ANIMATION CEL STORAGE AND PRESERVATION:
CARING FOR A UNIQUE AMERICAN ART FORM

by

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EXECUTIVE SUMMARY

Animation cels have been favorite collectors items since the Walt Disney Studios made the first cels available for sale in 1939. Animation cels inspire because they are a tangible piece of childhood for many, bringing back memories of being enchanted by animated films like Snow White and the Seven Dwarfs, Bambi and Pinocchio. In addition to serving as important touchstones of childhood, animated movies represent a significant American art form.

But what exactly is an animation cel? A cel is the shortened term for “celluloid” the first semi-synthetic plastic created in 1862 as a cheap substitute for tortoise shell and ivory. An animation cel commonly refers to a sheet of thin, clear plastic onto which characters were painted on during the animation process. There are two types of animation cels: cellulose nitrate, made before 1940, and cellulose acetate, a more stable material made after 1940 to replace cellulose nitrate.

The animation cel’s first induction into a museum was in 1939, when the Metropolitan Museum of Art in New York purchased a cel from Snow White and the Seven Dwarfs. The cel, with an image of two vultures perched on a limb, was composed of “cut-up celluloid drawings, mounted
on a background, and wrapped in cellophane.”¹ Now, museums all across America, from the Metropolitan Museum of Art in New York to the Oakland Museum of California have animation cels in their collection.

In addition to museums, private collecting of animation cels has grown considerably. By the late 1980s, animation cels were selling for as much as $286,000. Alongside their status as motion picture memorabilia, a significant contributor to the value of animation cels lies in their rarity. Many of the original cels were washed off or destroyed and fewer animation cels are being made today. Additionally, animation cels are readily susceptible to degradation. Environmental and physical factors affect their rate of deterioration. Ultraviolet lights can cause discoloration, excessive heat can cause warping and buckling, and moisture can cause paints to peel off and stick to other objects. Improper handling of a cel also contributes to the acceleration of the degradation process.

The biggest obstacle to preserving animation cels is a lack of information. Very few conservators are trained to work with animation cels, and there is scant literature on animation cel conservation. Moreover, conservators are often hesitant to discuss animation cel preservation in an effort to protect their own proprietary techniques.

Further complicating the task, the paint formula used on most animation
cels was a closely guarded trade secret for each studio. This poses a
problem for painting conservators because they depend on paint
identification as a starting point for their work. Other impediments
include the lack of familiarity with animation cels and the many
ambiguities regarding animation cels. Highlighting the dearth of
information, the several glossaries exist that discuss animation cels lack
consistency. Animation cels are sometimes classified as paper and at
other times as paintings. From my research, however, it is clear that they
are mixed media and should be treated as such.

This master’s project argues that it is important for collections
managers and registrars to recognize that steps can be taken to delay
degradation of animation cels. Providing a proper storage environment
with controlled relative humidity (RH) and light levels can minimize
environmental factors that accelerate the degradation process. In addition,
the use of zeolite molecular traps is effective in slowing down the
degradation process. MicroChamber® products, which use zeolite
molecular trap technology, block pollution gases from the animation cel
and neutralize acids generated within and outside the cel.

It is clear that more literature regarding animation cels is needed,
thus the impetus for the report that follows. This master’s project, in
conjunction with an article “Animation Cel Storage and Preservation,” submitted to *Registrars’ Quarterly*, will provide another valuable source of information on animation cel preservation and will contribute to the ongoing dialogue on the subject.
Glossary of Terms

To present the topic of animation cels, it is important to set forth a standard set of terminology that will be used in this paper. The following glossary applies to cel terminology as well as explanations of several products used for animation cel storage:

**Animation** – The process of creating motion by photographing successive drawings or objects simulating motion by slight progressive changes. In cel animation, characters are drawn on paper (also known as animation sheets) then traced and painted onto cels. The painted cels are then placed over a background painting and photographed one frame at a time. When the finished film is projected, at a rate of 24 frames per second, the illusion of motion appears on screen.

**Animation cel** – See Cel.

**ArtCare®** – A product name for a matboard and matboard housing system incorporating MicroChamber® Technology with molecular traps added to the fibers.

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Background of Background Painting – Scenes usually painted on illustration board or a heavy cardstock for an animated film. Cels were placed on top of background paintings and photographed.5

Cel – Shortened term for “Celluloid.” Commonly refers to a painted sheet of thin, clear plastic on which characters were painted during the animation process. The painted cel was placed over a background and photographed, becoming one frame of the animated film. Animated films have 24 frames per second of film. Cels prior to the 1940 were made of Cellulose nitrate (See Cellulose nitrate) and cels after 1940 were made of cellulose acetate. (See Cellulose Acetate).

Celluloid – Name for the first plastic synthetic material developed in 1867.6 (See Cel and Cellulose Nitrate).

Cel Set-up (Also called Key-Set Up) – A combination of a cel or several cels placed over a painted background that constitute a scene in one frame of film. The cels may include special effects and not just painted characters.

Cellulose Acetate – The acetate ester of cellulose created in 1865. Cellulose Acetate is used as a film base in photography and as a component in some adhesives; it is also used as a synthetic fiber.

Cellulose Nitrate – An ester mixture of sulphuric and nitric acids. First developed in the 1840s, the product was used as an explosive (guncotton). A less nitrated product, known as Celluloid, formed the basis for moldable plastic materials used as artificial ivory for knife handles, piano keys, etc.7

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5 Tim Campbell and Diane Pullano, “Un Roll ‘Em! Preserving animation art at Disney’s Animation Research Library,” Registrars’ Quarterly, (Fall 1999) 3.
Key Set-up – See Cel Set-up

Matching Set-up – See Cel Set-up

MicroChamber® – A name for a technology as well as a trade name for a product. MicroChamber® products remove acids and also neutralize and remove oxidative gases like nitrogen dioxide, sulfur dioxide, ozone, and peroxides.8

Molecular Traps – A general descriptive term for specific chemical entities such as zeolites and activated carbon that provide the function of filtration and/or separation of chemical mixtures.9

Zeolite – A naturally occurring aluminosilicate mineral that filters contaminants/pollutants. Naturally occurring mineral zeolites were first identified by Cronstedt, a Swedish mineralogist in 1756. In 1862 Deville produced a synthetic zeolite (levynite) from a mixture of potassium silicate mixed with sodium aluminate heated in a closed test tube. Studies on natural zeolites in 1925 established their molecular sieve attributes. In 1949, Union Carbide began the synthetic production of zeolites.10

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9 Ibid.
10 Ibid.
Statement of Purpose

The purpose of my master’s project is to inform collections managers and registrars on best practices and methods of animation cel storage and preservation. In addition, I hope to start a dialogue about the dying art form of animation cels and the need to properly store them to prolong their existence.

The result of my project is an article submitted to Registrars’ Quarterly on best practices on animation cel storage and preservation. It is hoped that this will help collections managers and registrars to deal with their animation cels and lead to further discussions among museum professionals and future published work on the subject.

The animated film is one of America’s few original art forms, yet there is no standard for animation cel storage and preservation in museums. Preservation of this art form has become more urgent as computers take over the field of animation and traditional cels are no longer created for filmmaking. Thus, the cels have great historical value and are increasingly rare in number. Furthermore, the fragile nature of the medium makes cels difficult to store. Cel preservation is vital to keeping the history of animation film alive and accessible for future generations.
Goals and Objectives

The following goals and objectives guided my research into animation.

Goals:

1. To research the history of the animation cel and its importance as an American art form.
2. Find and assess current practices for animation cel storage and preservation in museums, archives and libraries.
3. Analyze published material or conferences that have taken place on animation cel storage and preservation.
4. Develop written guidelines on animation cel storage and preservation.

Objectives:

1. Conduct a literature review on the history and cultural importance of the animation cel.
2. Interview conservators, collections managers and archivists on their current methods of animation cel storage and preservation.
3. Survey relevant institutions to find out the prevalence of animation cel collections and how they are stored.
4. Compare and analyze different methods and theories on cel storage and preservation and determine best standards and practices.
5. Compile the best methods for animation cel storage and preservation and write an article to disseminate that information.
Methodology

In order to research the history of animation art and assess current practices for animation cel storage and preservation, a variety of methodologies were employed. These included the review of existing literature, a survey of 95 institutions and three site visits to the Walt Disney Company, Animation Research Library, the Charles M. Schulz Museum and Research Center, and the Walt Disney Family Foundation. In addition, 17 professional interviews were conducted with conservators, collections managers, registrars and archivists.

Literature Review

My research began with a review of relevant books, journal articles, and periodicals. The literature provided the history and background on animation art in America. There were a number of books regarding the history of animation; however, there was not extensive information pertaining specifically to animation cels. Due to the limited sources on animation cels, I also explored thesis projects, scientific reviews, and other literature dealing with plastic objects made of cellulose nitrate and cellulose acetate.
Due to the limited literature available on the topic of animation cels in museums, my primary source of current practices and information on animation cels were conducted through interviews. I conducted 17 interviews with collections managers, registrars, conservators, the owner of a commercial animation conservation studio and the inventor of MicroChamber® Products. (For a list of interviewees, see Appendix A). Most of my interviews were conducted with collections managers and registrars since they are the handlers and storage-keepers of animation cels for museums and archives. Conservators helped to described the problems with animation cels and contributed resources and methods for storing and preserving animation cels.

I also interviewed Juliann Stark, co-owner of S/R Laboratories in Westlake Village, California-- one of the most written-about animation conservation studios in America. As the majority of magazine articles I found relating to animation cels use S/R laboratories as a source, it was necessary to get its perspective.

An additional interview with William K. Hollinger helped me to better understand MicroChamber® Products. Mr. Hollinger is the inventor of MicroChamber® Products as well as the President of Conservation Resources International.
Survey

To gain a general overview of the number of animation cels in museum collections, I sent a survey to 95 institutions. (See Appendix B for a list of museums). I randomly selected 95 institutions across the United States, with a preference for museums I hypothesized might have animation cels in their collections, such as contemporary art museums and film museums. Historic houses and type-specific museums, such as ship or aviation museums were not included in my survey. Surveys were mailed in March 2006. Each survey was addressed to specific registrars or collections managers if they were available. All other surveys were addressed to “Registrar.” Each survey was mailed with a survey card typed on one side of a self-addressed stamped postcard, and a letter of introduction. The five questions on each survey card intended to get a sense of how many institutions had animation cels in their collections and to identify any trends in storage practices and conditions of animation cels. The Walt Disney Studios, Animation Research Library was not included in my list of surveys because it is not technically a museum. Of the 95 surveys conducted, 70 institutions responded, for a responsive rate of roughly 74 percent. Three blank surveys were returned.

Surveys included a response card to find out 1) if an institution has animation cels, 2) how many animation cels are in their collection, 3) how
they are stored, 4) how old each cel was, and 5) what damages they saw in their animation cels, such as buckling, yellowing, or paint flaking. This information was helpful in gaining a perspective of how many institutions have animation cels in their collections. (See Appendix C and Appendix D for my survey instruments).

*Site Visit*

Lastly, between Winter 2005 and Spring 2006 I conducted three site visits so I could see animation cels in their storage environment first-hand. The first site visit was to the Walt Disney Studios, Animation Research Library in Glendale, California on December 27, 2005. The Disney Animation Research Library boasts the largest collection of animation cels in the world. With the largest collection in the world, it was essential to find out what methods they have been using to care for and store their animation cels. The second site visit was conducted on February 10, 2006, at the Charles M. Schulz Museum and Research Center in Santa Rosa, California. Finally, I visited the Walt Disney Family Foundation in San Francisco, California on April 12, 2006.
Limitations of Methodology

My research on animation cels in the United State was limited by many factors. Among the first limitations of my topic is its narrow scope. My research is limited to animation cels and does not include full-length feature films or background paintings used with animation cels. Although background paintings are integral to the animation process, the primary medium is paper, which has distinct preservation needs from the cellulose nitrate and cellulose acetate used for animation cels. My findings on animation cels, however, may apply to other plastic objects in museum collections. Secondly, my research is limited to American animated feature films and excludes international animation productions as well as cartoons made for television. Third, I limited my research to institutions and did not speak with private collectors. The information I gather is very useful to collectors, but surveying them was outside the scope of this project. There are also numerous personal websites dedicated to the art of collecting animation cels; however, there was no way to ascertain if these websites provided accurate information, so I excluded them from this study.

My research was limited to animation cels. There is much literature regarding film and the animation process, which was useful in my research, however, there are few articles or books with details
specifically on animation cels, and some information is proprietary. I did not deal with treatment, restoration and conservation, but rather focused on storage and preservation. The exact paint formulas used on animation cels are proprietary, to this day, and some private conservators who treat animation cels were reluctant to discuss how cels were treated.

Others constraints that limited my research were time, geography and economic resources. Because of the short time period in which I had to complete my project, I was not able to conduct more interviews. I was also unable to send out more surveys to get a broader sense of exactly how many museums have animation cels in their collections.
LITERATURE REVIEW

What is an Animation Cel?

An animation cel is broadly defined as a thin clear plastic sheet with painted elements used in the animation process. Typical animation cels are .005 millimeters thick and are 10 inches x 12 inches and sometimes as large as 12 inches x 16 inches. There are peg holes, usually on the bottom of the cel, so it could be attached to a pegboard to keep the cels in place and aligned. Animation cels can be categorized by the base material of the clear plastic sheet: those made of cellulose nitrate and those made of cellulose acetate. A final key element of the animation cel is the paint used to portray the moving image.

The two different materials used to make animation cels are rooted in the materials used for photography and motion pictures. Prior to 1940, animation cels were most often made of cellulose nitrate, an ester mixture of sulphuric and nitric acids used to create motion picture prints.¹¹ Both Eastman Kodak and Ansco produced cellulose nitrate film consisting of a polymer blend made up of 12 percent nitrogen and 20 percent plasticizer.¹² The plasticizer is an important component of animation cels, keeping them

soft and pliable. Unfortunately, cellulose nitrate is unstable. In its
deteriorating condition, it can be highly flammable and pose serious health
and safety hazards. The fires caused by improper storage of cellulose
nitrate films prompted the advent of cellulose acetate. Cellulose acetate is
the acetate ester of cellulose. In contrast to cellulose nitrate, cellulose
acetate is more stable and, even in its deteriorated state, is not
flammable.\footnote{Monique C. Fischer and Andrew Robb, “Guidelines for Care and
Identification of Film-Based Photographic Materials,” Art Conservation Program,
University of Delaware/Winterthur Museum, 1993.}

The next major component of an animation cel is the paint layer.
Although paint formulas are still a trade secret, some educated guesses can
be made as to what kind of paint was used on animation cels. It is guessed
that water-based paints were used on animation cels as they are water-
soluble. Paint needed to stick on the smooth surface of the cel, dry fast
and wash off. General adhesive properties suggest a water-based binding
agent was used on the cel such as gum-arabic. A plasticizer such as
glucose was added for smoothness and flexibility in the paint. Lastly,
glycerin was added to make brushing on color easier and reduce any
excessive caking or drying of the paint. Other additions that were likely
used include a wetting agent to prevent beading and a preservative to prevent mold growth and improve the odor of the paints.\textsuperscript{14}

However, the material make-up cannot simply define the animation cel. The research that is presented briefly explains the material make-up of the cel, which will aid in deciding proper storage. But there is so much more to the story of the animation cel.

\textbf{A Brief History of Animation}

The illusion of motion has always been intriguing to people. Thus, its practical manifestation-- animation-- cannot be described in one sentence. Animation is defined by Martin Krause and Linda Witkowski in their book \textit{Walt Disney’s Snow White and the Seven Dwarfs: An Art in the Making Featuring the Collection of Stephen H. Ison} as:

\begin{quote}
The process of creating motion from frame-by-frame techniques in filmmaking. In cel animation, the characters are first drawn on paper and then traced and painted onto cels. The painted cels are then placed over a background and photographed one frame at a time. When the completed film is projected at a rate of twenty-four frames per second, the illusion of motion is created.\textsuperscript{15}
\end{quote}


\textsuperscript{15} Ibid., 185.
Perhaps the first examples of trying to visually capture motion come from cave paintings where the illusion of motion was created with a progression of sequential drawings.\textsuperscript{16} The discovery of “persistence of vision” in the 1800s led to inventions that made pictures truly become active.\textsuperscript{17} One such device was the Zoetrope, or “life-wheel,” invented in 1834 by W.G. Horner. The Zoetrope was a drum-shaped cylinder with slits on the side that spun on an axis. A strip of sketches was placed inside, and when the wheel spun, the images appeared to be moving in repeated cycles. Another invention similar to the Zoetrope was the Praxinoscope, or “action-look.” The Praxinoscope was invented in 1877 by a Belgian professor named Emile Reynaud. Reynaud went on to create the Optical Theatre, which was a bigger version of the Praxinoscope, so moving images could be viewed by a large audience.\textsuperscript{18} The Optical Theatre was a complex and fragile instrument that had to be turned manually by a skilled operator. In spite of his creative ideas, Reynaud was not ahead of his time; his inventions were not practical and were quickly overtaken by new advances.

\textsuperscript{17} Ibid., 2.
\textsuperscript{18} Giannalberto Bendazzi, \textit{Cartoons: One Hundred Years of Cinema Animation} (Bloomington: Indiana University Press, 1994), 5.
Thomas Edison’s motion picture projector and the Lumiere brothers’ Cinematograph changed animation forever. With the appearance of these two devices, animation would involve photography.\textsuperscript{19} Louis and Auguste Lumiere projected their first film in front of a paying audience on December 28, 1895 in France. This date is regarded as the official invention of cinema.\textsuperscript{20} Eleven years later, the first animated motion picture was created in America. Stefan Kanfer, author of the book \textit{Serious Business: The Art and Commerce of Animation in America from Betty Boop to Toy Story} credits James Stuart Blackton, a vaudeville chalk artist, with producing America’s first truly animated motion picture, \textit{Humorous Phases of a Funny Face}, in 1906.\textsuperscript{21} Blackton hand outlined a face, and with a movie camera shot a still picture. Blackton then erased part of the face and redrew it in a slightly different pose. This process was repeated hundreds of times to create an illusion of movement.

Although this master’s project is about American animation, it is important to mention the pioneering work of Frenchman Emile Cohl along

\begin{footnotes}
\end{footnotes}
with American Windsor McCay. Cohl created short animation films a few years before McCay, but McCay is credited with launching the animation industry in America. McCay’s *Gertie the Dinosaur* ran at sixteen frames per second and created personality on screen with the character, Gertie. McCay later wrote, “The theatre patrons suspected some tricks with wires. Not until I drew Gertie the Dinosaur did the audience understand that I was making the drawings move.” McCay is also credited with using celluloid sheets, or “cels,” in animation for the first time with his animated film *The Sinking of the Lusitania* in 1916.

The cel was the single greatest breakthrough in cartoon animation production. As explained above, in cel animation, the animated characters or special effects are drawn on paper, traced and painted onto clear cels, placed over a background and photographed one frame at a time. This technique allowed animators to easily change only the parts of the image that required movement. When the completed film is projected at a rate of twenty-four frames per second, the illusion of motion is created.

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24 Ibid., 30.
On December 19, 1914, cartoonist Earl Hurd applied for a patent on this process of cartoon animation that became the standard for animation until the use of computers. Hurd proposed drawing a complete stationary background on paper, with the characters inked and painted on clear cels laid on top. He wrote in his patent application:

I believe I am the first to employ a transparent sheet or a plurality of transparent sheets in conjunction with a background which is photographed therethrough upon the negative film. In my process a single background is used for the entire series of pictures necessary to portray one scene. The background shows all of those portions of the scene that remain stationary and may conveniently be drawn, printed, or painted on cardboard or other suitable sheet.26

Hurd was interested in using this technique to save time. His use of several cels overlapping at one time was the start of what became known as “assembly-line animation.”

Around the same time, there were other advances in animation. The first was the creation of the peg system in 1914 by Raoul Barré, a French-Canadian artist. Each drawing sheet had mechanically perforated holes on the bottom that could be perfectly aligned on a pegboard, assuring perfect correspondence in successive phases. Another

advancement came from Bill Nolan, also in 1914. He discovered that backgrounds could be drawn on long sheets of paper and pass underneath a character, simulating the illusion of movement, even though the character was walking in place.27 Despite these advances, however, animated films were still primitive and considered “fillers” for audiences.  

_Walt Disney_  

Walter Elias Disney, better known as Walt Disney, did not invent animation; however, he set the standard for modern animation. Cartoon shorts shown in theatres were reminiscent of vaudeville acts, until Disney brought a storyline to animated shorts. In 1928, *Steamboat Willy*, the third film of the series featuring his famous character, Mickey Mouse, was one of the first cartoons to synchronize sound with movement on film.28 Audiences reacted enthusiastically to the idea that this cartoon character could “talk, sing, play instruments and move to a musical beat.”29 In a single film, Disney advanced the animation process and made the silent film obsolete. The success of *Steamboat Willy* was unprecedented; Mickey Mouse was patented and became a national celebrity.  

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27 Ibid., 11.  
Disney advanced the animation industry with several key achievements. One was specialization within the animation production process. Individuals were assigned to dedicated departments, such as the Story Department.\textsuperscript{30} A storyboard is a sequence of thumbnail sketches with notes that mapped out the entire story for everyone involved to see. The use of a storyboard, as obvious as it seems today, was revolutionary at the time. Another Disney innovation we take for granted today is the use of color in film. While color had been experimented with by other studios in the 1930s, no one could justify the results with the additional work and expense. Disney thought otherwise, and believed color would be an asset to his films. Thus, Disney signed a three-year exclusivity contract with Technicolor. His first color short, \textit{Flowers and Trees}, was a hit and won an Academy Award in 1937 for best animated short subject of the year.\textsuperscript{31} The third important step Disney took was to give characters personality. Disney wanted his characters to be charming and he wanted audiences to respond with emotion. The fourth advance made by Disney was his invention of the multiplane camera. This 14-foot camera used stacked planes of glass each painted with different elements of the animation. The multiplane camera allowed the animator to re-use the same background or

\textsuperscript{30} Ibid., 38.

\textsuperscript{31} Ibid., 39.
foreground saving hours of labor and adding depth and dimension.\textsuperscript{32}

These advances in talent and technical development would forever change the animated film.

\textit{The Animated Feature Film}

Disney’s advances culminated in the creation of his first feature film, \textit{Snow White and the Seven Dwarfs}, in 1937. Many of the principles and procedures of animation known today were developed for the creation of \textit{Snow White}.\textsuperscript{33} As described by the Walt Disney Studios, the process of creating an animated feature film begins when a story is chosen. A script is then written and the visual development begins. Visual developments or concept sketches are created with pastels, paints or other mediums to plan the look of a film, from characters to environments. From these visual developments, color models are created to determine the paint colors and keep the colors consistent throughout the film and “size comparison charts” are developed to show the main characters in relation to one another. Next, story sketches, 16 individual drawings shown sequentially with dialogue and notes written on them in a comic strip fashion, are produced. The story sketches and notes are stapled, taped and

\textsuperscript{32} Ibid., 51-52.

glued on to a board and become a storyboard. Multiple Photostatic reproductions are made and distributed. Voice-over actors and actresses read the dialogue and the sketches are photographed so there is a timed version of each scene. After assembling all the scenes in order, the director is able to get an early idea of the sequence of events and the total length of time of the animation film even though nothing has been animated yet.\textsuperscript{34}

The next step is animation. Not surprisingly, animation drawings make up the bulk of the material produced for animated films. Rough animation is created on paper, usually with graphite and red or blue pencils and often with notes written on them. Then the rough animations are sent to clean-up animators who trace the line drawings on clean sheets of paper and make them look as they would on film. Until 1989, at Disney, the clean up drawing would then be traced on to animation cel sheets and painted.\textsuperscript{35}

It was expensive to make theatrical animation shorts, and early animation creators were always looking for ways to save money. Walt Disney is quoted as saying, “it costs me $100,000 to make a seven-minute

\textsuperscript{34} Tim Campbell, “An Introduction to the Forms and Materials Used in Animation Art.” \textit{Western Association of Art Conservators Newsletter}. (September 2000).

\textsuperscript{35} Ibid.
In an effort to save money, most cels were reused or destroyed after several washings in an acid bath, meaning that relatively few animation cels exist compared to the number of cels that were created. When computers began to replace hand-painted cels, an obscure art market arose for the original work. Ron Schultz’s article “Character Sketches: Everyone’s After America’s Favorite ‘toon,” discusses the animation art market with references to auction houses like Christie’s and Sotheby’s. This article argues that animation art is a fine art form and lists selling prices that support this claim. Animation art sales were estimated to be close to 15 million dollars in 1988. A single black and white animated cel marking Donald Duck’s first appearance with Mickey Mouse sold for a record $286,000 at a Christie’s East auction in 1989.37 Dana Hawkes, Sotheby’s resident animation expert believes animation cel prices show that animation art is finally accepted as “a true American art form and it should be respected as such.”38

38 Ibid., 46.
Celluloid Preservation: A Special Case

Although this paper discusses animation cels, it is important to also consider photographic materials because animation cels before the 1940s were made of cellulose nitrate, the same material used for photographic film. A review of literature on cellulose nitrate film and acetate film helps to better understand animation cels.

Cellulose nitrate has been used in photography since the 1840s, in explosives since 1845, and in moldable plastic objects since 1870. Most literature on cellulose nitrate focuses on the preservation of nitrate-based photographs or as an adhesive material. Monique C. Fischer and Andrew Robb’s Guidelines for Care and Identification of Film-Based Photographic Materials applies to animation cels as they are made of the same materials – cellulose nitrate or cellulose acetate. This article states that the major difference between animation cels and photographic materials is that animation cels do not have gelatin binders on them, which was used on photographic materials to hold the sensitizing chemicals to the surface. It also stresses that institutions should isolate and properly store cellulose nitrate objects because of its flammability. Nitrate objects should especially be isolated when in a deteriorated condition. Prolonged exposure to deteriorated negatives can be dangerous for registrars and other people who come into close contact with these objects and
precautions such as wearing gloves, using a respirator, maintaining good air circulation and limiting exposure should be taken. Proper maintenance of the environment is key to the longevity of film-based materials as well as the health of conservators and collections managers who are exposed to these objects.39

Another important reference manual, “Cellulose Nitrate in Conservation” by Charles Selwitz, distinguishes between animation cels and photographic materials. Selwitz examines cellulose nitrate in art conservation, and more specifically as an adhesive for ceramics and as a metal coating. Again, the focus is not specifically on animation cels. What are of interest are Selwitz’s test samples that were animation cels from the Walt Disney Studios. The animation cels that Selwitz cites were made of cellulose nitrate and dated back to the 1930s, and had been stored in diffused light at room temperature over their lifetime. All were flexible, clear, odorless, of good strength, and had a very pale yellow tint in some sections. Selwitz noted that it was common to find cellulose nitrate photographic film that was far more colored and with a pungent acid odor that the animation cel samples had. The old nitrate animation cels had none of the symptoms associated with decomposing film, probably

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because they were never exposed to the harsh chemicals in the developing process.\textsuperscript{40}

Other notable resources on film-based nitrate products include the master’s thesis by Aisha Ayers, \textit{Preservation of Home Movies and Amateur Films in Museums} focusing on film made of cellulose nitrate and cellulose, Julie Reilly’s article “Celluloid Objects: Their Chemistry and Preservation,” and articles from \textit{CCI (Canadian Conservation Institute.)} As mentioned by other sources, Reilly notes, “One source of deterioration in celluloid comes from the instability of the cellulose molecule and the chemicals used to process the cellulose.”\textsuperscript{41} An article from \textit{CCI Notes 15/3} adds, “The stability of cellulose nitrate is strongly influenced by the amount of nitrogen present in it—the greater the nitrogen content, the more unstable the product.” While some cellulose nitrate products with nitrogen content greater than 13 percent will explode when subjected to heat, friction, or shock, objects and films with less than 12 percent nitrogen content are not explosive. They are, however, extremely

flammable and produce corrosive, acidic, and oxidizing gases as they degrade.\textsuperscript{42}

Ayers addresses acetate film in her thesis, noting that acetate film has a longer lifespan than nitrate, and is not flammable. However, she lists problems with acetate film, which apply to cellulose acetate animation cels, including its susceptibility to shrinking when stored in dry conditions and its susceptibility to mold and fungi when stored in moist conditions above 60 percent RH. She also discusses the chemical reaction known as “vinegar syndrome,” where acetic gas is emitted from both degrading film and degrading acetate animation cels when not stored properly.\textsuperscript{43}

**Planning for Impermanence**

It is important for any preservation effort to recognize that animation art was never meant to be permanent. Animation cels were meant to be kept only long enough to be photographed for one frame of film.\textsuperscript{44} A consequence of efforts to make animation films cheaply,

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animation cels were never meant to be permanent works of art. The paints used on animation cels were formulated to dry fast, have good adhesion, and wash off easily. Animation cels could then be re-used several times. This practice stopped around 1943, once the cost of washing animation cels became more expensive than buying new ones.45

These days, each individual animation cel is considered a work of art and some have lasted for over 75 years! Many factors account for their survival, and one of those factors is the work of conservators who increasingly understand the temporary nature of some art forms in the late 20th century. Martha Buskirk states in her article, “Planning for Impermanence” from Art in America:

“Perhaps it was once the case that artists were likely to use impermanent material in temporary installations than in works intended for longer existence. But the regular employment of ephemeral materials by artists has increased, and so has museums’ interest in acquiring potentially fugitive works. Conservators now have to deal with previously unimaginable questions: how to arrest inevitable decay.”46

Identifying signs of degradation is the first step in the preservation process. Anel C. Rodriguez provides a manual called “The Trouble with Plastics: A Manual for the Identification and Storage of Cellulose Acetate,

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45 Steve Stringer-Smith “A Guide to Collecting and Preserving Animated Film Cels” (n.p., n.d.)
Cellulose Nitrate, and Polyurethane Foam” in her thesis, *When Dolls Cry: Proper Storage Techniques for Cellulose Acetate, Cellulose Nitrate and Polyurethane Foam in Historical Organizations*. This manual contains a chart showing degradation signs in plastics. Visual signs of degradation that appear in both cellulose nitrate and cellulose acetate objects include the following:

*Blistering*, where small bubbles appear on surfaces caused by trapped gases and localized heating.

*Bloom*, powder or crystal growths caused by additives or plasticizers that migrated to the outside.

*Brittleness*, breaks easily with little pressure caused by loss of plasticizes or shortening of polymer chain.

*Cracking*, large random fissures that splits caused by accidental damage or stress.

*Warping*, distortion caused by plasticizer loss, polymer breakdown, heat or pressure on the sheet.

*Weeping*, a chemical breakdown in cellulose nitrate and acetate, where liquid appears on the surface. There are two types of liquid, a non-sticky and not oily liquid, which is not dangerous, and a sticky and oily liquid, which is acid coming to the surface and is dangerous to the skin.

*Disintegrating paper*, where surrounding paper becomes brittle or crumbling caused by release of acids form plastic, causes breakdown of cellulose in paper.

Visual signs of degradation that appear with just cellulose nitrate is:

*Yellowing*, where acidic or alkaline vapors in the air or ultraviolet rays cause the object to turn yellow in color.
Another sign of degradation is scents. Cellulose nitrate objects smell like camphor when in a deteriorated state and cellulose acetate emits a vinegar-like scent. This chemical reaction is known as Vinegar Syndrome.

Any of the signs above, whether from the look of the object or the smell, is a good indicator that cellulose nitrate and cellulose acetate objects have started to deteriorate. While deterioration itself is inevitable, what can be controlled is the rate of deterioration. Plastic, once thought of as an indestructible material, deteriorates continuously. Once chemical degradation starts it is almost impossible to reverse the process. Therefore, steps in preservation are critical to the survival of these objects.

Preservation methods slow down the rate of deterioration of plastic objects according to several sources. *CCI Notes 15/1*, from the Canadian Conservation Institute, and Amanda Paliarino and Yvonne Shashaoua in “Part Two: Caring for Plastics in Museums, Galleries and Archives” from *Plastics Collecting and Conserving* address preservation of plastics.

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Genevieve Fisher in “Preventive Care” from *The New Museum Registration Methods*, does not address plastics specifically, but provides general applicable guidelines for all objects. Fisher believes it is possible to extend the life of objects by properly handling objects and providing a clean, stable storage environment. Fisher also writes that 95 percent of conservation treatments are a result of improper routine maintenance and the remaining five percent result from inappropriate handling.⁴⁹ Because rates of deterioration vary and forms of deterioration are unpredictable there are some generalizations and not all recommendations are identical.

All of the existing literature agrees that limiting objects to agents of deterioration was a good start. The primary agents of deterioration listed by Fisher, *CCI Notes 15/1*, and Paliarino and Shashaoua include high levels of light, extreme relative humidity (RH), high temperatures, pollutants, stress and other direct physical forces. Fisher and Paliarino and Shashaoua also listed pests and poor record keeping as other agents of deterioration while *CCI Notes 15/1* listed oxygen as a deteriorating agent, which is particularly harmful to plastics and rubbers. However, it should be noted that materials which release acidic gases as they degrade, such as

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cellulose nitrate, should not be stored in an oxygen-free environment because acidic gases in a gas-tight environment speeds up degradation. Fisher, *CCI Notes 15/1*, and Paliarino and Shashaoua recommend similar guidelines to control the process of deterioration, but call out different variations. The first is to keep low levels of light; Fisher and Paliarino and Shashaoua recommends a light level of 50 lux, while *CCI Notes 15/1* recommends never exceeding 150 lux. The second and third is to keep objects in moderate to low levels of RH and temperature. Fisher recommends keeping the RH between 50-60 percent, emphasizing that high humidity may cause mold growth. Fisher also recommends a temperature range between 68 degrees and 72 degrees for objects in general, with paper and textiles reduced to 41 degrees, and color photographic material temperatures between 25 degrees to 40 degrees. *CCI Notes 15/1* addresses rubber and plastic objects specifically, and recommends that ideal storage conditions should be cold, dark and dry, but notes that, although cooler conditions promote longevity, they may also cause brittleness. Paliarino and Shashaoua suggest a more suitable

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52. “Care of Objects Made from Rubber and Plastics.” *CCI Notes* (April 1986), 15/1.
condition for plastics is at 20 degrees C or below, and 30 – 50 percent RH. The fourth recommendation is to keep pollutants such as dust, pollen, soot and gaseous pollutants out of the museum and by storing objects in neutral tissue, untreated cotton or linen under polyethylene sheeting or in acid-free boxes. The final recommendation is to properly handle and store objects, remembering to provide support when moving objects and refrain from stretching plastics.

There were some differences in recommendations by Fisher, Paliarino and Shashaoua, and CCI Notes 15/1. Fisher and Paliarino and Shashaoua stress monitoring the condition of objects and keeping good records with visual images. Fisher also suggests prompt attention to pests that can feed on organic objects and leave waste, so an infestation can be avoided.

Planning for impermanent collections is not specific to animation cels or even plastics, but relates to all museum objects. As all objects age, steps to preserve objects will be crucial. Simple precautions, like the recommendations listed above, can significantly increase the lifespan of

55 Ibid. 107.
objects. Furthermore, documentation is crucial to monitoring the work’s condition and provides a resource for easier and safer treatments in the future.

**Preservation of Animation Cels**

There is little literature that deals specifically with animation cel storage and care. The best resource available is Martin Krause and Linda Witkowski’s book, *Walt Disney’s Snow White and the Seven Dwarfs: An Art in the Making Featuring the Collection of Stephen H. Ison*. As a trained painting conservator, Witkowski approaches animation cel preservation from a museum perspective.

According to Witkowski, inhibiting deteriorating agents are the key to animation cel preservation. Standard museum practices are also applicable to animation cels. Witkowski agrees that controlling light levels, relative humidity (RH), temperatures, and pollutants, as well as stress and other direct physical forces are steps that need to be followed to prolong cel life. Unfortunately, no specific recommendation on what temperature, RH, or light level should be used is listed. She does, however, include designing and using archival material for storage and display, as a preventive conservation method. She goes on further to state
when necessary, preservation also includes stabilizing materials used in
the creation of animation art.  

With these standards in mind, Witkowski provides general care
guidelines for animation cels. The first step is to properly handle
animation cels by wearing cotton gloves and to handle them by their
edges, remembering never to roll or bend the cels as this could cause paint
to crack and flake off. The second step is to avoid getting water on a
painted cel. Because many of the paints used were water-soluble and
earlier cels were meant to be washed off, water should never encounter the
paint. Witkowski recommends using a soft, dry, cotton cloth to remove
any dirt or fingerprints, avoiding painted areas, and applying minimum
pressure. Rub the cloth horizontally over the cel, avoiding the use of
compressed air as it may blow off paint. The third step in caring for
animation cels is to remove cellulose nitrate cels from their storage or
framing environment once a year to air out completely, for a period up to
24 – 48 hours.  

Witkowski goes on to recommend storage for animation cels. Her
first recommendation is to store unframed animation cels flat. She also

\[56\] Martin Krause and Linda Witkowski, *Walt Disney’s Snow White and the
Seven Dwarfs: An Art in the Making Featuring the Collection of Stephen H. Ison* (New
\[57\] Ibid., 179.
acetate sheets directly against water-based painted cels. The paint on the cel can stick to the polyester sheet or acetate sheet if it gets too humid. Her second recommendation is to place unframed animation cels between a folded leaf of acid-free glassine, then place the wrapped cel in an acid-free Solander® box or in a similar acid-free box with acid-free tape. She also suggests stacking no more than five cels of the same size on top of each other.

The most prolific writer on animation art is animation cel conservator, Ron Stark. Stark’s company S/R Laboratories Animation Art Conservation Center (S/R Labs) in Westlake, California bills itself as the “world’s only animation art conservation center.” S/R Labs publishes S/R Lab Notes, a free newsletter about animation. His newsletters are intended for amateur collectors and enthusiasts, not museums. However, his work must be mentioned as he is the most frequently cited person in articles about animation cel conservation.

In S/R Lab Notes, “No. 1: On the Subject of Caring for Animation Art,” Stark lists general care guidelines. The first guideline is to control light levels by never hanging art in direct sunlight or too close to a light source. The second is to control temperature and RH by never hanging art in extreme temperatures and a constantly changing environment. The

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58 Julie Bain, “‘Toon Town’s Surgeon General,’” Popular Science (May 2002), 84.
third is to examine art at least every three to four months. The fourth guideline is to store art in an envelope, lying flat with no other weight on top. Stark recommends no more than 10 – 15 cels stacked on top of each other, separating the cels with clean paper and avoiding plastic wrap.59

Specific care for animation cels is also noted by Stark. The first step to cel care is to never roll or flex a cel. He also recommends washing your hands, and handling cels only by their edges. Cotton gloves, he adds, are also a good idea. The next step he highlights is that “cleaning is the most beneficial thing you can do to enhance the appearance and longevity of your cels.” He recommends cleaning surface debris by wiping horizontally with a clean, dry, soft cotton or flannel cloth. Unlike Witkowski, Stark condones wiping over inked or colored areas with very light pressure. The third step Stark recommends is to never use any liquid or compressed air when cleaning a cel. He instead recommends using a brush to remove light dust particles. However, he does not specify what kind of brush to use. His final recommendation is to remove cellulose nitrate cels from their frames and mounts every 12 months and air them out for 24 hours.60

60 Ibid.
Witkowski and Stark’s approach to handling animation cels are similar; however, Witkowski’s approach is more cautious. Besides recommending museum standards for the general care of animation cels, Witkowski also approaches the preservation steps in the same manner. Tim Campbell writes, “It is important to understand the original context in which a piece of animation art was created before making decisions about any kind of conservation treatment, as some of these pieces have history, purpose, and additional value beyond the aesthetic.”\(^6\) Keeping this in mind, it is better to provide take preventative steps in preservation, than full conservation or restoration of animation cels.

\(^6\) Tim Campbell, “An Introduction to the Forms and Materials Used in Animation Art.” *Western Association of Art Conservators Newsletter.* (September 2000).
FINDINGS

This master’s project is geared towards museum registrars and collections managers who may be responsible for storing and caring for animation cels. Its purpose is to identify best practices and methods of animation cel storage to help preserve animation cels. A chief finding of this research was that there is no standard—or even classification of animation cels in museum collections. Every institution contacted seems to do things a bit differently and there is little, if any, communication between institutions as to best practices for animation cel storage. In addition, information on animation cels is limited. There are few experts on animation cels—and since many are in private practice, few are willing to share information.

Interviews and Site Visits

Seventeen interviews were conducted for this project. Interviews were conducted in person, over the phone, and via e-mail. Because this master’s project is geared towards museum registrars and collections managers -- the people who may be exposed to animation cels first -- the majority of my interviews were with collections managers and registrars. In addition, I interviewed four conservators, one preparator, one curator, one animation producer, one director, an owner of a commercial animation
conservation studio and the inventor of MicroChamber® Products. Three site visits were also conducted to see how animation cels were stored and what kind of condition they were in.

The first three interviewees helped identify basic guides for this research. I spoke with two conservators; one specializing in photography and the other specializing in paper. Interestingly, each conservator had unique category listings for animation cels in their museums. One museum stored their cels with paper drawings, while the other grouped cels into their own category. These differing views on how to classify animation cels highlighted the lack of information on animation cels.

My third interview was with Lella Smith, Director of the Walt Disney Company, Animation Research Library, (referred to hereafter as ARL), in Glendale, California.\(^\text{62}\) She introduced the idea that museums may not have enough cels in their collection for these items to be seen as a high priority for proper storage and preservation. She also pointed out that museums may be limited in their resources, both physically and monetarily, to properly store and preserve animation cels. These initial interviews raised some important issues and questions regarding animation cels including the ambiguity in the classification of animation cels.

\(^{62}\) Lella Smith, Director, Walt Disney Company, Animation Research Library, telephone interview by author, December 14, 2005, Glendale, California.
Subsequent interviews helped me to gain more insight into current trends and practices of animation art storage and preservation. Additional interviewees included conservators, registrars, collections managers, one preparator, one curator, one animation producer, one director, and a co-owner of a commercial conservation studio. There was no consensus. Each response was as varied as each person and each institution.

The first site visit took place at the Animation Research Library (ARL) in Glendale, California, on December 27, 2005. The ARL houses more than 35 million pieces of animation art, including over 150,000 animation cels. With the largest collection of animation cels in the world, this site was an essential source of information. ARL is accessible only to Walt Disney employees for research and tours. Yet, the storage and preservation techniques of animation cels at ARL were among the best and set the standard for the rest of this research.

Timothy L. Campbell, Senior Manager at ARL served as my guide and provided insight into their storage strategies and approach to preservation. Campbell stated that ARL, “preserves historic pieces rather than creates aesthetic pieces.” In other words, the objects, including animation cels, receive no conservation treatments that alter their original state, and the objects themselves are considered historical references.
When ARL moved into its current location in 1999, they took the opportunity to start planning for preservation of its objects. One preventative step they took was to mitigate the dangers of combustible animation cels. To do this, they disposed of blank cellulose nitrate sheets, eliminating a potential fire hazard. These blank cellulose nitrate sheets, used as covers on background paintings, were replaced with sleeves made of Mellinex®, a thin polyester sheet similar to Mylar®.63 Another preventative step they took to slow down the degradation process of existing animation cels was to separate cels from other materials. Background paintings, usually painted on cardboard, were stored separately from animation cels. Each animation cel was placed in individual archival mat board folders with a piece of zeolite molecular trap paper. According to William K. Hollinger, President of Conservation Resources International and the inventor of MicroChamber® products, zeolite molecular traps help neutralize acidic pollutant gases and actively trap pollutants.64 This process dramatically slows the natural yellowing and brittleness of aging animation cels. The trade names for these folders containing zeolite molecular traps are called MicroChamber® and ArtCare®. Newer folders at ARL have molecular traps inside the folder,

63 Timothy L. Campbell, Senior Manager, Walt Disney Company, Animation Research Library, interview by the author, December 27, 2006, Glendale, California.
and eliminate the need to insert molecular trap paper into each folder. The folders are then interleaved with sheets of polyethylene, a permeable material. To further help preserve the objects, ARL uses special environmental equipment that actually pushes dust and debris out of the building, further protecting the objects inside.

The next site visit was to the Charles M. Schulz Museum and Research Center (referred to as the Schulz Museum hereafter) in Santa Rosa, California on February 10, 2006. Collections Manager Annee Booker Knight reviewed the museum’s collection and their preservation techniques. Like ARL, the Schulz Museum stores their cels in acid-free mats, placed in acid-free folders, inside acid-free boxes. Unlike ARL, however, the Schulz Museum stores their cels with the background paintings associated with the cel, as well as the preliminary animation drawings on paper created before paint was applied to cels. Most of the cels in the collection are from the 1970s and are on cellulose acetate sheets. These cels do not exhibit the same characteristics as older cellulose nitrate cels. However, very slight buckling was found on a few cels.

A final site visit was conducted to the Walt Disney Family Foundation in San Francisco, California on April 12, 2006. As part of a

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65 Annee Booker Knight, Collections Manager, Charles M. Schulz Museum and Research Center, interview by the author, February 10, 2006, Santa Rosa, California.
new dedicated facility, the Walt Disney Family Foundation has proposed to renovate existing buildings in the Presidio to house a museum dedicated to Walt Disney. Their collection is currently maintained in a building in the Presidio. This institution has the advantage of resources and foresight that will allow it to properly plan for their collection of animation cels.

Michael Labrie, Director of Operations/Collections Manager at the Walt Disney Family Foundation’s current location, oversees the collection. Though their cel collection is small, each of the 39 animation cels is stored in custom-made animation cel mats and boxes. These mats and boxes are fabricated with MicroChamber® board from Conservation Resources International. Like ARL, the mat board had a window cut-out to allow several mat boards to be stacked on top of each other without ever putting pressure on the cels below. The cels are interleaved with polyester, which is smooth and has little static cling. Like the Schulz Museum, cels with corresponding background paintings are stored together under one mat board, interleaved with polyester.

The different strategies used by each institution beg the question, how should animation cels be stored? Should they be stored with their corresponding background painting or without? This question relates to my earlier question of how animation cels are classified: as paper, plastic, 

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66 Michael Labrie, Director of Operations/Collections Manager, Walt Disney Family Foundation, interview by the author, April 12, 2006, San Francisco, California.
painting or something else in museum collections? Anel Muller, who had just been hired as registrar at the Walt Disney Family Foundation, and author of a master’s project on proper plastic storage procedures in museum collections, believes, “cels should be classified on their own—they are mixed media.”67 She goes on to state, “Ideally, all (cellulose) nitrate objects should go together, and all (cellulose) acetate objects should go together and be separated from the rest of the collection. Realistically this will not happen, due to the lack of space and the lack of funding in most museums.” She further adds, “(cels) are a minority in a collection and museums are not going to invest in them.”

Much of the difficulty in finding proper storage solutions for animation cels is the ambiguity in its classification as an art medium. Still, common trends in storage took place between several institutions. Most interviewees reported their animation cels were stored in archival mat boards placed in archival boxes. Some museum professionals, like Doug Kerr,68 preparator from the San Francisco Museum of Modern Art, Debra Evans,69 Paper Conservator from the Fine Arts Museums of San Francisco, and

67 Anel Muller, Registrar, Walt Disney Family Foundation, interview by the author, April 12, 2006, San Francisco, California.
68 Doug Kerr, Senior Preparator, San Francisco Museum of Modern Art, telephone interview with the author, April 12, 2006, San Francisco, California.
Francisco, Legion of Honor, and Sarah Evans, Assistant Registrar from the Dallas Museum of Art identified Solander® boxes for storage. Solander® boxes are ready-made acid-free boxes used to store documents and unframed works of art. This appeared to be the only common technique among storage methods. Kerr stated the cels at the San Francisco Museum of Modern Art were placed in archival mat boards before they were placed in Solander® boxes, while Evans stated the animation cels at the Dallas Museum of Art were individually wrapped in acid free tissue, then placed in Solander® boxes. The cels at the Fine Arts Museums were covered with a mat cover, placed horizontally in a Solander® box, but were interleaved with drawings on paper. After our discussions, Evans planned to segregate the cels from the other objects in the Solander® box as a preservation method.

One of the largest animation cel collections, The Cartoon Art Museum in San Francisco, uses none of these storage techniques. Second only to ARL in its quantity of animation cels, the Cartoon Art Museum owns more than 300 animation cels in its collection; the most cels in the

70 Sarah Evans, Assistant Registrar for Data Management and the Permanent Collection, Dallas Museum of Art, e-mail interview with the author, April 7, 2006, Dallas, Texas.

San Francisco Bay Area.\textsuperscript{72} Their collection includes a cel from \textit{Lady and the Tramp}, featuring the irresistible spaghetti-eating scene. Unfortunately, the Cartoon Art Museum lacks the same resources as ARL and its storage techniques are more limited. Cels are stacked in drawers, one on top of the other, interleaved with acid-free paper. According to Andrew Farago, Gallery Manager, the museum is understaffed and does not have the funds necessary to put all of their cels in archival folders or mats. Fortunately, an effort has been made to store their collection in a climate-controlled room and Farago noted they appear to be in relatively good condition. Without a conservator on staff, Farago says they send their objects to an outside source to be conserved.

Nicolas Ricketts, a curator at the Strong Museum in Rochester, New York, uses a unique storage technique.\textsuperscript{73} The museum’s entire collection of 20 animation cels is stored in an acid-free mat board frame interleaved with Mylar®, inside a custom-made air circulation cabinet. A conservation volunteer under the supervision of the museum’s conservator designed the cabinet. Ricketts described the operation of the cabinet: “air is drawn in through the bottom on one side, circulates past all the shelves with the cels and exits through the fan and filter on the top of the other

\textsuperscript{72} Andrew Farago, Gallery Manager, Cartoon Art Museum, interview by the author, February 17, 2006, San Francisco, California.

\textsuperscript{73} Nicolas Ricketts, Curator, Strong Museum, e-mail interview with the author, March 17, 2006, Rochester, New York.
side.” He added, “The filter is changed yearly, at least.” Ricketts concluded by saying that the air circulation cabinet, which has been used in the museum for ten years, is, “our best preservation method.”

The question of preservation turned out to be controversial amongst conservators. Two conservators were cautious about sharing information and declined to be interviewed. The first conservator was concerned my questions would be an “infringement of proprietary information” and would reveal trade secrets essential to his business; he pointed out that he bills people for the information he gives out. The second conservator thought the topic of animation cel preservation was too complicated for collections managers and registrars to deal with. She thought any research on animation cels could only be done by accurate materials testing, and did not want to share information for fear of liability issues. Juliann Stark, co-owner of S/R Laboratories in Westlake Village, California, had another take on information sharing.74 In a phone interview she pointed out that, “If you tell people how to do something, they think they can do it on their own.” People without proper knowledge or experience oftentimes try to treat objects and end doing more harm than good.

The uncertainty of the paint used on animation cels further contributes to conservator’s unwillingness to discuss the topic.

Conservator of paintings and mixed media, James Bernstein stressed the importance of finding out what kind of paint was used on the animation cel. He could not provide me with characteristics of paints because there were so many different types of paints, and unless I knew exactly what kind of paint was used on animation cels, his recommendations were useless. “The nature of a plastic film is it doesn’t want anything to stick to it. Cels themselves flex and paint doesn’t want to flex, unless the paint is airbrushed on,” Bernstein said. However, “most animation cels were opaque so there is probably a high pigment to binder ratio.”

Martin Salazar, a photography conservator who works at the Walt Disney Family Foundation, elaborated on the difficulties with animation cel conservation. He pointed out that conservators, “tie their names and techniques to objects. You change history—for better or for worse. Only time will tell if you had a positive effect or a negative effect on an object and that makes people nervous. With cels,” he continues, “there is no protocol.” Salazar suggested that the best way to preserve cels is with proper storage, proper handling, a proper environment, a very conservative

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75 James Bernstein, Paintings and Mixed Media Conservator, telephone interview by the author, June 12, 2006, San Francisco, California.
76 Martin Salazar, Photography Conservator, Walt Disney Family Foundation, interview with the author, April 12, 2006, San Francisco, California.
exhibition policy, and by limiting access to the collection. He also
stressed the importance of keeping good, accurate records. Before a cel
enters a collection, Salazar determines the stage of deterioration in the cel
and asks, “Is it stable enough to enter a collection? Will off-gasing affect
the collection? Do I need to take steps to stabilize the object?” Proper
documentation is also essential in this process to record how the cel
currently looks. Salazar suggests taking a photo of the cel with a raking
light to get a physical record of the cel’s current state. This photograph
can help determine any physical changes in the future.

*Family Guy* producer Kara Vallow discussed current information
on animation art techniques.77 *Family Guy* is an animated cartoon on the
Fox television network. I knew from my literature review that traditional
animation art was replaced by computers in animated feature films, but I
wanted to see if traditional hand-painted cels still existed in television.
Vallow confirmed that everything is still drawn by hand—the models,
storyboards and animation, but that is where the similarities with
traditional animation ended. Cels are not used. The Paint Module button
on a digital ink and paint system called USAnimation® is used to quickly
add color to drawings.

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77 Kara Vallow, Producer, *Family Guy*, e-mail interview with the author, March
16, 2006, San Francisco, California.
Surveys

In mid-March 2006, surveys were sent to 95 museums throughout the United States. Institutions were selected on a mostly random basis though historic houses and genre-specific museums like aviation museums were avoided. In addition, ethnic specific museums like Asian art museums were purposely avoided because my thesis was focused on animation art in America. Ninety surveys were mailed; two were delivered via email and three were conducted in person.

Of the 95 surveys conducted, 70 institutions responded (roughly 74 percent). I received three blank response cards with no data entered anywhere. These blank cards were not counted as responses. Out of the 70 responses received, 19 museums (27 percent), had animation cels in their collection. This was a much higher number than expected! However, the percentage of animation cels in these institutions is small, making up less than .01 percent to five percent of their collection. The Cartoon Art Museum in San Francisco had the highest percentage of cels among collections in my survey, a total of 300 cels out of a collection of about 6000 total objects (five percent). Of the museums with cels in their collection, 21 percent had just one cel. For example, the Michigan State University Museum in East Lansing had just one cel in their collection of 125,000 objects in their archives alone.
Of the museums with animation cels in their collections, all reported that they stored their animation cels with archival materials. Nine museums (47 percent) stored their animation cels in archival folders and seven museums (37 percent) stored their cels in archival boxes. Of those who stored their cels in archival boxes, five museums (71 percent) named their archival boxes as Solander® boxes. The Walt Disney Family Foundation in San Francisco, California stored their cels in custom-made MicroChamber® mats and boxes and the Strong Museum in Rochester, New York stored their cels in a custom designed air-circulation cabinet. Two museums stacked their cels in a drawer with archival paper between each cel.

Though storage methods varied, most cels seemed to be quite stable. A high number of museums reported no problems with their cels. Of the 19 museums with cels in their collections, 10 museums (53 percent) said their cels were in good condition and did not report any deterioration problems even though half of those cels were between 60 to 70 years old. The good condition of these collections could be due to proper storage and handling and excellent environmental factors, or, on the other hand, the cels were not carefully evaluated. Cels between 60 to 70 years old will inevitably have some damage, even on a minimal scale. Damage may go unnoticed because the collections manager or registrar may not have a
basis for comparison or be acquainted with basic information on animation
cels, and may think the slight yellowing of the cel is its original color.

Five out of nine museums that reported some problems in their cels
reported severe damage. The remaining four museums listed minor
damage to their cels. (See Appendix E for a list of all survey results).
CONCLUSIONS

My research has shown that there is very little information specifically dedicated to the storage and care of animation cels and what does exist is ambiguous. Much literature exists on cellulose nitrate and cellulose acetate used for photographic materials, such as negatives, positive transparencies, motion pictures and other photographic materials; however, not much is written specifically about the unique art form of the animation cel. Even though both photographic materials and animation cels are made of both cellulose nitrate and cellulose acetate, they are quite different. For one, animation cels have paint on them that must be addressed as part of the object. Secondly, animation cels are not subject to the harsh chemical process that photographic film goes through. Contrary to current beliefs, they are far more stable than photographic materials. With this said, however, they must still be treated as a fire hazard.

The literature currently available on animation cels is easy to read and follow but there remain ambiguities. For example, each of several different glossaries available for animation cels is a bit different. One is focused on animation made for the movie *Snow White and the Seven Dwarfs* and S/R Laboratories wrote the other glossary. Evidence of confusion with definitions related to animation cels was clear when one of my interviewees, a collections manager, requested a glossary of terms to
be distributed to help catalogue their museum’s animation cels. There are no set standards for terminology related to animation cels or for museum practices regarding animation cels. An additional point of confusion lies in the classification of animation cels. Currently, animation cels are categorized differently and under various mediums. To repeat, there is no set standard in the field. Paper, painting and photograph conservators all work with animation cels. However, in spite of this ambiguity, most museum professionals are caring for their animation cels in a relatively good manner.

Because collections managers and registrars are typically the first people to encounter objects as they enter a collection, they need to be aware of how to handle and store animation cels. For smaller museums without a conservator on staff, it is even more important that registrars are well informed on best practices for animation cel handling and storage.

Data gathered from my surveys showed a small percentage of animation cels in museum collections. One quarter of the museums surveyed had just one cel in their collection. This suggests two conclusions. The first is that care and storage of cels are not a priority in museums because they are not the bulk of the museum’s collection. One museum explicitly stated that its animation cels were acquired early in the museum’s history and the mission of the museum has since changed, so
the cels were no longer a priority in their collection. A second conclusion is that because so few animation cels exist in a typical collection, museums should easily be able to make an effort to care for these objects. It would not be too costly or time consuming for museums to do so. In addition, because of the rarity of the animation cel, museums should make their proper storage a priority.

Animation art is highly collectible and is increasingly being recognized as an important art form. Prices at auction houses reflect the public’s interest and demand for these objects. There may be few animation cels in museum collections now; however, it is hoped that as more museums with an interest in animation art open up, such as the Walt Disney Family Foundation Museum, more cels will find a home in museum collections. It is important that existing cels in museum collections last as long as possible for future generations and as new cels enter collections, collections managers and registrars know how to properly address their unique needs. As the caretakers of objects, collections managers and registrars must take steps to ensure cels are properly handled, stored, and documented.

Storage and preservation techniques for animation cels are not difficult to adopt. Standards for preventive care such as controlling light levels, RH, temperatures, and pollutants, as well as stress and other direct
physical forces are steps that most museums already take. In order to provide proper storage, museum registrars must be educated about what these storage techniques for animation cels are. A widely recognized standard for museum practices in animation cel storage will best help preserve the cels for the future.
RECOMMENDATIONS

The following recommendations address storage and preservation needs specific to animation cels. These storage recommendations are directed towards museum collections managers and registrars to help them take steps to help preserve a dying artform. With this in mind, one must always proceed with caution and keep the integrity of the cel unchanged. If conservation treatment is needed, do not take this role on uninformed. Please take your cel to a professional conservator.

1. Understand the Materials and Methods Used to Create Animation Cels

The first step to properly address storage needs for animation cels is to understand the materials. The simple breakdown of an animation cel consists of two components: the animation cel itself and the ink and paint applied to the animation cel surface. Animation cels were made of cellulose nitrate before the 1940s and cellulose acetate after the 1940s. Cellulose nitrate is flammable but cels made of cellulose nitrate are

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unlikely to explode or spontaneously combust under normal museum conditions.\textsuperscript{79}

Character outlines were inked on the front of the cel and then painted on the back. The earliest cels, before color was introduced, were inked with India ink and colored with Chinese black and white.\textsuperscript{80} Hand inking the character outline was replaced by the use of a Xerox reproduction known as Xerography. This method was first used in 1959 at the Disney Studios to create One Hundred and One Dalmatians.\textsuperscript{81} Other animation studios soon followed the same process.

Although exact paint formulas are a trade secret to this day, some generalizations can be made. Paint needed to be able to stick on the smooth surface of the cel, to dry fast and to wash off. General adhesive properties suggest a water-based binding agent was used on the cel such as gum-arabic. A plasticizer such as glucose was added for smoothness and flexibility in the paint. Lastly, glycerin was added to make brushing on color easier and to reduce any excessive caking or drying of the paint. Other likely additions used include a wetting agent to prevent beading and a preservative to prevent mold growth and improve the odor of the

\textsuperscript{80} Steve Stringer-Smith “A Guide to Collecting and Preserving Animated Film Cels” (n.p., n.d.)
\textsuperscript{81} Ibid.
paints. Understanding the materials will help museum collections managers and registrars better care for animation cels.

2. Institute the Practice of Prudent General Care for Animation Cels

The first steps in properly caring for animation cels are being careful and wearing cotton gloves when handling. Direct handling of animation cels should be kept to a minimum, but if it must be done, the cels should be handled by their edges. Cels should also remain as flat as possible. Another important tip is to never roll or bend the cels as this could cause paint to crack and flake off. The next step is to avoid cleaning cels unnecessarily. If a cel must be cleaned, a soft, dry, cotton cloth should be used to remove dirt. Rub the cloth horizontally over the cel very lightly. Do not rub the cloth on painted areas. Most importantly, do not use compressed air to remove dirt or dust as this may blow off paint. It is also important to avoid getting water on a painted cel. The final step in caring for animation cels is to completely air out cellulose nitrate cels from their storage or framing once a year for a period up to 24 – 48 hours in a controlled environment.

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3. Provide Proper Storage for Animation Cels to Help its Preservation

Since there is no way to stop the natural degradation process of any object, steps must be taken to slow down the process. Proper storage is the key to longevity. The best solution for animation cel storage is to place individual cels inside folders or matboards that contain zeolite, also called molecular traps.

MicroChamber® is a trade name of Conservation Resources International, which produces molecular trap folders and matboards. Nielsen & Bainbridge also use MicroChamber® technology under the trade name of ArtCare®. Since MicroChamber® technology boards and papers actively trap pollutants, they dramatically slow down the natural yellowing and brittleness of aging animation cels. Ideally, unframed animation cels should always be stored flat in a MicroChamber® mat board with a window cut-out. The cut-out window will allow several matboards to be stacked on top of one another without ever putting pressure on the cel below. Matted cels can then be stacked on top of each other and placed in an acid-free box or, preferably, a MicroChamber® box. It is also recommended to avoid directly touching water-based painted cels against polyester such as Mylar® and Mellinex®, or even other acetate sheets in humid and unstable conditions: the paint on the cel
can stick to the polyester or acetate sheet. If an animation cel must be stored in humid conditions, wrap the cel in acid-free glassine.

4. Provide Proper Environmental Conditions for Storing Animation Cels

Light levels, relative humidity (RH), and temperature affect all objects, including animation cels. The best preventive measure that can be taken to prolong the life of a cel is to provide proper storage environments. The preferred environmental conditions for animation cels should be maintained to achieve the best results. First, light levels should be kept low. Storage in a dark environment is ideal as ultraviolet (UV) radiation is damaging to objects. The recommended level is 50 lux, never exceeding 100 lux. Second, moderate to low levels of RH should be maintained in environments for animation cels. Extreme and rapid changes in RH can result in damage to the cel. A high RH can cause mold growth and a low RH can cause brittleness. The appropriate RH for animation cels should be at 50 percent (+/- 5 percent). Third, temperatures should also remain stable as they affect RH levels. For most objects, the temperature range should be between 68 degrees Fahrenheit to 72 degrees Fahrenheit, with
two to three degrees in fluctuation over a 24-hour period. The preferred temperature for animation cels is 68 degrees Fahrenheit. It is also important to be aware of environmental conditions; pollutants such as dust, pollen, soot, and gaseous pollutants should be kept out of the museum.

5. Monitor the Collection

Part of maintaining a good environment is monitoring the condition of all objects in the collection. Examining the condition of animation cels enables staff members to become aware of any changes that may occur. Animation cels should be examined every three months for any changes in color of the cel and the paint. Paint loss or flaking should also be noted. Any changes should be clearly documented. Photographs of the cel with a raking light are highly recommended to provide a basis for comparison. Regularly monitoring objects is also a good way to catch any pest infestations early. Consistent and frequent monitoring as well as accurate record-keeping is vital to maintaining the best environment for animation cels.

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6. Continue to Learn About Animation Cels and Share Information with Other Museum Professionals

This project has shown that there is a noticeable lack of information regarding animation cels for museum professionals and in some cases a reluctance to share information because of trade secrets or lack of confidence in registrars’ skills. The little information that is available is written by conservators for other conservators or collectors. This literature ignores an important audience that should also be aware of preventative measures: registrars and collections managers. In smaller museums, where a conservator is not on staff it is even more important that registrars and collections managers are aware of preventative steps to be taken with animation cels especially since they are no longer produced and increasingly rare. **84** Therefore, as articulated in the Registrar’s Code of Ethics to “maintain and physically care for collections, registrars must work in close cooperation with curators, conservators, collections managers and other museum staff.” **85** Sharing information will help to preserve animation cels for future generations to enjoy.

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84 Ibid., 107.
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Booker Knight, Anne, Collections Manager, Charles M. Schulz Museum and Research Center. Interview by the author, February 10, 2006. Santa Rosa, California.


Evans, Sarah, Assistant Registrar for Data Management and the Permanent Collection, Dallas Museum of Art. E-mail interview by the author, April 7, 2006. Dallas, Texas.

Farago, Andrew, Gallery Manager, Cartoon Art Museum. Interview by the author, February 17, 2006. San Francisco, California.


Labrie, Michael, Director of Operations/Collections Manager, Walt Disney Family Foundation. Interview by the author, April 12, 2006. San Francisco, California.


Muller, Anel, Registrar, Walt Disney Family Foundation. Interview by the author, April 12, 2006. San Francisco, California.


Salazar, Martin, Photography Conservator, Walt Disney Family Foundation. Interview by the author, April 12, 2006. San Francisco, California.


Vallow, Kara, Producer, *Family Guy*. E-mail interview by the author, March 16, 2006. Los Angeles, California.
APPENDIX A: List of Interviewees

James Bernstein
Conservator of Paintings and Mixed Media
Telephone interview with the author
June 12, 2006, San Francisco, California

Annie Booker Knight, Collections Manager
Charles M. Schulz Museum and Research Center
Interview with the author
February 10, 2006, Santa Rosa, California

Timothy Campbell, Senior Manager
Walt Disney Company, Animation Research Library
Interview with the author
December 27, 2005, Glendale, California

Debra Evans, Head of Paper Conservation
Fine Arts Museums of San Francisco, Legion of Honor
Interview with the author
December 12, 2005, San Francisco, California

Sarah Evans, Assistant Registrar for Data Management and the Permanent Collection
Dallas Museum of Art
E-mail interview with the author
April 7, 2006, Dallas, Texas

Andrew Farago, Gallery Manager
The Cartoon Art Museum
Interview with the author
February 17, 2006, San Francisco, California

William T. Hollinger, Jr., President
Conservation Resources International
Telephone Interview with the author
May 25, 2006, Springfield Virginia
APPENDIX A: List of Interviewees (continued)

Amanda Hunter Johnson, Assistant Paper Conservator
San Francisco Museum of Modern Art
Telephone interview with the author
April 12, 2006, San Francisco, California

Doug Kerr, Senior Preparator
San Francisco Museum of Modern Art
Telephone interview with the author
April 12, 2006, San Francisco, California

Michael Labrie, Director of Operations/Collections Manager
Walt Disney Family Foundation
Interview with the author
April 12, 2006, San Francisco, California

Anel Muller, Registrar
Walt Disney Family Foundation
Interview with the author
April 12, 2006, San Francisco, California

Lynne Phillips, Registrar
Walt Disney Family Foundation
Interview with the author
April 12, 2006, San Francisco, California

Nicolas Ricketts, Curator
Strong Museum
E-mail interview with the author
March 17, 2006, Rochester, New York

Marin Salazar, Photography Conservator
Walt Disney Family Foundation
Interview with the author
April 12, 2006, San Francisco, California

Lella Smith, Director
Walt Disney Company, Animation Research Library
Telephone interview with the author
December 14, 2005, Glendale, California
APPENDIX A: List of Interviewees (continued)

Juliann Stark, Co-Owner
S/R Laboratories
Telephone interview with the author
March 13, 2006, Westlake Village, California

Kara Vallow, Producer
Fox Television, Family Guy
E-mail interview with the author
March 16, 2006, Los Angeles, California
## APPENDIX B: LIST OF MUSEUMS SURVEYED

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APPENDIX C:  
SURVEY INSTRUMENT – Cover Letter

Karen Hong
(Address)
San Francisco, CA 94107

March 13, 2006

«Name_Person»
(Museum)
(Address)
(City, ST ZIP)

Dear «Name_Person»

Hello, my name is Karen Hong. I am a graduate student in Museum Studies at John F. Kennedy University in Berkeley, California. Currently, I am working on my thesis project, researching animation cel storage and preservation. I would greatly appreciate your valuable input.

I understand you may not have any animation cels in your collection, however, that data is also pertinent to my thesis. Enclosed is a very quick survey card. Please reply with your responses before April 7, 2006. I apologize for the short response time, but it will greatly benefit my research.

Thank you in advance for your participation. Please feel free to contact me at any time if you have any further questions.

Sincerely,

Karen Hong
karenhong12@yahoo.com
(phone number)
APPENDIX D: 
SURVEY INSTRUMENT: Reply Card

1. How many objects are in your collection? 

2. Does your institution have any animation cels? Yes ____ No ____
   a. If yes, how many animation cels are in your collection? 
   b. If no, please do not continue, and return this survey.
   Your responses are important to my research. Thank you.

3. How are the animation cels stored? (Please check all that apply.)
   a. In archival folders, placed flat in drawers 
   b. In archival, micro-chambered mats 
   c. In drawers, with no folders 
   d. Other(s) 

4. How old are your animation cels? 

5. What problems do you see with the animation cels?
   Buckling ____ Yellowing _____ Paint flaking ____
   Other(s) 

For more information, please e-mail: karenhong12@yahoo.com, or call 415-XXX-XXXX
APPENDIX E: Survey Results

1. How many objects are in your collection? *(see results below)*

- 15,011,000
- 150,000
- 150,000
- 125,000
- 5,500
- 30,000
- 500,000
- 1,000,000
- 25,290
- 20,300
- 3000
- 7,000
- *(left blank)*
- 45,000

2. Does your institution have any animation cels?  Yes _19_  No __76__

a. If yes, how many animation cels are in your collection? *(see results below)*

- 5
- 18
- 4
- 1
- 6
- 20
- 10
- 5
- 5
- 39
- 35
- 4
- 15

b. If no, please do not continue, and return this survey. Your responses are important to my research. Thank you.

3. How are the animation cels stored? (Please check all that apply.)

a. In archival folders, placed flat in drawers ___9___________

b. In archival, micro-chambered mats _________1__________

c. In drawers, with no folders _______________2___________

d. Other(s)___(see results below)_____________________

- Inserted into photo corners, on mats, in Solander boxes
- One is framed
- In polyethylene in sleeve in folder
- Wrapped in glassine and tissue in a drawer
- Matted in archival material, placed in flat in drawer
- archival (museum board) mats in own Solander box in open shelving
APPENDIX E: Survey Results (continued)

• Custom cabinet with air circulation – held in Mylar and acid-free mat board frames
• Archival box in cabinet
• Matted in Solander boxes
• In Solander boxes, each wrapped in acid-free tissue, 1 framed with acid-free matting
• Custom-made animation cel mat and boxes fabricated with MicroChamber board
• In climate control vaulted room, in flat files, stacked on top of each other interleaved with acid-free paper
• Acid-free folders, matted, inside acid-free boxes
• Stored in archival folder with drawings
• Each in an archival mat folder, all in Solander boxes

4. How old are your animation cels? ___(see results below)________

• 50 years old • 1- 1937, 11- 1980s, 6-unknown
• 1988 -1989 • 1937
• late 20th c. • 1940
• 70 years old • 1937 – 1939
• 1930 – 1950 • 70 years old
• 1940 • 70 years old
• Mid 20th c. • 1930s – 40s
• 69 years old • Bulk from 1960 – 1990s, some older
• From 1970s • From 1940s
• unknown

5. What problems do you see with the animation cels?
Buckling ___6___ Yellowing ___4___ Paint flaking ___4___
Other(s)___(see results below ____________

• Mold and mildew on framed piece
• Becoming brittle
• Warping at edges
PRODUCT

Animation Cels: Caring for a Unique American Art Form

This article was submitted for publication in Registrars’ Quarterly as part of my graduation requirements.
Animation Cels: Caring for a Unique American Art Form

While interning at the Walt Disney Family Foundation in San Francisco last summer, I had the opportunity to view original *Snow White and the Seven Dwarfs* animation cels. Seeing these cels reminded me of the joy I felt as a child upon seeing my first animated film. I also thought of their rarity and important role in culture over the last 75 years. As more museums with an interest in animation art open up, more cels will find a home in museum collections. As a result, more people will experience the same excitement and nostalgia of seeing a tangible piece of their childhood. Yet, because animation cels are so rare and the practice of creating hand painted cels is a disappearing art, it is important that existing cels in museum collections last as long as possible for future generations.

As a registrar, I was not aware of how to handle animation cels, and thus my quest for information began.

Much of the information I discovered on animation cel preservation was written for conservators rather than for registrars or collections managers. In most small institutions, collections managers and registrars are usually the first to see the cels that enter collections, making it more important for them to take steps that ensure cels are properly handled, stored, and documented.
Fortunately, storage and preservation techniques for animation cels are not difficult to adopt. Most museums already follow standards for preventive care such as controlling light levels, relative humidity (RH), temperatures, pollutants, as well as stress and other direct physical forces. The following recommendations address storage and preservation needs specific to animation cels for collections managers and registrars to follow.

Glossary of Terms

To better understand animation cels, it is important to set forth a standard set of terminology that will be used in this article. The following glossary applies to cel terminology as well as explanations of several products used for animation cel storage:

**Animation** – The process of creating motion by photographing successive drawings or objects simulating motion by slight progressive changes.\(^86\) In cel animation, characters are drawn on paper (also known as animation sheets) then traced and painted onto cels. The painted cels are then placed over a background painting and photographed one frame at a time. When the finished

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film is projected, at a rate of 24 frames per second, the illusion of motion appears on screen.87

**Animation cel** – See Cel.

**ArtCare®** – A product name for a matboard and matboard housing system incorporating MicroChamber® Technology with molecular traps added to the fibers.88

**Background of Background Painting** – Scenes usually painted on illustration board or a heavy cardstock for an animated film. Cels were placed on top of background paintings and photographed.89

**Cel** – Shortened term for “Celluloid.” Commonly refers to a painted sheet of thin, clear plastic on which characters were painted during the animation process. The painted cel was placed over a background and photographed, becoming one frame of the animated film. Animated films have 24 frames per second of film. Cels before the 1940s were made of Cellulose nitrate (See Cellulose nitrate) and cels after 1940 were made of cellulose acetate. (See Cellulose Acetate).

**Celluloid** – Name for the first plastic synthetic material developed in 1867.90 (See Cel and Cellulose Nitrate).

**Cel Set-up** (Also called Key-Set Up) – A combination of a cel or several cels placed over a painted background that constitute a scene in one frame of film. The cels may include special effects and not just painted characters.

89 Tim Campbell and Diane Pullano, “Un Roll ‘Em! Preserving animation art at Disney’s Animation Research Library,” *Registrars’ Quarterly*, (Fall 1999) 3.
**Cellulose Acetate** – The acetate ester of cellulose created in 1865. Cellulose Acetate is used as a film base in photography and as a component in some adhesives; it is also used as a synthetic fiber.

**Cellulose Nitrate** – An ester mixture of sulphuric and nitric acids. First developed in the 1840s, the product was used as an explosive (guncotton). A less nitrated product, known as Celluloid, formed the basis for moldable plastic materials used as artificial ivory for knife handles, piano keys, etc.  

**Key Set-up** – See Cel Set-up

**Matching Set-up** – See Cel Set-up

**MicroChamber®** – A name for a technology as well as a trade name for a product. MicroChamber® products remove acids and also neutralize and remove oxidative gases like nitrogen dioxide, sulfur dioxide, ozone, and peroxides.

**Molecular Traps** – A general descriptive term for specific chemical entities such as zeolites and activated carbon that provide the function of filtration and/or separation of chemical mixtures.

**Zeolite** – A naturally occurring aluminosilicate mineral that filters contaminants/pollutants. Naturally occurring mineral zeolites were first identified by Cronstedt, a Swedish mineralogist in 1756. In 1862 Deville produced a synthetic zeolite (levynite) from a mixture of potassium silicate mixed with sodium aluminate heated in a closed test tube. Studies on natural zeolites in 1925 established their molecular sieve attributes. In 1949, Union Carbide began the synthetic production of zeolites.

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93 Ibid.

94 Ibid.
What Materials Make up an Animation Cel?

To properly address storage needs, it is essential to understand the basic materials that make up animation cels. The simple breakdown of an animation cel consists of two components: the animation cel itself and the ink and paint applied to the animation cel surface. Animation cels were made of cellulose nitrate before the 1940s and cellulose acetate after the 1940s.\textsuperscript{95} Cellulose nitrate is flammable but is unlikely to explode or spontaneously combust under normal museum conditions.\textsuperscript{96} Animation cels made of cellulose nitrate are even more unlikely to combust as they were not exposed to the harsh chemicals used to develop nitrate films.

Character outlines were inked on the front of the cel and then painted on the back. Hand inking the character outline was replaced by the use of a Xerox reproduction, known as Xerography. This method was first used in 1959 at the Disney Studios to create \textit{One Hundred and One Dalmatians}.\textsuperscript{97} Other animation studios soon followed the same process. Paint needed to be able to stick on the smooth surface of the cel, to dry fast and to wash off. Although paint formulas used on animation cels remain a trade secret to this day, a few generalizations can be made.

\textsuperscript{96} \textit{Display and Storage of Museum Objects Containing Cellulose Nitrate.} \textit{CCI Notes} (1994): 15/3.
\textsuperscript{97} Ibid.
General adhesive properties suggest a water-based binding agent was used on the cel such as gum-arabic. A plasticizer such as glucose was added for smoothness and flexibility in the paint. Lastly, glycerin was added to make brushing on color easier and to reduce any excessive caking or drying of the paint. Other likely additions used include a wetting agent to prevent beading and a preservative to prevent mold growth and improve the odor of the paints.98

General Care for Animation Cels

The first steps in properly caring for animation cels are being careful and wearing cotton gloves. Direct handling of animation cels should be kept to an absolute minimum, but if necessary, cels should be handled by their edges. Cels should also remain as flat as possible. Never roll or bend the cels as this could cause paint to crack and flake off. The next step is to avoid cleaning cels unnecessarily. If a cel must be cleaned, a soft, dry, cotton cloth should be used to remove dirt. Rub the cloth horizontally over the cel very lightly. Do not rub the cloth on painted areas. Most importantly, do not use compressed air to remove dirt or dust as this may blow off paint. It is also vital to avoid getting water on a

painted cel. The final step in caring for animation cels is to completely air out cellulose nitrate cels from their storage or framing environment once a year for a period up to 24 – 48 hours in a controlled environment.

Storage Solutions for Animation Cels

Since there is no way to stop the natural degradation of any object, steps must be taken to slow down the process. Proper storage is the key to longevity. Fortunately, materials exist that can help slow down the degradation process. The best solution for animation cel storage is to place individual cels inside folders or mat boards that contain zeolite, also called molecular traps.

MicroChamber® is a trade name of Conservation Resources International which produces molecular trap folders and mat boards. Nielsen & Bainbridge also use MicroChamber® technology under the trade name of ArtCare®. Since MicroChamber® technology boards and papers actively trap pollutants, they dramatically slow down the natural yellowing and brittleness of aging animation cels. Ideally, unframed animation cels should always be stored flat in a MicroChamber® mat board with a window cut-out. The cut-out window will allow several mat boards to be stacked on top of one another without ever putting pressure on the cel below. Matted cels can then be stacked on top of each other and
placed in an acid-free box or, preferably, a MicroChamber® box. It is also recommended to avoid directly touching water-based painted cels against polyester such as Mylar® and Mellinex®, or even other acetate sheets in humid conditions: the paint on the cel can stick to the polyester or acetate sheet. If an animation cel must be stored in humid conditions, wrap the cel in acid-free glassine.

**Environmental Conditions for Storing Animation Cels**

Light levels, RH, and temperature affect all objects, including animation cels. The preferred environmental conditions for animation cels should be maintained to achieve the best results. First, light levels should be kept low. Storage in a dark environment is ideal as ultraviolet (UV) radiation is damaging to objects. The recommended level is 50 lux, never exceeding 100 lux. Second, moderate to low levels of RH should be maintained in environments for animation cels. Extreme and rapid changes in RH can result in damage. A high RH can cause mold growth and a low RH can cause brittleness. The appropriate RH for animation cels should be at 50 percent (+/- 5 percent). Third, temperatures should also remain stable as they affect RH levels. For most objects, the temperature range should be between 68 degrees Fahrenheit to 72 degrees Fahrenheit, with only two to three degrees in fluctuation over a 24-hour
period. The preferred temperature for animation cels is 68 degrees Fahrenheit. It is also important to be aware of environmental conditions; pollutants such as dust, pollen, soot, and gaseous pollutants should be kept out of the museum.

It is essential to monitor the status of a collection. Animation cels should be examined every three months to note changes in condition. Any changes should be clearly documented. Photographs of the cel with a raking light are highly recommended to provide a basis for comparison. Regularly monitoring objects is also a good way to catch pest infestations early. Consistent and frequent monitoring as well as accurate record-keeping is vital to maintaining the best environment for animation cels.

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For more information on MicroChamber® products, please visit Conservation Resources International’s website, under technical information at:

http://www.conservationresources.com/Main/S%20CATALOG/Technical Info.htm

or the Nielson-Bainbridge website on ArtCare® products at:

http://www.nielsen-bainbridge.com/Bainbridge/NB-ArtcareTOC.html

MicroChamber® products can be found at Conservation Resources International:

Conservation Resources International, LLC
5532 Port Royal Road
Springfield, Virginia 22151
USA

Phone: (800) 634-6932
Phone: (703) 321-7730
Fax: (703) 321-0629
E-mail: sales@conservationresources.com

and at Bainbridge & Neilson, under the trade name ArtCare®

1.800.342.0124
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