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# Lamination Methods and Survey of Collections Containing Lamination

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## Introduction

Cellulose acetate (CA) lamination was a widely applied paper conservation/preservation method within libraries, archives, and museums during the 20<sup>th</sup> century. The two major methods of CA lamination were covered in the previous issue of the *WAAC Newsletter*.<sup>1</sup> Because CA degrades with time, the acidic degradation products can damage both the object as well as further degrade the CA.

As a conservation community, we are well aware of the potential damage of CA to collections. Understanding the influence of this treatment upon US based collections today requires working with multiple institutions around the country. The Heritage Science for Conservation group at Johns Hopkins University set out to answer questions regarding: the age, quantity, and condition of laminated documents currently in collections; the kinds of deacidification that may have been done prior to lamination; the quantity, method, and reasons for delamination; and the use of climate controlled storage for laminated documents in the United States and its territories.<sup>2</sup>

Recently, a report was published detailing the results of the survey. It revealed that at the lowest estimate there are well over 2.9 million documents in collections. There may be more than twice this number, based upon information from earlier sources.<sup>3-9</sup> However, the amount of CA laminated documents currently in collections as well as their current condition was not known prior to this survey.

## Background

Lamination adds physical strength to an object by adhering one material to another stronger material. Lamination has been and is currently used in paper conservation/preservation to support documents using a variety of materials and adhesive technologies. This article summarizes the methods of lamination and where and when these methods originated. It also provides some guidance for identifying methods of lamination. It should be stressed that not all institutions followed the specific guidelines as laid out by the originators of a particular method, hence there are variations for all of these lamination types.

### Ademco (United Kingdom mid-late 1900s)<sup>10-20</sup>

Ademco was a company (originally the Adhesive Dry Mounting Company) located in the UK. It produced multiple materials for paper and photo repair contemporaneously to Barrow and National Bureau of Standards (NBS) lamination. The company produced a CA film backed with a heat and pressure set adhesive,<sup>13,21</sup> dry mounting materials, tissue,<sup>10</sup> heat activated adhesives,<sup>12</sup> heat-set tissues,<sup>19</sup> adhesive tapes, and laminator presses.<sup>15</sup>

While it may not be technically correct to call the use of any of these materials an Ademco method,<sup>14</sup> Darlington lists the use of cellulose acetate with an adhesive applied by heat and pressure to the paper surface as an “Ademco” method in her articles.<sup>13,16,21</sup> Typically the Ademco CA films that were used are thicker than those applied in the Barrow and NBS

laminations. Given the potential variety of material, unless there is documentation of what was used, it is difficult to identify an “Ademco” lamination after the fact. However the presence of adhesives will indicate this is neither the NBS nor the Barrow methods.

### Barrow Lamination (originated in the US, 1937-1990s)<sup>22-24,1</sup>

As discussed in the previous *WAAC Newsletter*, the Barrow lamination method was typically preceded by a two-bath deacidification. This method laminated a document using CA film with an outer layer of semi-transparent tissue. Barrow sold his laminator around the world, but was not the only vendor of laminating presses. The Arbee Company out of New Jersey/New York also sold a laminator and the related film. It is difficult to know whether Arbee employed the NBS or the Barrow method more, but it is likely that one of the two methods was used by anyone with an Arbee laminating press.

The easiest way to identify a likely Barrow lamination is the presence of the outer layer of tissue, a relatively thin overall lamination (the original films were 0.001 inch thick), and the presence of CA. CA can be detected by a vinegar odor, the fact that it has a slight yellow color, or otherwise conducting a chemical test. It should be noted other methods also used either tissue or CA film, but a combination of these factors is a good indication of Barrow lamination.

### Cellulose Nitrate Film – or Coating (aka zapon) (developed in Germany, late 1800s-early 1900s)<sup>25-32</sup>

Cellulose nitrate has multiple tradenames including (but not limited) to pyroxylin, zapon, and celluloid (though the term celluloid was sometimes used for cellulose acetate as well). Cellulose nitrate is dangerous to paper-based collections because it is flammable even when intact, and produces nitric acid, a strong acid, as it degrades. A mixture of cellulose nitrate (with typically camphor, acetone, and amyl acetate) was applied by painting or dipping.

Citations for use of this preservation method largely appear to be from Germany and Belgium where it was called “Zaponing” or “Zaponization.” It should be noted that it was used to treat both paper and vellum documents. This will appear more as a paint film/coating and will have penetrated into the document.

### Cellophane (1930s)<sup>25,33</sup>

Cellophane is reconstituted cellulose made into a transparent sheet. This material is not thermoplastic and has to be applied using adhesives. The use of cellophane as a laminating material, at least in the US, was investigated and dismissed by the NBS. However there is documentation that it was being used in the Reichsarchiv in Germany as late as 1938.

### Dipping/ Spraying CA or Painting CA (early 1900s)<sup>25,33</sup>

These techniques of applying CA to paper were tested by the NBS in the 1930s. The application of CA “dopes” or lacquers to textiles was used in airplane fabrics and was proposed for paper documents. It is possible that this

method may have been applied to paper documents, but there is little or no evidence that it was used as a method of preservation within archives or libraries.

**Goel Process** (aka Hand Lamination) (India, mid 1900s – modern day)<sup>34,35</sup>

The Goel process was developed in India and uses acetone to adhere thin CA films to the surface of the treated document. No heat or substantial pressure was placed on documents thus laminated, which was a major reason it garnered support. The method was developed to circumvent the purchase of expensive laminating machines. CA films thus applied will be potentially less uniform in application across the surface, and the resulting lamination thicker since there was comparatively little pressure used to apply the CA film.

**Mipofolie Process** (Germany, mid 1900s)<sup>35</sup>

Mipofolie used polyvinyl chloride (PVC) films applied with pressure-sensitive adhesives to the surface of a document. PVC has been linked to the release of chlorides and hydrochloric acid, which is dangerous to many collections. This technique can be identified using chemical tests for chlorides (Bielstein test).

**Morane/Ultraphan Process** (Britain, mid 1900s)<sup>35</sup>

This method was invented by the Morane Plastic Co. Ltd, of Ashford, Kent, UK in the mid-20<sup>th</sup> century. They used CA film, either di or tri-acetate (which have different solubilities and stabilities), and applied the film using a heat-sensitive adhesive, typically at about 80°C. This method can be identified by the presence of CA film (typically thicker than those used for Barrow or NBS) and a heat-sensitive adhesive. CA film can be identified chemically and typically is slightly yellow in color.

**National Bureau of Standards Lamination** (1934-1990s)<sup>1,33,36,37</sup>

The National Bureau of Standards Lamination was discussed in more detail in the last *WAAC Newsletter*. The method used CA films and applied them to both sides of a document using a combination of heat and pressure. Typically this is identifiable as a thin film without an outer tissue layer. CA can be identified chemically or by the odor of vinegar, and it tends to have a slight yellow color.

**Postlip Duplex Laminating Tissue** (mid 1900s)<sup>35</sup>

This method used a laminating tissue with a polyvinyl acetate adhesive containing magnesium acetate (a pH neutralizing buffer). This was applied using “moderate pressure” for 60 seconds with 80°C heat. This will appear closest to a standard tissue lining in appearance, but with a different adhesive.

**Polythene or Polyethylene** (started in Europe)<sup>21</sup>

Polyethylene lamination was done typically by using a combination of heat and pressure to apply the polymer to either side of the document. This polymer is not soluble in many organic solvents, has no odor, and may have a semi-transparent quality to the edges of the lamination. The edges often tend to be stiffer than films of other lamination methods, though this is dependent on the type of polyethylene employed.

**Silking** (Europe and US, 1800s to mid-1900s)<sup>32,38</sup>

Silking was done by applying a thin silk, typically with an open weave, to a document using a starch paste adhesive. This was done slightly differently in the US and Europe. Though other woven fabrics have been used, one way to identify silked objects is by the grid pattern of the woven fabric on the surface. Also chemical tests can be done for proteins and sulfur to confirm the presence of silk.

**Sundex** (England, mid-1900s)<sup>21</sup>

Sundexing was invented by Charles Sunderland of Twickenham, England. He used a glazed paper called glassine and applied it with an adhesive (either starch or soluble cellulose derivative) at 70°C. This glassine paper has often not aged well and typically becomes opaque. The surface texture is slick, which helps to identify the material.

**Tissue Lining** (currently in use)<sup>38</sup>

Paper tissue is typically applied with a wheat starch paste, though the exact adhesive used is the choice of the conservator. Typically one can see the difference between this and the Barrow lamination method as a factor of the transparency of the tissue. The object tends to be more compressed in the Barrow lamination method than in the tissue lining method.

### Survey Design/Method

Eighty-nine US libraries, archives, and museums were invited to participate in an online-survey that was open June 27–August 31, 2014 (65 days). Federal, state, county, local, and private institutions of varying sizes were invited to participate, with special care taken to invite institutions from every US state and territory. Fifty-two of the invited institutions submitted complete responses.

There were a total of thirty-nine possible questions, with some questions asked only if the respondent’s answers to core questions were affirmative, i.e. if a respondent said that their institution had not delaminated documents, the follow-up questions asking how the delamination was conducted would not appear. Respondents were allowed to skip questions that they could not answer and were asked to respond to questions to the best of their ability. Many questions allowed respondents to choose multiple answers or provide additional detail.

The survey was distributed and collected via the online SurveyMonkey® platform. Being online, respondents read and completed the survey without assistance. All reported data in this article is anonymous. Respondents were allowed to skip questions. Therefore the data below reflects percentages of the total numbers of responding institutions, which may vary question to question.

### Reporting of Results

The results of the survey are summarized on the following pages. The format of these results is: the question (Q) as it was posed to the respondents, followed by the response, in the form of a graph, chart, or table.

## Lamination Methods and Survey of Collections Containing Lamination, continued

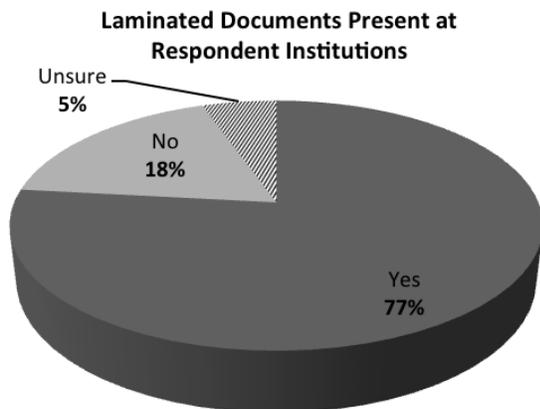
### Quantity and Kind of Laminates

Respondents were asked whether they had laminated documents. They were then asked whether they had CA laminated documents. The number of respondents who had laminated documents was greater than those with CA laminated documents indicating there were other methods of lamination being used besides CA lamination.

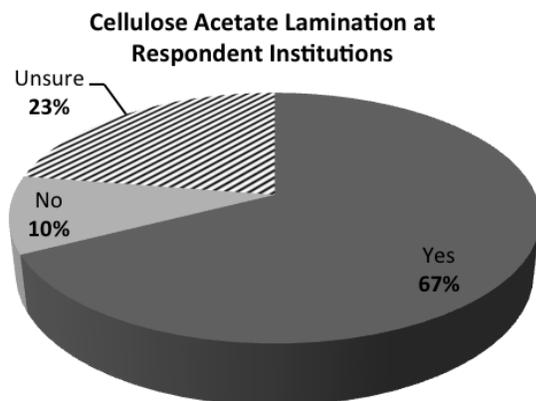
The respondents were then asked whether they could identify the type of lamination that was used. One third said they could, more than a third said they might be able to, and the remaining 28% said they could not identify the type of lamination used. While some of this lack of knowledge could be due to the inheritance of laminated documents from third parties, it also points to a troubling loss of information.

Respondents were asked to identify the method of lamination used at their institution, and suggestions were provided as shown in (Q4). Finally the respondents were asked to estimate the total number of laminated documents at their institution. These responses show that 66% of the respondent institutions have fewer than 10,000 documents that were laminated, with 21% of the respondents having 100 or fewer laminated documents. These numbers, however, are self-reported estimates and should be treated as such.

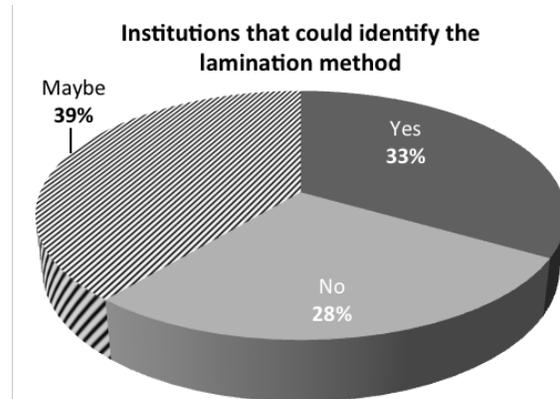
(Q1) Does your institution have laminated documents?



(Q2) Does your institution have CA laminated documents?



(Q3) Can you identify the lamination method that was used?



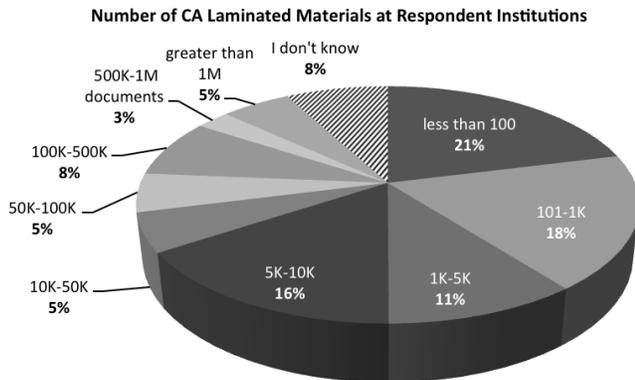
(Q4) What kinds of lamination were conducted? (Note, not all of these methods are cellulose acetate lamination.)

Lamination Type	Percent of Respondents
Not known/not sure	35%
Barrow Lamination Method* – single encapsulation with only cellulose acetate film – heated to 160°C	23%
Barrow Lamination Method – double encapsulation with cellulose acetate film + Japanese tissue heated to 160°C	62%
Cellulose Nitrate	4%
Cellulose Acetate with adhesive backing	8%
Goel Process (cellulose acetate applied using acetone)	0%
MipofolieProcess – polyvinyl chloride film and an adhesive	0%
Morane/Ultraphan Process – cellulose acetate film bonded using a heat-sensitive adhesive heated to 80°C	8%
Mylar-Polyethylene Composites – mylar bonded to the surface using polyethylene	4%
Postlip Duplex Laminating Tissue – tissue paper bonded to document using polyvinyl acetate with magnesium acetate as a deacidifying agent	4%
Polythene – application of polythene at a lower heat to documents	4%
Silking – silk applied to document using an adhesive (often starch paste or dextrin)	42%
Sundex – glassine is applied using starch or some cellulose derivative at 70°C	0%
Other (please specify) – soluble nylon and Barrow Lamination of unknown type	8%

\*This first method is actually better described as the National Bureau of Standards lamination method 1. No tissue paper was used with the lamination.

## Lamination Methods and Survey of Collections Containing Lamination, continued

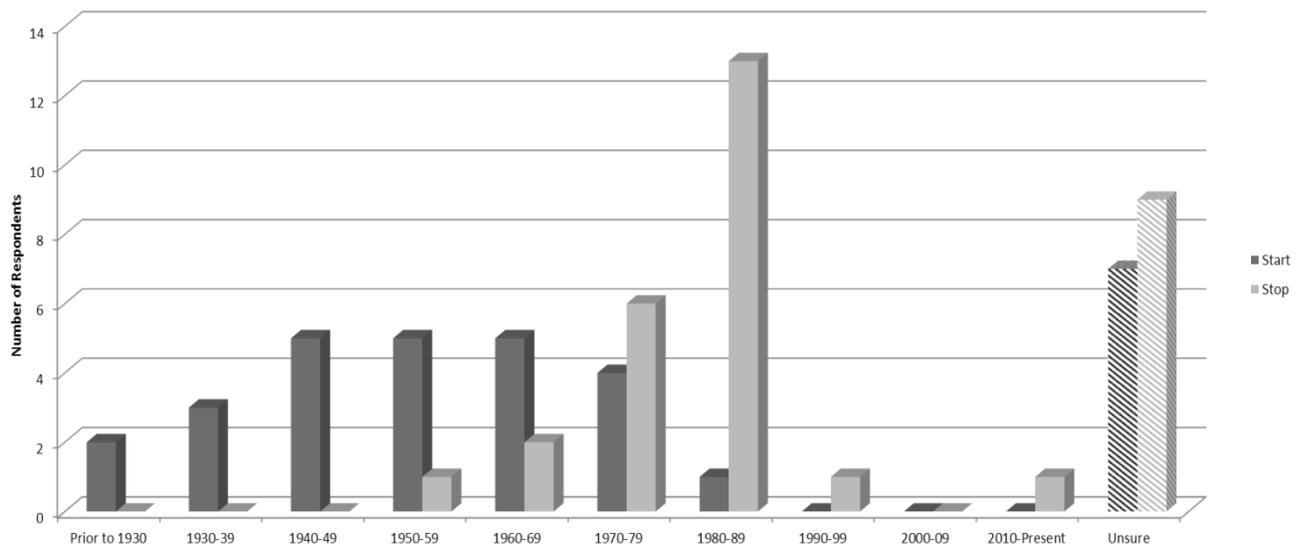
(Q5) What quantity of cellulose acetate laminated materials would you estimate that you have?



### Lamination History at Institutions

Many questions surround how lamination was applied, when it was used, and why certain documents were chosen. Respondents were asked to identify the decades in which their institution began laminating and stopped laminating. For clarity, the chart is plotted in terms of number of respondents answering, rather than percent. As noted below, the earliest laminations were begun prior to 1930, with two respondents checking that box. This predates the NBS recommendation,<sup>33</sup> so may indicate that these institutions were experimenting with lamination early. There is a steady increase in use over the following decades, but most institutions stopped using lamination in the 1980s, likely due to the introduction of encapsulation.<sup>39</sup> The youngest likely age of the lamination treatment on a document is around 25 years old with most being decades older.

(Q6) In which decade did your institution begin using lamination? In which decade did your institution stop using lamination?



Respondents were asked why documents were laminated. They were given the option of choosing reasons that we had found in the literature or by talking with collaborators. They could also fill in their own reasons as seen below. As noted below, there were many reasons that documents were selected for lamination ranging from protection to repair. Also a substantial number of respondents said that documents were laminated solely because it was the standard preservation method.

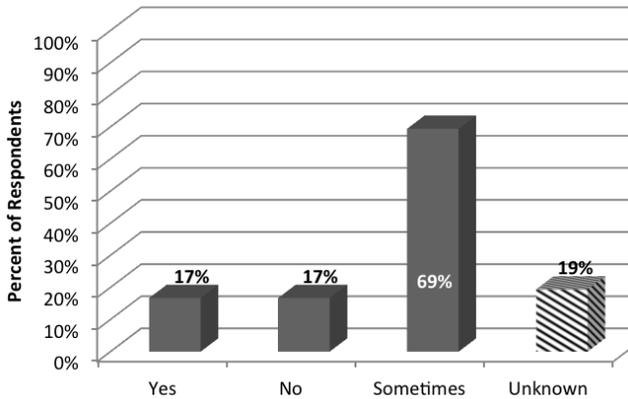
(Q7) Why were documents laminated to your knowledge?

Reason for Lamination	Percent of Respondents
To protect the document from the environment	39%
To allow handling of a document that was too damaged to handle without lamination	61%
To increase the strength of a brittle document	53%
To reconnect pieces of a document	39%
To prevent mold	6%
To prevent damage to the document	56%
It was the standard preservation method	56%
Unsure	22%
Other (in respondents' words)	22%
Best guess is "protection" of valuable records.	
Strengthen documents weakened by mold.	
Institution is located in tropics, protection from climate was main motivation.	
To make the pages more accessible to copying.	
Items were not laminated in-house. Acquired laminated.	
Items were laminated by owner/donor prior to becoming part of permanent collection.	
The lamination of historic documents was undertaken by the county in early 1980s.	

## Lamination Methods and Survey of Collections Containing Lamination, continued

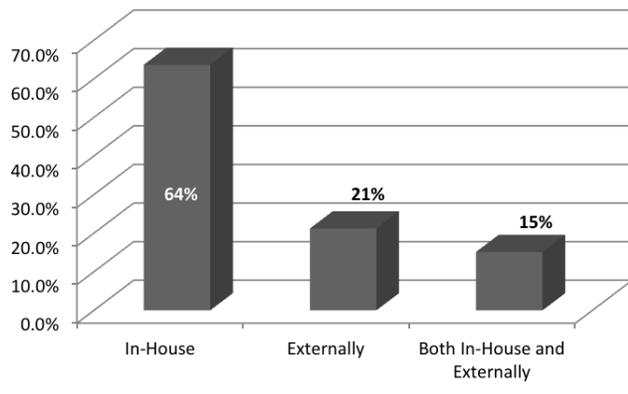
Respondents were asked whether documents were damaged prior to lamination. Most indicated that this was sometimes the case, and some indicated that this was unknown. In many collections it will be difficult to determine whether a laminated document has suffered solely due to lamination as its condition prior to lamination is unknown.

(Q8) Were the documents damaged prior to lamination?



Given the potential for variability in the application for lamination, we wanted to know whether the laminations were done in-house or by specialty vendors. Most respondents answered that the lamination was done in house. An oversight of this question, which was pointed out by a respondent, was the lack of an unknown option. There was a follow up question requesting additional information about where the external lamination was done.

(Q9) Where was the lamination conducted?



The majority of respondents did not know where the external lamination was done. Some external vendors were suggested in (Q10) based either on companies who advertised in the literature like Arbee or Barrow or were suggested by collaborators like Gregory Minnick who took over Barrow's business in the late 1980s.

(Q10) If the lamination was done externally, who conducted the lamination?

### Lamination Agencies

Lamination Agencies	Percent of Respondents
The William J. Barrow Restoration Shop	29%
The Arbee Company	0%
Gregory Minnick in Ashland, VA	7%
Unknown	79%
Other	21%
Some documents have been acquired in this condition	7%
Gale Fields	7%
Ham Rebinding	7%

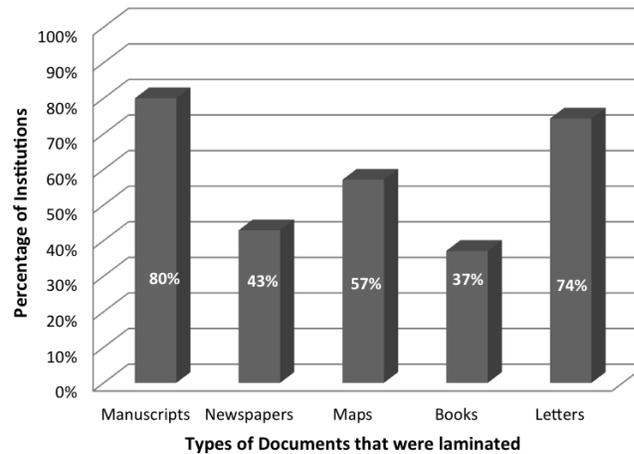
### Characterization of the Documents

Care of laminated documents hinges on many variables. Two major variables are the type of document that was laminated and the media on said document.

The two most common categories of reported laminated documents were manuscripts and letters. Many of these laminated documents are conjugated and/or bound, which adds more complexity to any treatment or future reversal of the lamination.

Interestingly, although CA lamination was originally tested for by the NBS for newspapers, fewer than half of the respondent institutions have laminated newspapers. This may be due to the prevalence of using microfiche or microfilm in preserving this media.

(Q11) What kinds of documents were laminated?

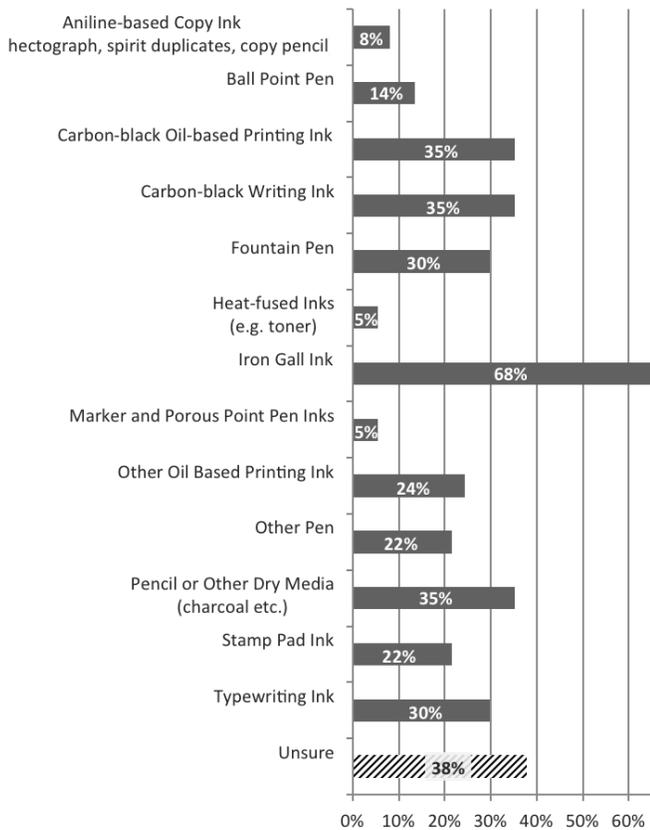


A substantial variety of media was laminated. The goals of this question were to understand the variability of the laminated media, and to determine whether there was any predilection for laminating particular media types.

## Lamination Methods and Survey of Collections Containing Lamination, continued

The single most laminated media type was iron gall ink documents. Over 60% of the respondent institutions have iron gall ink laminated materials. It is unknown at this time whether this is due to the prevalence of iron gall ink media, or if documents were chosen because of prior damage due to paper deterioration caused by iron gall ink. Additionally, two institutions volunteered that they had media containing watercolors that had been laminated.

(Q12) What kinds of media are present in laminated documents?

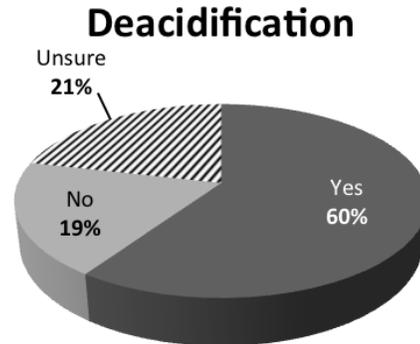


### Deacidification

A major cause of deterioration for cellulose acetate is hydrolysis in the presence of acid. Therefore, if documents were acidic prior to lamination, there is an increased likelihood of deterioration of the laminating film and consequently the laminated document. Thus a major area of concern for us was the pre-treatment of documents by deacidification.

Additionally we were interested in the extent of deacidification being done at institutions around the United States. First in (Q13) we ascertained whether any deacidification had been conducted at the institution. Most of the respondents reported that deacidification had been done on at least one of their materials.

(Q13) Have any of your materials undergone deacidification?



For those institutions where deacidification had been done, we wanted to know whether or not they had done the deacidification in-house. Most of those institutions that had done deacidification, had done the process in-house.

(Q14) Did your institution conduct the deacidification?

Answer	Percent of Respondents
Yes	69%
No	15%
Sometimes	12%
Unsure	4%

We also wanted to know what kind of deacidification was done at the institutions, so (Q15), (Q16), and (Q17) were used to determine what level of confidence the respondents had about their knowledge of what deacidification method had been used, whether deacidification had been done prior to lamination, and the identification of those deacidification methods respectively.

As can be seen in (Q15) most institutions were able to identify the type of deacidification that was done.

(Q15) Can you identify what type(s) of deacidification were done?

Answer	Percent of Respondents
Yes	69%
No	12%
Unsure	23%

The answers to (Q16) were enlightening in terms of what we might expect of laminated documents. While the largest percentage of respondents indicated that they did deacidification prior to lamination, this was not done most of the time. Ignoring the 28% of those who answered the question as not applicable, only half of the remaining respondents always did deacidification prior to lamination. The other half was divided among those who did not deacidify, those that sometimes did, and those that were unsure as to whether it was done.

## Lamination Methods and Survey of Collections Containing Lamination, continued

(Q16) Was deacidification done prior to lamination?

Answer	Percent of Respondents
Yes	36%
No	16%
Sometimes	12%
Unsure	8%
Not Applicable	28%

Many different methods of deacidification were identified as being used prior to lamination. The most common method used for deacidification was Barrow's two bath method with 59% of the respondents choosing that method. This is understandable as many of the respondents used Barrow's lamination method.

(Q17) What deacidification was done before lamination?

Answer	Percent of Respondents
Alkaline gases	12%
Barium hydroxide	12%
Barrow's two bath method: calcium hydroxide (bath 1) + calcium bicarbonate (bath 2)	59%
Battelle or Papersave® process	0%
Bookkeeper ®	6%
Bückeberg conservation procedure, Neschen AG and the C-900	0%
Calcium carbonate	12%
Calcium chloride + ammonium carbonate	0%
Calcium bicarbonate	12%
Calcium hydroxide	6%
Calcium-Magnesium bicarbonate	6%
CSC Booksaver®	6%
Diethyl zinc (DEZ) or Akzo process	0%
Dry Ammonia Ethylene Oxide (DAE) and Book Preservation (BPA) methods	0%
Forced air (Bell) or Libertec®	0%
FMC or Lithco process	0%
Graft polymerization	0%
Magnesium carbonate	0%
Magnesium bicarbonate	18%
Sablé system	0%
Sodium tetraborate	0%
Supercritical carbon dioxide	0%
The Vienna Process	0%
Wei T'o system	41%
Other	30%
Successive baths of calcium enriched deionized water	6%
Answers are best guesses	12%
Not applicable	12%

The deacidification methods were suggested based on a review article about deacidification.<sup>40</sup>

### Condition Today

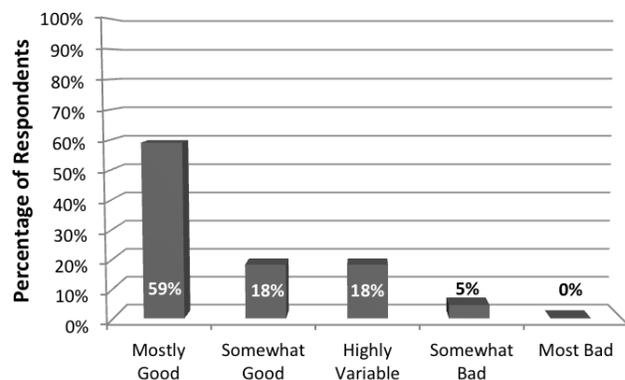
A major reason for this survey was to understand the state of laminated documents in collections today. Thus, respondents were asked whether they could comment on the condition of these laminated documents in (Q18). Most stated that they could comment on the condition of their laminated documents, making their responses in (Q19) stronger.

(Q18) Can you comment on the condition of laminated documents at your institution?

Answer	Percent of Respondents
Yes	78%
No	4%
Unsure	19%

Next they were asked to characterize the condition of their laminated documents. (Q19) provided a Likert scale for the respondents to answer whether their laminated documents (as a whole) were in: Mostly Good, Somewhat Good, Highly Variable, Somewhat Bad, or Mostly Bad condition. Most institutions responded that their laminated documents were either in mostly good or somewhat good condition. However, there were a substantial percentage of the respondents who had laminated documents in either highly variable or somewhat bad condition. It would be advisable to follow this study up in a few years to see if these percentages change.

(Q19) What is the condition of the laminated documents at your institution as a whole?



The chemical deterioration of CA films is sometimes difficult to observe, even though it is occurring. Therefore we wanted to know if respondents had observed any difference in the condition of the documents based on the date of lamination. There was no consensus or trend observed on this question. This may be because the composition of films changed from manufacturer to manufacturer, and may have changed from year to year even when they were purchased from a single manufacturer. Thus, there are likely more variables than simply the age of the lamination contributing to the current condition of the documents.

## Lamination Methods and Survey of Collections Containing Lamination, continued

(Q20) Is there an obvious difference in condition of documents known to have been laminated earlier in the century than those laminated later?

Answer	Percent of Respondents
Yes	24%
No	24%
Unsure	52%

There is no single defining characteristic of deterioration for laminated documents in the literature, so we wanted to know what major types of deterioration were observed in laminated documents. The two most common characteristics were cracking and darkening of the paper, followed by bubbling and delamination of the plastic.

(Q21) What characteristics have you noticed in deteriorating laminated documents?

Answer	Percent of Respondents
Bubbling	44%
Cracking	61%
Shrinking	22%
Breaking	39%
Discoloration of the media on the paper	39%
Darkening of the paper	61%
Formation of holes	0%
Curling or other change in shape of the paper	33%
Delamination of the plastic	44%
Page being pulled (split) by the laminate	6%
Vinegar (acetic acid) smell	28%
Other	24%
Heavy use caused breakage/peeling	6%
Tobacco odor	6%
Good condition-minimal deterioration	6%
Misaligned pages	6%

### Delamination

Delamination is the method of reversal for lamination, and as such is the first logical step in remediating damaged documents. We wanted to know whether institutions had done delamination, how they did it, why they did it, and how often.

We first started by asking if lamination had been removed. Most responding institutions either did not remove lamination or were unsure if it had been done. The remaining 41% said that lamination had been removed from documents belonging to their institution.

(Q22) Has lamination been removed from any documents belonging to your institution?

Answer	Percent of Respondents
Yes	41%
No	44%
Unsure	16%

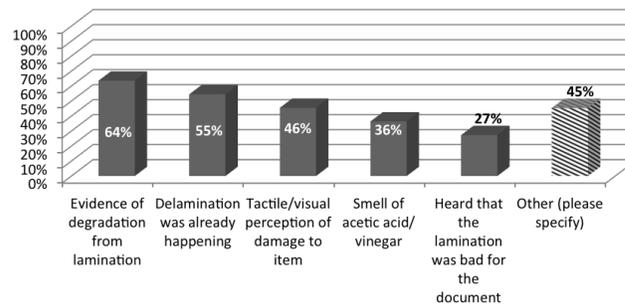
We wanted to know whether the delamination was done in-house. Most of those who had done delamination had done the delamination in-house.

(Q23) Was the removal of lamination done in-house?

Answer	Percent of Respondents
Yes	62%
Sometimes	15%
No	23%
Unsure	0%
Not applicable	0%

Given the often invasive method of delamination a major question for us has been, why do institutions delaminate? We supplied a number of options shown in (Q24). The most common reason was that there was evidence of degradation from the lamination, with the next most common reason being that delamination was already occurring.

(Q24) Why did you delaminate?



We wanted to know who did the lamination removal, with this being an open option for the response. Most of the institutions responded that they did the removal, but a substantial number, 38%, responded that they had an outside conservation company do the work.

(Q25) Who did the lamination removal?

Answer	Percent of Respondents
In-house conservation staff	77%
Outside conservation staff	38%

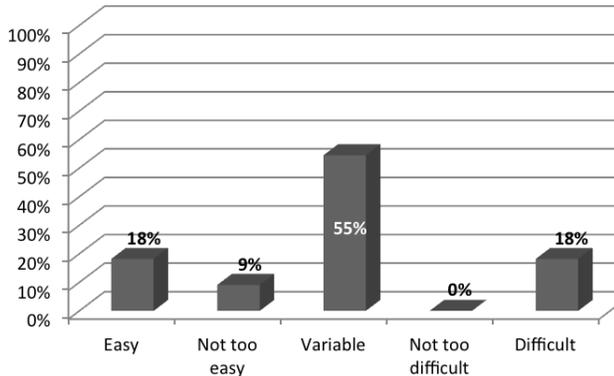
Methods of delaminating are varied, and so we wanted to get an idea of how people were doing the delamination. This was an open answer question, with most respondents stating that the delamination was done in an organic solvent.

(Q26) How was delamination done?

Answer	Percent of Respondents
Organic solvent bath	77%
Mechanical removal	15%
Water bath	8%
Poultice	8%
Unknown	15%

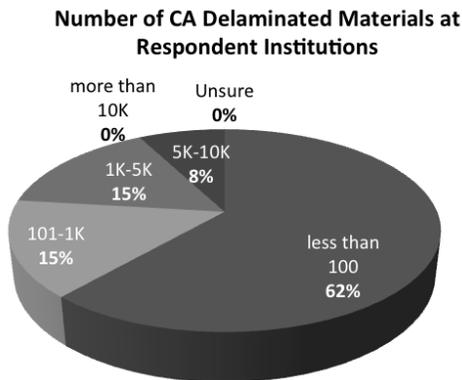
## Lamination Methods and Survey of Collections Containing Lamination, continued

A concern with CA lamination is that as the CA film degrades, it can become less soluble in solvents like acetone. Thus, we wanted to know how difficult delamination was for our respondent institutions. Most institutions stated that the difficulty of delamination was variable.



(Q27) How hard was it to delaminate the documents? Given the complexities associated with delaminating documents, we wanted to get an idea of how many documents had been delaminated. Most responding institutions had delaminated fewer than 100 documents.

(Q28) How many documents would you estimate have been delaminated?



### Storage and Documentation

Given that CA deteriorates by hydrolysis and this is enhanced in humid environments, we wanted to know how the laminated documents were stored by the institutions. Most responded they stored documents in environmentally maintained storage.

(Q29) Are your laminated documents in an environmentally maintained storage?

Answer	Percent of Respondents
Yes	68%
No	4%
Sometimes	0%
Unsure	0%
Not applicable	28%

As most institutions stopped laminating in the 1980s, almost 30 years have passed from the time period when they were laminating. We wanted to know whether documentation from the period of treatment (and also retreatment in the case of delamination) might be in existence at the respondent institutions. Sadly, most often, there is no detailed documentation of these processes.

(Q30) Do you have detailed documentation of conservation at your institution from the period of lamination or delamination?

Answer	Percent of Respondents
Yes	15%
Sometimes	12%
No	42%
Unsure	9%
Not Applicable	21%

### Summary

The survey revealed that institutions across the United States have large quantities of cellulose acetate laminated documents, with only a small number of laminated documents currently in poor condition.

We cannot say, at this time, whether the current good condition of laminated documents observed in collections is truly because the treatment is uniformly successful. We have limited data on retreatment of laminated documents. Thus we may be seeing some amount of survivor bias, i.e., laminated documents are in good condition because they have survived the treatment.

In our interactions with institutions containing laminated documents, we have found instances where the entirety of the collection was in good condition. We have seen others where documents were selected for delamination because the lamination was in bad condition. We had hoped to discover whether we could determine the impacts of deacidification on the survival of lamination. However, the information that institutions provided was not sufficient to assert any conclusions at this time.

The survey depends upon the observation and knowledge of the respondents. Because CA deterioration may happen without visible markers of deterioration, we need to evaluate the chemistry of the laminates analytically, preferably doing a longitudinal study to determine the effects of time on laminate film. This research is currently underway in the HSC laboratory.

Only a small percentage of laminated documents have been delaminated to date. This may be due to the fact that most of the collections appear to be in good condition. It may also be because the removal of lamination is a costly project in terms of time and resources. Given the results of the longitudinal study, we may want to focus more on lamination removal methods.

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## Lamination Methods and Survey of Collections Containing Lamination, continued

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