

# A SURVEY OF PHOTOGRAPHIC NEGATIVE COLLECTIONS FROM 1925-1950: SOME RESULTS AND OBSERVATIONS

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## 1. INTRODUCTION

In 1889, the introduction of a flexible, plastic film base changed photography forever (Adelstein 1987). Picture taking moved out of the realm of professional studios and into the mainstream. As the process of film manufacture was refined and perfected over the next half century, many different types of film were introduced to the mass market throughout the early 1900s. The study of a discrete collection can give insights into the rapidly shifting materials and techniques during this period. The Eliot Elisofon Archive at the Harry Ransom Humanities Research Center (HRC) at the University of Texas at Austin is typical of photographic records from this era and includes many of the brands and types of film available during his broad career. The collection also provides a perfect example of the wide range of problems one can encounter when managing early black and white film collections. This study explores the assorted types of film observed in the Elisofon Archive and other collections from the first half of the twentieth century on the University of Texas campus and attempts to place them within the context of their creation. Why did photographers choose to use the types of films they did? Can patterns noted in these collections shed light on the types of problems prevalent in other film collections from the early 1900s? The answers to these questions could help archivists and conservators make better housing and storage decisions for their collections ensuring that the images they contain will be available for successive generations.

## 2. THE COLLECTIONS

Four collections from the HRC and two collections from the Center for American History (CAH) were used for this study. The entire black and white negative collection in the Elisofon Archive received a full-length statistical survey. An additional five collections were used as investigative collections to establish that the patterns observed in the Elisofon Archive could be extrapolated to others. The date range used for materials in the investigative collections was 1925 to 1950.

### 2.1. ELIOT ELISOFON (1)

Eliot Elisofon is recognized as one of the preeminent photojournalists of his time. Born to immigrant parents in New York City in 1911, Elisofon began his photographic career in 1935 when he opened a commercial photography studio with two colleagues in New York. He developed an interest in photography as a vehicle for social commentary and began taking pictures of street life around the city. In 1937, he showed his portfolio to *LIFE* magazine and soon after began receiving assignments from *LIFE* as well as a number of other magazines. In 1938, he left the studio to become a full-time, freelance photojournalist. He spent the year 1939 as a staff photographer for the Museum of Modern Art and became a skilled photographer, and eventually collector, of works of art. He worked on several art books during his career and was a

painter in his own right. Truly a renaissance man, he was also an avid chef and released a cookbook in 1949 entitled *Food is a Four-Letter Word*.

As one might imagine, his work covers a broad range of subjects including travel journals, photographs of artists and works of art, fashion photography, photo essays about everyday life in America and portraits of the rich and famous. He was a war correspondent during World War II and shot the photograph of General George S. Patton that would become the first full color cover of *LIFE*. Some of the highlights of the black and white collection include a 1939 photo essay of the rural poor who were the subjects of the Federal Writers Project book *These Are Our Lives* and an extensive photo journal of his travels in Israel in 1964. Many of these essays were eventually published in *LIFE*, *National Geographic* and other publications, but there are some that remain unpublished.

Elisofon used many different types of film and shot both color and black and white throughout his career. In the black and white collection, there are examples of 3 x 4 inch single sheet film, 3 x 4 inch pack film, 120mm roll film, 35mm roll film, the occasional 4 x 5 or 5 x 7 inch sheet film and a few other odd size negatives. He seems to have been fairly non-discriminatory in terms of the brands of black and white film he used. Because he was mainly a field photographer, it may not have been a conscious choice on his part, but rather a matter of having to use film that happened to be at hand. Elisofon often took several different types of cameras with him on a single shoot to accommodate the variety of film he used. Throughout the archive it is possible to find roll, sheet and pack film within a single story line.

The Elisofon Archives are currently housed in the Photography storage area of the HRC. Received in 1992, the collection is processed to a folder level, housed in Hollinger boxes and accompanied by detailed finding aid. The black and white negatives are housed in chronological order, separate from the color negatives and transparencies. Negatives were removed from their original paper sleeves and placed in polyethylene sleeves within the folders. The original envelopes with Elisofon's notations remain in the folder of negatives to which they correspond.

## 2.2. INVESTIGATIVE COLECTIONS

The following collections were examined as comparisons to the negatives in the Elisofon Archive and contained a wide variety of different types of film.

- Harvey and Julius Patteson Collection, HRC: The majority of the negatives in the Patteson Collection are 8 x 10 inch sheet film both nitrate and safety from several different manufacturers including Kodak, Agfa-Ansco, and some examples of Defender and Hammer. There are also a few examples of 3 x 4 inch pack film. The negatives are housed in folders usually without sleeves.
- John Frederick "Doc" McGregor Collection, HRC: The McGregor Collection consists mainly of 3 x 4 inch sheet film, both Kodak and Agfa-Ansco, with a few examples of 3 x 4 inch pack film and various sizes of roll film. The negatives remain in their original paper envelopes with McGregor's notations as to date and subject.
- Harry Pennington Collection, HRC: Pennington's archives contain 3 x 4 inch sheet and pack film, mainly Kodak, as well as various sizes of color transparencies shot on Kodachrome. One drawer has been processed and the negatives have been placed in individual plastic sleeves and then back into their original glassine sleeves. The remaining negatives remain in their original sleeves. A small amount of the pack film is separated out from the rest of the collection and labeled as nitrate but the majority of the pack film is still distributed throughout the drawers.

- Harry Annas Collection, CAH: The Annas Collection features a large number of studio portraits on 5 x 7 inch sheet film, almost entirely Kodak, in their original paper envelopes. There are a variety of images taken outside of his studio on 3 x 4 inch pack film and some early negatives on various sizes of nitrate sheet film.
- Jimmie Dodd Collection, CAH: The Dodd Collection consists almost entirely of 3 x 4 inch pack film, mainly Kodak but there are some examples of Agfa-Ansco film. Each negative is sleeved in a four-flap paper enclosure.

### 3. PHOTOGRAPHIC FILM IN THE 1930s AND 1940s

To gain a better idea of why photographers utilized so many different film formats, it is important to understand the types of film available at the time and their working properties. The HRC's collection contains many examples of trade publications and manufacturer's guidebooks that would have been readily available to Elisofon and his contemporaries during the 1930s and 1940s. These documents provide a window into the various corporations that were producing film and how they were marketing themselves. While there were a few others, such as Hammer, the three main companies that were manufacturing film in the U.S. in the early 1900s were Agfa-Ansco, Kodak and Defender. Each one of these companies advertised prominently in *Popular Photography* throughout this time period and published their own trade magazines. Usually, Agfa-Ansco advertisements appeared on the inside of the front cover, Defender was featured on page one, and Kodak could be found on the back cover (2). There was a lot of experimentation with film bases at this point because of the realization that cellulose nitrate film was dangerously flammable. Each company was trying to develop a suitable replacement film base and there was no standard formula between them (Horovath 1987).

#### 3.1. THE COMPANIES (3)

##### 3.1.1. AGFA-ANSCO

Agfa-Ansco Company was the first manufacturer of photographic materials in the United States. Edward Anthony became interested in the daguerreotype process soon after it was introduced in the United States and achieved success as a dealer of daguerreotype materials in New York City. His brother Henry joined the business in 1852 and they staged the first photographic competition in the world. What was then E. and H.T. Anthony and Company followed the move from daguerreotypes to the wet collodion process. Civil War photographer Matthew Brady was a loyal client by this point and when the gelatin dry plate process was introduced, they were quick to begin production. In 1884, they launched their first line of hand held cameras and soon became involved with Hannibal Goodwin, the first person to apply for a patent for a flexible film base in 1887 (Adelstein 1987). They began marketing his invention by 1890, which led to the manufacture of smaller, more simplified cameras.

Following the death of his father and uncle, Edward's son Richard merged the company with Schovill and Adams Company in 1902, forming the Ansco Company, and the main manufacturing plant moved from New York City to Binghamton, NY. They continued to produce a wide range of photographic materials and equipment and gained a large following among amateur and professional photographers alike. In 1928, the American sector of the German company Agfa Film Corporation combined with Ansco to create the Agfa-Ansco Company. They remained on the cutting edge of film technology and received Academy Awards for their work with both infrared and color films during the 1930s. In 1944, at the height

of World War II, the company dropped the name Agfa and returned to calling itself the Ansco Film Company (Ansconian, Jan-Feb 1944).

### 3.1.2. EASTMAN KODAK

The Eastman Kodak Company was by far the largest manufacturer of photographic materials and equipment in the early days of popular photography. George Eastman, a bank clerk in Rochester, NY, became interested in photography and invented and patented a machine for coating dry plates with a photographic emulsion. In 1880, he established a small business and began producing and selling plates. He always envisioned a large-scale production line and began to think about a flexible film base that might speed up the process. In 1885, the Eastman Dry Plate and Film Company introduced the first roll film on a paper base. The opaque paper had to be stripped off the emulsion after developing and mounted to glass for printing, so Eastman hired a full-time research chemist to create a transparent flexible film base (Adelstein 1987). In 1888, the first Kodak hand-held camera designed specifically for roll film was introduced.

In 1889, Eastman was the first to manufacture and market a flexible and transparent film base. There was a great rivalry between Eastman and Agfa-Ansco's Hannibal Goodwin because both had been granted patents for the same invention a year apart from one another, Goodwin in 1888 and Eastman in 1889. A ferocious court battle ensued which was not settled until 1914 (Adelstein 1987). Eastman continued to lead the way in manufacturing both film and cameras and was heavily involved in the budding motion picture industry made possible by flexible and transparent film. Now called The Eastman Company, they were the first to market 16mm color film for motion pictures and subsequently for still cameras. They were also awarded several Academy Awards during the 1930s for their research and development of different types of motion picture film, both color and black and white (Eastman Kodak Company). By 1939, the company employed roughly 40,000 people all over the world and had four manufacturing plants in the U.S. alone.

### 3.1.3. DEFENDER

The Defender Photo Supply Company, the smallest of the three, was founded in 1896 by Frank Wilmot in Rochester, NY. He began by producing photographic paper alone with a hand-made machine and was soon selling out his stock on a regular basis. His first major client was Corning Glass Works, and soon after, he was joined by his partner Martin Hoyt. Both men were avid yachtsmen and named their company after *The Defender*, the boat that had successfully defended the America's Cup just as their fledgling company was beginning to expand. Defender continued to specialize in photographic paper, but also produced film and chemicals. They never developed their own line of camera equipment. In 1945, Defender was purchased by DuPont, and it has been shown that after this merger, the quality of the film declined (Horvath 1987).

## 3.2. THE FILM

The first flexible film base was made of cellulose nitrate. Cellulose in the form of cotton linters was treated with nitric acid to form cellulose nitrate (Neblette 1942). The discovery that cellulose nitrate was highly flammable and unstable following a deadly fire involving x-ray film at the Cleveland Clinic in 1929 resulted in a great push to invent an alternate film base (Horvath 1987). Cellulose acetate, also called "safety" film, was manufactured in the same way as cellulose nitrate except the cellulose was treated with acetic anhydride (Neblette 1942). In the

search for a stable and non-flammable film base which would meet the needs of a very finicky industry, companies experimented with several different type of cellulose acetate from the 1920s through 1940s including cellulose diacetate, cellulose acetate propionate, and cellulose acetate butyrate (Thomas 1973). It took over 25 years for cellulose acetate to replace cellulose nitrate entirely, one of the main reasons being that cellulose acetate was not as flexible and became more brittle over time (Stroebel et al. 1990). In addition, it could not stand up to the rigors of the film industry like cellulose nitrate and was not accepted as a support for motion picture film until cellulose triacetate was introduced by Kodak in 1949 (Adelstein 1987). Both cellulose nitrate and acetate film bases required that solvents and plasticizers be added to achieve the proper consistency and flexibility. Plasticizers were added in part to increase flexibility and reduce the dimensional instability of the film, but their main purpose in cellulose acetate film was to reduce the rate at which the film would burn should it catch fire (Reilly 1993).

Regardless of base material, most cellulose nitrate and acetate film had the same basic structure. A gelatin emulsion was attached to one side of the base. Different types of emulsions were designed for various conditions, including film for bright days, indoors and infrared film. An anti-curl layer of gelatin was adhered to the other side of the base to counteract the pull of the emulsion layer and prevent the film from curling, especially during drying (Mack and Martin 1939). Sometimes an anti-halation dye was also included in the anti-curl layer (Morgan 1942). The dye absorbed excess light, which would have otherwise been reflected back onto the emulsion causing halos around bright objects. The anti-halation dyes, designed to decolorize during developing, usually appeared as green or magenta (Neblette 1938). Finally, another thin, transparent layer of gelatin was added over the emulsion layer to protect the surface from damage due to abrasion (Kodak Reference Handbook 1947).

### 3.3. FORMATS

Photographic film came in several different formats during the 1930s and 1940s. Glass plate negatives were still being used for special purposes such as photoengraving or aerial topographic mapping where dimensional stability was very important (Mack and Martin 1939). However, most film being used by both amateurs and professionals consisted of a plastic base of either cellulose nitrate or cellulose acetate depending on the time period and film format. Usually the manufacturer and material from which the film base was made appeared along the edge of the film. Three formats of film available on plastic bases during this time were sheet or cut film, roll film, and pack film. All have been found in the Eliot Elisofon Archives and were noted in various concentrations in the other collections as well. Unless the photographer specialized in panoramic or aerial photography, the majority of black and white photographic archives from the first half of the twentieth century contain these three film formats.

#### 3.3.1. SHEET FILM

The earliest negatives in the Elisofon Archives are mainly 3 x 4 inch sheet film made from cellulose acetate or "safety" film. Sheet film usually came in boxes of 12 sheets, which were then loaded into holders by the photographers. Most holders only held one or two sheets, but there were some that could hold up to 12 sheets (Mack and Martin 1939). Sheet film needed to be thicker than roll film because it had to be able to maintain its rigidity in the holder. This meant that sheet film was also more adept at keeping its shape during developing and for this reason tended to be preferred by professional studio photographers (Morgan 1942) such as Harry Annas who operated a portrait studio. The type of emulsion and correct direction of the film was

identified by notch codes specific to each manufacturer in the upper right hand corner of the sheet when the emulsion side was facing the photographer (Neblette 1942). Notch codes helped the photographer both to identify the type of emulsion and orient the film correctly in the holder. Another benefit for professional photographers was that with the help of large tanks and film holders, sizable quantities of sheet film could be developed at one time (Morgan 1942). The drawback to using sheet film was that, since loading and unloading required darkness, it proved more difficult for a photographer in the field to change the film in the camera, especially if it needed to be changed after every shot.

### 3.3.2. FILM PACKS

Several of the collections contain numerous 3 x 4 inch negatives from film packs (Figure 1). Because pack film was pre-loaded by the manufacturer, there are often no identifying marks other than numbers at the bottom to identify the order of the negatives. All manufacturer and materials information would have been on the outside of the pack so there was no reason to print it on the film. The film pack eliminated the need to load and unload film in the dark while retaining the ability of the photographer to use sheet film. Twelve cut film sheets were attached to paper strips and packed in the cartridge. The cartridge was sealed in front with a paper safety cover, which could be removed once the film was loaded into the camera. As each negative was exposed, the photographer pulled the paper tab and the negative moved to the back of the cartridge. When the photographer had shot the last negative and pulled it to the back of the cartridge, a spring-loaded partition moved to the front of the pack replacing the paper safety cover and rendering the pack light tight (Neblette 1942). Jimmie Dodd worked mainly out of the back of his truck rather than in a studio and the abundance of pack film in the collection reflects this working method.

There were several other advantages to pack film. The film packs could be loaded into special cameras designed especially to hold packs or they could be used with an adapter in regular sheet film cameras. This gave the photographer the option of using several different kinds of film emulsions during a single shoot with the same camera. Also, it was possible to remove single exposed negatives from the film pack and develop them individually, an advantage over roll film which had to be shot in its entirety before it could be processed. A disadvantage with film packs was the possibility for light leakage in the area of the paper tabs if the photographer was not careful (Mack and Martin 1939). A more recent issue to arise in older film collections is that Kodak, the main producer of film packs, used cellulose nitrate film for film pack sheets until 1949, as did Agfa-Ansco (Reilly 1993). Agfa-Ansco did stamp their pack film with the company name and the emulsion type but no indication of safety or nitrate. Kodak began to stamp their pack film as "safety" only after they began to use cellulose acetate. Unfortunately, because no identification marks appear on earlier pack film and the packaging with all the materials information has long since been discarded, the only way to identify cellulose nitrate pack film is to be familiar with its properties. It is thinner, lighter and considerably more flexible than cellulose acetate sheet film and will curl when placed on a warm, gloved hand. Because the mechanics of the pack required the film to be flexible and thin enough to make the turn around to the back of the pack once the negative had been exposed, the working properties of pack film mirror those of roll film rather than the sheet film it resembles in size.

### 3.3.3. ROLL FILM

Roll film also provided daylight loading capability for photographers in the field. In addition, it was light and easy to carry and not nearly as inclined to light leakage as were the film pack cartridges (Mack and Martin 1939). Cameras that used roll film tended to be smaller than those designed for sheet film and, as he started to work on larger projects, Elisofon began to use roll film more frequently along with the film packs. Usually stamped "safety" if it was made from cellulose acetate, 35mm film was manufactured with cellulose nitrate until 1938 but larger size roll film did not change from nitrate to acetate until 1950 (Fischer 2002). It is also important to note that some photographers would purchase bulk quantities of 35mm motion picture film, which was manufactured with a nitrate base until 1951, and respool it for still camera use (Fischer 2002). Therefore, it is possible to find 35mm negatives on a nitrate base until the mid-1950s. Nitrate roll film in particular seems to lack any identification stamps because, as with pack film, the label information would have appeared on the outside of the roll. Larger size roll film is numbered in a similar fashion to pack film with black numbers in the corner of each negative.

Because both roll and pack film needed to be lighter and more flexible than sheet film (Mack and Martin 1939), film manufacturers utilized cellulose nitrate until cellulose triacetate provided the necessary flexibility to perform in the configuration of rolls and packs. Roll and pack film was marketed primarily to amateur photographers, as evidenced by their prominence in amateur catalogues versus their relegation to the back pages of professional catalogues (4). Even though roll and pack film were not available in as many emulsion types as single sheet film, there seems to have been quite a few professional photographers who preferred the ease of film packs and rolls (Mack and Martin 1939). In addition, there were photographers who preferred cellulose nitrate to cellulose acetate films (Adelstein 1987), especially to cellulose diacetate which was well known to be inferior in its physical properties (Horvath 1987). Both of these factors may have contributed to the greater than expected presence of pack film in the collections surveyed.

## 4. OBSERVATIONS

The Elisofon Archive provides an interesting study of the problems inherent in film bases from the 1930s and 40s because of the diversity of both formats of film as well as brands. In folder after folder of negatives, it is clear how the deterioration of each negative depends on many different factors. Some of the effects observed in the collection are warping, channeling, curling, blue discoloration, and bubbling. Many of the problems with aging films arise because of chemical instability within the film itself. In addition, common external degradation catalysts include exposure to heat, high humidity and the presence of acidic materials such as other degrading film or acidic paper products (Horvath 1987). Interestingly, there does not necessarily seem to be a direct correlation between the condition of the original housing and the condition of the negatives within. Many of the negatives in the worst housings were actually in good condition while others in better housings were in poor condition.

### 4.1. DATA

The following tables are drawn from the Elisofon survey to demonstrate the types and prevalence of specific degradation mechanisms present in the collection. While the problems observed in the Elisofon collection appear in the other collections as well, it is important to

reiterate that the Elisofon Archive is comprised of a very wide variety of film types and brands, more diverse than any of the other collections viewed for this project. While the statistics gathered in the Elisofon survey may not necessarily mirror findings in other discrete collections, they do offer insight into larger bodies of assorted collections.

As expected, the early film in the collection exhibited the most problems. Most negatives taken before 1940 are on 3 x 4 acetate sheet film, which is in poor condition. From 1950 forward all the film in the collection is on an acetate base, either 35mm roll film or safety pack film, and is in good condition. The count below represents the number of individual frames in each format in the sample. Because the sample size was about 45% of the collection, it is estimated that the number of individual frames in the entire collection is roughly 37,000.

3 x 4 inch sheet film	4 x 5 inch sheet film	5 x 7 inch sheet film	120mm roll film	35mm roll film	Odd size film	Grand total
2,713	969	27	1,436	11,408	181	16,718

The following table summarizes the presence of various types of degradation in relation to the collection as a whole, but one must keep in mind that most of these problems are pervasive mainly in the first half of the collection. Also note that these numbers represent the percentages of folders, not of negatives, showing these characteristics. In other words, they should be read as “\_\_\_\_% of the folders contained negatives exhibiting \_\_\_\_ type of deterioration.” A random sample of 352 folders was pulled from the 778 folders in the collection to achieve a 99% confidence rating with a margin of error of +/- 5%. Many of the folders from the first half of the collection contained fewer, albeit larger, individual negatives than those in the second half of the collection.

	1=Slight	2=Moderate	3=Severe
Warping	16%	3%	0%
Bubbling	6.5%	6.5%	12%
Channeling	7%	5%	14%
Silver Mirroring	18%	15%	4%
Blue Stains	4%	9%	8%
Tape	4%	1%	0%
Overall Folder Rating	27%	7%	32%

Other commonly observed problems include the following.

Curling	4%
Cracking	5%
Pink Discoloration	8%
Brown Discoloration	8%
Sticking to Sleeves	8%
Nitrate Film	24%



## 5. EFFECTS OF TIME

### 5.1 CHANNELING

One of the first indications of the degradation of cellulose acetate film is the distinctive odor known as vinegar syndrome. The strong smell can be attributed to acetyl groups splitting off from the polymer chains and being released as acetic acid. The loss of the acetyl groups shortens the polymer chains and the base begins to shrink, as much as 10% in the worst cases (Reilly 1993). This shrinkage causes the film to become warped and channels begin to develop. Channeling is a result of the imbalance in the deterioration rates of the emulsion gelatin versus that of the acetate film base. At a certain point the gelatin simply pulls away from the base and, if there is an anti-curl layer of gelatin, buckling can happen on both sides of the film (Reilly 1993).

### 5.2. PLASTICIZERS

It was noted in all the collections that early Kodak sheet film displays channeling to an extreme. One reason for this phenomenon could be that Kodak's formula either did not contain enough plasticizers to counteract the dimensional instability of the cellulose acetate or the plasticizers were more volatile than those used in other brands and dissipated more quickly. Defender sheet film also displays a tendency to channel. On the other hand, a high concentration of less volatile plasticizers can also be detrimental to the film. As the polymer chains get shorter, the structure of the film weakens. The base no longer has the structural integrity to hold the plasticizers and they begin to seep out of the film. Less volatile plasticizers can become trapped between the various layers of emulsion and anti-curl gelatin causing bubbles to form across the surface of the negative. If the plasticizers are exposed to enough circulating air, they will crystallize. If not they will simply remain in liquid form inside the bubbles (Reilly 1993). Early Agfa-Ansco film tends to display this type of deterioration in the form of bubbles across the surface of the film. Unlike the Kodak film, there is usually very little channeling and, when present, it is almost always related to the bubbles. Clearly Agfa-Ansco was using a different concentration or configuration of plasticizers in their recipe for cellulose acetate film than Kodak.

### 5.3. ANTI-HALATION DYES

As noted earlier, the anti-halation dyes that were added to the anti-curl layer of the film were decolorized during the developing process. However, upon extended exposure to an acidic environment, the dyes often regain their chromophoricity. Because of the different kinds of dyes that were used by each manufacturer, pink colors are associated with Kodak film, although a few examples of green discoloration of Kodak sheet film were noted in the Annas Collection, and blue is usually present in Agfa-Ansco film (Reilly 1993). The Kodak film in these collections exhibit only slight color changes if any at all. On the other hand, much of the Agfa-Ansco film displays bright blue discoloration regardless of the film format. Before the Elisofon collection was rehoused and the negatives were placed in plastic sleeves, they were stored in bad quality paper sleeves and the acidic nature of the envelope clearly influenced the degradation of the film. The sleeves are glued together down the center on the back and the lower pH of the adhesive left an obvious mark on the negatives. The Agfa-Ansco film that was housed in these envelopes tends to display a blue stripe, sometimes accompanied by silver mirroring, down the center of the negative placed closest to the back of the sleeve. Kodak film that had also been housed in the same envelopes exhibits only the silver mirroring.

#### 5.4. CURLING

The roll film tends to be in better condition overall than the single sheet film with one exception. The early 35mm film in the Elisofon was so curled, it was not possible to unroll it for examination. The filmstrips were not curling in the direction in which they had originally been rolled, but rather in the lengthwise direction, giving the strips the appearance of drinking straws. A probable explanation for this reaction is that the manufacturer did not adhere an anti-curl layer of gelatin to the back of the film. As the base began to degrade, there was nothing to counteract the pull of the emulsion and the film began to curl. It is possible the coating was omitted to preserve as much flexibility as possible allowing the film to be rolled properly onto the spool.

#### 5.5. NITRATE

One unexpected finding in the survey of the Elisofon Collection is the large amount of cellulose nitrate pack film in the collection. Elisofon began to use pack film more frequently in the late 1930s. Since none of the film has notch codes or identification stamps, the processors believed it to be regular sheet film and it is sleeved and housed with the rest of the collection. In comparison to the acetate film from the same period, the pack film is fairly pristine, even when surrounded by acetate film in very poor condition. In the 1940s, Elisofon began to shoot entire stories on pack film and many folders contain only pack film mostly in very good condition. Often the only evidence of deterioration present in the pack film is a stripe of silver mirroring where the film had been in contact with the original envelopes or a light brown discoloration associated with nitrate film. It is interesting that the pack film has actually fared better over the years than cellulose acetate film from the same period. Cellulose nitrate is regularly described as a highly unstable medium and the expectation is that it will be the most deteriorated material within a collection.

Every one of the six of the collections in this study has at least a few examples of pack or roll film, all of which are currently in good condition. However, if one is not aware of the difference between pack and sheet film, there would be no reason to suspect that sheet negatives from the mid to late 1940s would be nitrate, seeing as the generally accepted dates for the discontinuation of nitrate sheet film predate this time frame. In addition, pack film was manufactured in the same sizes as acetate sheet film and the base is not as rigid as many of the older examples of nitrate sheet film. Had such information been available at the time these various archives were being processed, the archivists may have decided to segregate that film from the rest of the collection and place it in the nitrate vault for safety reasons. A revised nitrate dating chart has been included as Appendix 1 based on information found in contemporary source materials such as Agfa-Ansco and Kodak product catalogues.

#### 6. A BETTER UNDERSTANDING

What can be learned about the degradation of cellulose acetate film from the observations made in the Elisofon Archives and the other collections used for this survey? Similar issues were addressed in David Horvath's study of numerous collections of cellulose acetate negatives in the late 1980s. He focused mainly on the level of degradation found in each brand in relation to other bands of film manufactured at the same time. The aim of the Horvath study was to establish a pattern whereby archivists and conservators could evaluate the types of film in their collections and anticipate future problems based on these factors. The first of its kind, Horvath's research has proven to be an incredibly useful resource for those with film

collections. However, while Horvath notes that he observed diverse types of deterioration and even gives some very thorough analysis as to why this might be occurring, no correlation is drawn between types of deterioration mechanisms and brands of film. In his study, an Agfa-Ansco negative could have received the lowest score for exhibiting blue discoloration and bubbling, while a Kodak negative may have been assigned the same score for warping and channeling. Both negatives certainly deserved a low score, but for entirely different reasons.

Had the archivists been aware of the variance in degradation mechanisms between the brands of film, different decisions might have been made with regards to rehousing the negatives in the Elisofon Collection. Clearly, the old, acidic paper envelopes had a detrimental effect, not only on individual negatives, but also on the collection as a whole. As is done with many photographic collections, the negatives were removed from these envelopes during processing and placed in polyethylene sleeves. This has proven to be a satisfactory solution for the Kodak negatives, but the Agfa-Ansco film is beginning to stick to the plastic sleeves. With less exposure to circulating air, the liquid plasticizers remain on the surface of the negatives, fusing them to the plastic sleeves. In contrast, a few Agfa-Ansco negatives left in their old paper sleeves were actually in slightly better condition. It is believed that the paper sleeves may have allowed the plasticizers to evaporate at a faster rate, preventing the negatives from becoming sticky. While this is certainly not meant to advocate leaving negatives in acidic sleeves, new paper enclosures may have been more suitable for these particular negatives. Now that they have been placed in the plastic sleeves, it is more complicated to change their housing. Not only will it be difficult to physically remove them from the plastic sleeves, rehousing each negative in an individual paper sleeve will require much more space than was originally allotted to the collection.

It has been shown that cellulose diacetate, cellulose acetate propionate and cellulose acetate butyrate films degrade in almost an identical manner (Adelstein et al. 1992). During the first half of the 1900s, all film companies were experimenting with different combinations of plasticizers and solvents to speed up the manufacturing process as well as to make a better quality film. While modern manufacturing methods have virtually eliminated the possibility of mixing errors and inconsistent additive ratios, it is known that Kodak made their film in batches until 1960 and each one could have been mixed with slightly different proportions of materials (Horvath 1987). Different chemicals intended to perform the same basic functions can have widely variant long-term effects and many of the current problems in film collections stem from the vast array of additives with which films were doped. Unfortunately, it is nearly impossible to determine what types and in what percentages various additives were included in individual film recipes without extensive specialized testing, which is often infeasible. The challenge of deciphering the degradation patterns of cellulose acetate film is a difficult one and this investigation only scratches the surface of what should be a full-scale study along the lines of Horvath's survey. Looking critically at the degradation mechanisms at work in broad ranging film collections can provide a wealth of information leading to solutions for the storage and preservation of these materials. A continuing dialogue and investigation into these issues will help us all to better understand this complicated and often daunting subject.

## NOTES

1. All historical information about Elisofon comes from the detailed introduction in the finding aid for the archives (Mosley, K. 1999).
2. Advertisement information was gleaned by looking through issues of *Popular Photography* from the years 1938-1944.
3. Historical information about Agfa-Ansco, Defender, and Kodak is from Morgan (1942) unless otherwise noted.
4. Agfa-Ansco and Eastman Kodak product catalogues from the late 1930s and early 1940s were consulted for this comparison.

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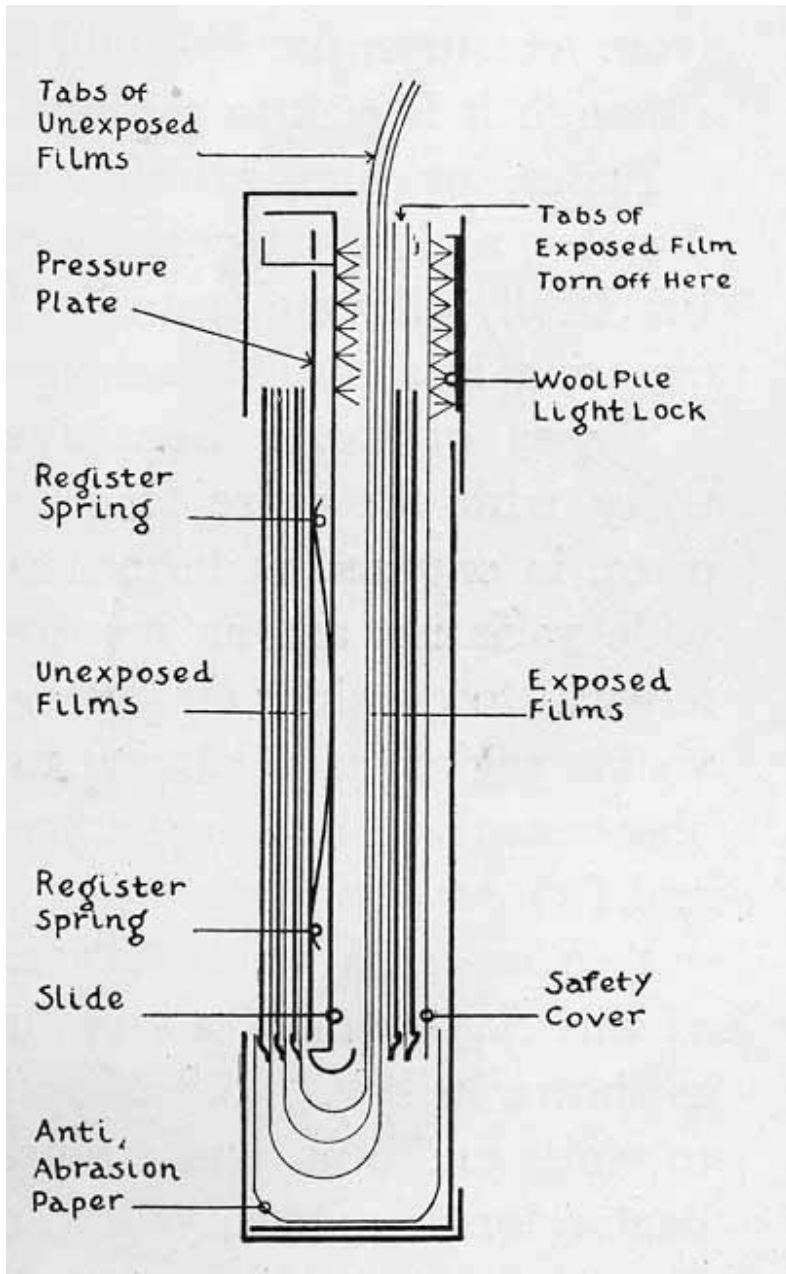
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**Figure 1**

Drawing of a film pack cartridge (Neblette 1939).



**APPENDIX 1**

Revised dating chart for cellulose nitrate film base, 1890-1950.

Film Type	1890	1900	1910	1920	1930	1940	1950
X-ray	----- Last manufactured in 1933.						
35mm roll	----- Last manufactured in 1938. It was not uncommon for photographers to respool 35mm motion picture film for use in still cameras. 35mm film is suspect until the mid 1950s.						
Aerial	----- Last manufactured in 1942.						
Sheet	----- Kodak ceased manufacture of nitrate sheet film in 1939. Agfa-Ansco continued to manufacture some emulsions of sheet film in nitrate until the mid-1940s.						
Packs	----- Both Kodak and Agfa-Ansco manufactured nitrate pack film until 1949. Kodak pack film made after this date should be marked safety.						
Roll	----- Kodak manufactured roll film larger than 35mm with a nitrate base until 1950.						
35mm motion picture	----- Last manufactured in 1951.						

It should be noted that products were still available to consumers for a short time after being discontinued while retailers dispensed with the old film stock. Therefore the dates above are only rough guidelines and photographs taken after the manufacturer's discontinue date could still be nitrate.