidermic plastic preservation/imaging practices of Chapter 1.

Now that analog media formats have largely disappeared due to natural aging and decay as well as forced obsolescence, it can now be nostalgically returned to and revalued as a historic treasure; it can now be rediscovered and "found" since it has been "lost." On one level, this describes the resurgence of analog media aesthetics and the nostalgic return to pre-digital imaging formats. The actual forms and formats have disappeared from commercial production and sale, but their visual aesthetics have been resurrected as detachable "skins" that, like the plastic taxidermy skins discussed in Chapter 1, can be applied to and draped over new objects or content. And yet, while this practice offers the promise of reviving historic imaging media and bringing increased awareness to them, as Usai theorized, detaching the visual qualities from these formats and re-appropriating them within digital platforms seems to simply reenact taxidermic effigy making, giving way to a disregard for the actual original forms and a type of ahistorical aestheticism that erases the actual names of the analog source material. A filter channeling the aesthetics and qualities of Kodachrome, for example, becomes as an Instagram filter renamed "Lo-Fi." The omission of the "Kodachrome" monicker is most likely due to copyright issues and trademark licensing, and is certainly not done maliciously. Whatever the

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[18] Paolo Cherchi Usai, *The Death of Cinema: History, Cultural Memory, and the Digital Dark Age* (2001; reprint, Houndmills: Palgrave Macmillan, 2008).

intention, though, the effect remains the same: even if the appearance of Kodachrome seems to have come back from the margins of forgotten obsolescence, the name and Kodachrome itself has ultimately disappeared.

Passing digitally captured images through old, analog image filters provides a twist on acetate's historic use as a mediated covering, and a literal replacement skin used within taxidermic "image" creation. As discussed in Chapter 1, taxidermic preservationists and model-makers used acetate plastic coverings to improve the appearance of their mounts and to satisfy the aesthetic requirements of the early twentieth century — vibrant, lively, enduring colors that translated into a sense of lasting vitality, even in the face of death. The aesthetic tastes today may have changed to now revalue the look of oldness and pastness, but the process used to create this visual impression has remained similar and still utilizes the latest in high-technological mediation to achieve these desired visual effects. In both historic taxidermy and contemporary digital photo sharing, what is privileged and prioritized is the form, the aesthetic trappings, and the external skin even more than content (the actually animal body or the newly created photographic image). Departing from archival practices, it is the form and rather than the content that occupies the center of attention and analog media formats, especially those that were based in acetate plastics, have become re-valued skins that dress up new photos and make them worthy of publicly distributing and being put on display.

Case 3: Snapchat, Bioplastics, and an Emerging Post-Preservation Ethos

One final case that sheds a new light on the current state of preservation discourse, and that continues to reflect back to the formative tenants of acetate plastics, is the emergence of what I forecast will become a "post-preservation" ethos. In many ways, permanence and preservation — the two qualities so highly valued and sought after in twentieth century American consumer, visual, and popular culture — have faded from advertisement discourse as “selling points,” and have instead become problematic liabilities that are positioned as causing more harm than good. The history of acetate reveals how the ways in which we talked about and consumed technologies have changed. As the advertisement history of acetate media reveals, the discourse used to be quite different: durability used to be one of acetate’s biggest selling points, whereas today the marketing discourse surrounding technologies is skewed towards newness, improved upgrades -- all arms of planned obsolescence which come hand-in-hand with writing technological impermanence as the selling-point instead of the problem. In many ways, longevity stands in the way of consumption: if things lasted forever, there would be less need to continue purchasing new items or consuming new replacements. This is the crux logic behind industry practices of planned obsolescence as well Appadurai’s reading of modern consumerism. In order to be profitable, consumption needs to be a repetitive act and reproduced behavior; ephemerality drives repeat consumption whereas permanence, durability, and longevity stands in the way of constant, continual consumption habits. With this, we have plunged headlong into an age where the ephemerality of materials is not feared, but expected, and even embraced within consumer culture.[19]

Within the realm of media technologies, industry trends and consumer desires do indeed appear to be swinging towards impermanence and short-lifespans as desirable features. The case of Snapchat also provides a compelling media example. Brought to market in 2011 as a photo messaging application for Apple and Google smart phones, Snapchat enables users to can take

[19] This does, however, also lead to an excess of technological waste in the form of old, cast-off products which become their own bemoaned source of environmental pollution.

digital photos, record videos, edit, and send them as "Snaps" to a privately curated group of recipients. Setting these "Snaps" apart from other socially distributed image-based content, however, is their built-in lifespan: senders can predestine their images to self-destruct and delete themselves from the recipient's devise as well as (allegedly) Snapchat's corporate servers after 1-10 seconds. While Snapchat provides the disclaimer that they cannot prevent recipients from capturing and saving these images by taking screenshots, this only leads to produce a further irony: once again, re-photography is used as a tool/weapon to subvert the ephemerality of the image and fight against its disappearance.

In her 1954 article for *Woman's Home Companion,* mentioned in Chapter 4, Virgina Ryland attempted to encapsulate the sentiments and impetus behind twentieth century home imaging making: "We make movies [or photographs]" she claimed, "for remembering." Imaging was not a hobby or fun past-time, but rather a necessity and purposeful active of preservation. In contrast to Ryland, the popularity of Snapchat seems to suggest twenty-first century users make movies and photographs to be quickly forgotten. Actual users, writing to review the application on iTunes, emphasize the importance of instantaneity, immediacy, and even anonymity — all features offered by Snapchat, whose very company logo is a faceless ephemeral ghost.[20] Whether short attention spans or rabid media consumption habits are the culprit, it seems that Snapchat is indicative of an emergent trend for images to self-destruct and fade into forgotten oblivion within seconds after their birth instead of lasting forever or creating memories that can withstand time and outlive their subjects. In the case of acetate media products, this same self-destructive nature (brought about naturally by the auto-catalytic aging process turned into a named malady with

[20] see Franziska Roesner, Brian T Gill, and Tadayoshi Kohno, "Sex, Lies, or Kittens? Investigating the Use of Snapchat's Self-Destructing Messages," *Financial Cryptography and Data Security Conference*, 2014.

The Vinegar Syndrome), are not seen as a beneficial or desirable features in a post-preservation age, but rather as detestable liabilities that stand in the way of lauded preservation.

As mentioned earlier, this embrace of ephemerality also undergirds the emergence of ruin porn and the desires for sights that are not permanent, impeccable buildings, but rather a messy display of frailty and failure of previous technological feats of civilization. In the twentieth century, such visions of civilization obliterations — as described in Dr. Thornwell Jacobs' apocalyptic description of a rubble covered, post-war future in Chapter 4 — were the stuff of nightmares and a cultural desire for lasting preservation that materialized in acetate fortified bomb shelters, time-capsules, and other media archives.[21] Now, this same scene would be reposted on one's Tumblr as an exemplar of "ruin porn" and the alternative beauty found in decomposing remnants of humanity and failed human intervention overtaken by the return of repressed nature.

"Forever" and "long-lasting" were some of the positive features once praised and valued in plastics during the twentieth century. Plastics promised to outlive and outlast natural materials; yet, once acetate (and other plastic formulations) proved to not be as durable nor invincible as promised, public opinion turned and plastics were demonized for being flimsy, cheap, and disposable towards the end of the twentieth century. Ironically, this entire discourse has again shifted in the twenty-first century: now, plastics are bemoaned for lasting too long and not decomposing quickly enough or in the proper, biodegradable manner. As discussed in the introduction, plastic bags have become pariahs banned in various California counties, and plastic

[21] Thornwell Jacobs, "Today—Tomorrow: Archeology in A.D. 8113." *Scientific American* (November 1936).

debris in the form of discarded bottles and other consumable castoffs have coalesced into five floating plastic "garbage patches" polluting nearly every ocean.

To counteract the environmental threat posed by non-degradable plastics (referred to as "durable" plastics, thought not in a positive sense), researchers have turned their sights to the creation of "green" "bioplastics" that are either derived from repurposed recycled materials or organic materials, including microorganisms.[22] Human intervention in the form of bioengineering is now marshaled to right the wrongs of previous tinkerings: manmade plastics were designed to be artificial solutions that could supersede the shortcomings of the natural world, yet they are now being re-tweaked by infusing organic elements back into them so that they no longer pose a threat to the natural environment. Ironically however, part of this recuperative —"re-naturalization" of plastics and movement towards green and biodegradable forms uses genetically modified biomatter. It seems that the belief in human intervention, scientific manipulation, artificial modification as the best, saving solution to our (self-created) problems still remains intact.

Finale

In 2002, film actor, producer, director, and archivist Lord Richard Attenborough described preservation as a "race against time, archeological rescue, [and] the tragedy of loss."[23] These same sentiments also characterized the deployment of celluloid acetate preservation measures in the century before: chemists raced against time and rushed to create new synthetic materials that could resist decay and aging; cultural archivists became obsessed with constructing

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[22] see, for example, E.S. Stevens, *Green Plastics: An Introduction to the New Science of Biodegradable Plastics* (New Brunswick: Princeton University Press, 2001).

[23] qtd. in Frick, *Saving Cinema: The Politics of Preservation*, 9.

time capsules and indestructible acetate storehouse; and governmental official urged parents to take every safety measure at home to protect their children from loss. In each of these ways, acetate plastics become synonymous with outwitting nature, becoming free from the effects of time, finding protection, and aspiring towards future survival. In all of its various applications, acetate promised a form of "future-proofing" obtainable through duplication, replacement, artificiality, and access. In a larger sense, acetate also promised safety-proofing, fire-proofing, and essentially "nature-proofing" by putting mankind in control of the environment. These discourses gave rise to a type of "preservation" that sought to improve upon the natural world in order to make it last — a discourse formed by and in acetate plastics.

By turning a critical eye towards "preservation" as a historically, culturally constructed concept and by looking outside of the typical forums for preservation discussions — outside of the film archive, the museum conservation department, or the architectural restoration committee —this dissertation has revealed how a pervasive cultural fever for preservation came to a head during the twentieth century. Feeding this fever were acetate plastics which, in moments of crisis, were turned to as pillars of safety and longevity. As a result, it's material features become equated with preservation. As an important and trustworthy mode of preservation, acetate interventions set the tone for how preservations would continue to practiced out into the twenty-first century. Even though we are not using acetate as our preservation medium of choice today and is no longer associated with safety and longevity, it has nonetheless informed how preservation is thought of and carried out today. The tactics used in contemporary restoration efforts, for example, have remarkably remained the same: there is still an emphasis on using the newest and latest technologies to improve whatever came before, and an emphasis on reproduction, access, artificiality, and heritage. These ideologies and tenants all grew out of acetate, and have continued to live on even after its material demise. Acetate may be dead, but long lives its mark upon preservation.

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