Mass Deacidification: Effects of Treatment on Library Materials Deacidified by the DEZ and MG-3 Processes

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Disclaimer

The information presented in this paper is the result of research carried out on mass deacidified library materials between 1990 and 1991 while I was Preservation Officer at the Milton S. Eisenhower Library of The Johns Hopkins University. Since moving to Princeton University Libraries I have not kept up with all the advancements and/or refinements in commercially available mass deacidification technologies which might abrogate my research and consign it footnote status in some future text on the history of these processes. This presentation is made to the conservation field in the spirit of fairness, fact, and information exchange, and also in the spirit of being an informed and educated consumer, one who can make decisions based squarely and entirely on fact.

Introduction

For several years a small number of libraries and consortia have been involved with the testing and analysis of several commercially-available mass deacidification technologies. A short list of those involved includes: Harvard University; University of Connecticut at Storrs; Harry Ransom Humanities Research Center, University of Texas, Austin; Johns Hopkins University; the Library of Congress; and the consortium of midwestern libraries constituting the Committee on Institutional Cooperation (CIC). Thousands of items have been treated for and evaluated and tested by these institutions: books, flat paper, and archival materials. The results of and opinions about this work have been conveyed and exchanged both formally and informally. By the time unpublished information reaches the library and archives communities, however, it has little more than anecdotal value to the institutions requiring solid, reliable, and replicable data with which to make decisions. Little has appeared in print which presents any institution's test data, except for several recent publications by the Library of Congress, the Association of Research Libraries, the CIC, and Harvard University[1]. In addition, the test data presented in some of these reports has limited utility. Vendors have provided more information to institutions about their

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mass deacidification systems than the institutions testing these same processes have provided to colleagues in their fields.

The Johns Hopkins and Harvard Universities have signed contracts for mass deacidification services. During the Hopkins contract signing, the library expressed confidence in both the process and in the product, but without sharing data from its year-long testing program with the news media to support its assurances. Although health and safety concerns for staff and users were also not mentioned, it must be implicit that these concerns had also been assuaged to the Hopkins library administration's satisfaction.

The message being sent to the library and archives communities by these contract signings is that mass deacidification works and that it is OK for these institutions collections. My experience indicates that it is not that simple. What is not being conveyed is straight forward, unequivocal information about process effectiveness and side effects on both materials and people. Very simply:

-- When do the mass deacidification processes work and how do they work, and when do the processes not work and why?
-- Are there perceptible as well as imperceptible differences between treated and untreated materials?
-- Are there any changes in binding materials: adhesives, glues, cloth, paper, board, thread, coatings, plastics, inks, etc?
and
-- What are the effects of treatment and to what degree do they occur? How many and what percentage of items are affected?

The short and simple answer to these questions is that all mass deacidified materials were affected in some way by the two commercially-available processes with which I am familiar: Akzo's DEZ process and FMC/Lithco's MG-3 process.

The Johns Hopkins Experience with Mass Deacidification, 1990-1991

In my experience at the Milton S. Eisenhower Library of The Johns Hopkins University the results of mass deacidification test runs on typical library materials, what I have named the "effects of treatment", were so startling that I had to wonder why these results had not been known earlier, considering especially all the DEZ research conducted by and for the Library of

Congress on books since the 1970s.

In some cases, the physical damage to some items was so great that it required remediation, commercial rebinding, or replacement. Covering material components--binding adhesives, cloth, paper, and illustration colors and inks--were all affected to one degree or another, depending upon the items selected for treatment. Book paper cockled. All paper discolored somewhat and emanated an odor. Hot-melt adhesives expanded or embrittled. Cold-melt adhesives dissolved. With one process or the other, Selin call number labels either bubbled and shriveled up or their adhesives oozed, precluding treatment of retrospective collections labeled in this manner. Flat paper, archival materials, and photographs were affected less so. Some materials also were incompletely treated and remained acidic in part. Charts 1 and 2 present empirical and statistical data compiled for 1,162 books mass deacidified for Johns Hopkins by Akzo and FMC between May 1990 and May 1991.

The photos on the following pages illustrate some of the effects of treatment I have just glossed over.

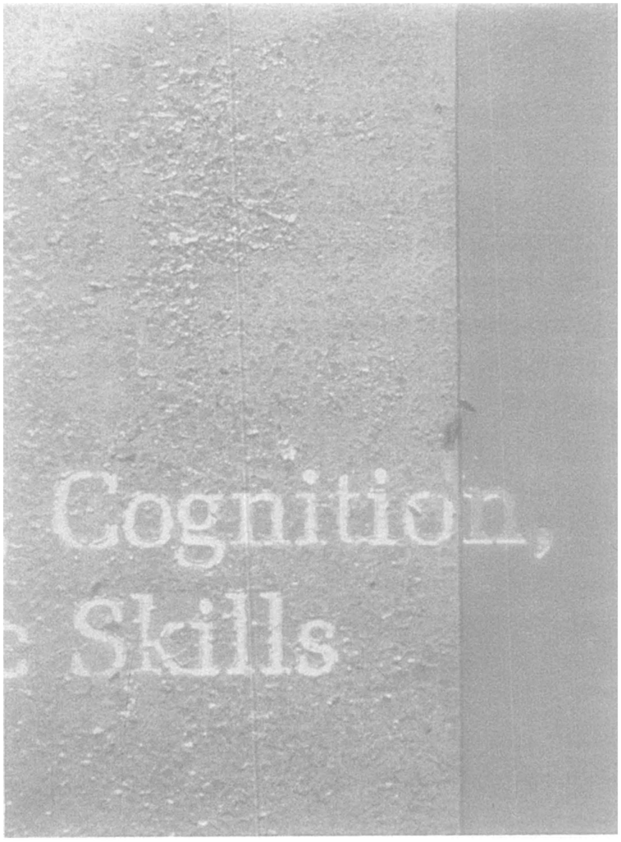

Fig. 1 DEZ: Adhesive Effect

Fig. 2 DEZ: Flaking Cover Effect

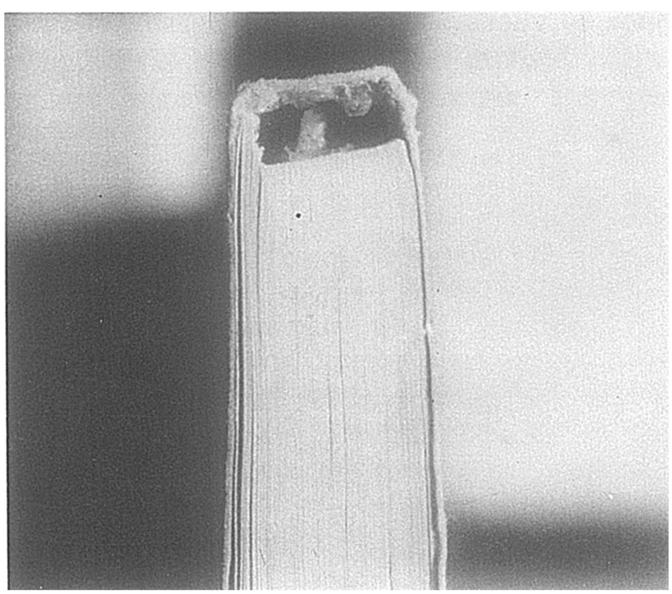

Fig. 3 DEZ: Adhesive Effect

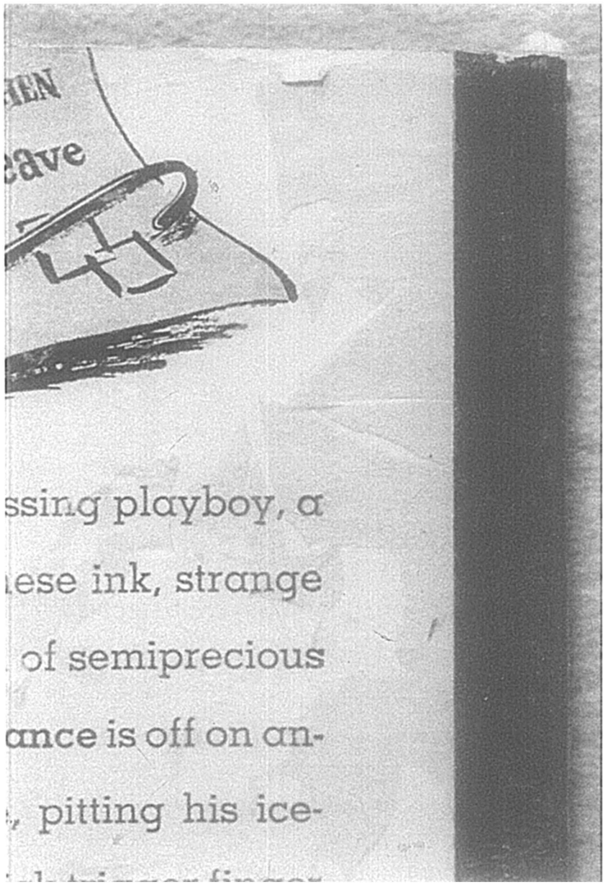

Fig. 4 DEZ: Plastic Film Effect

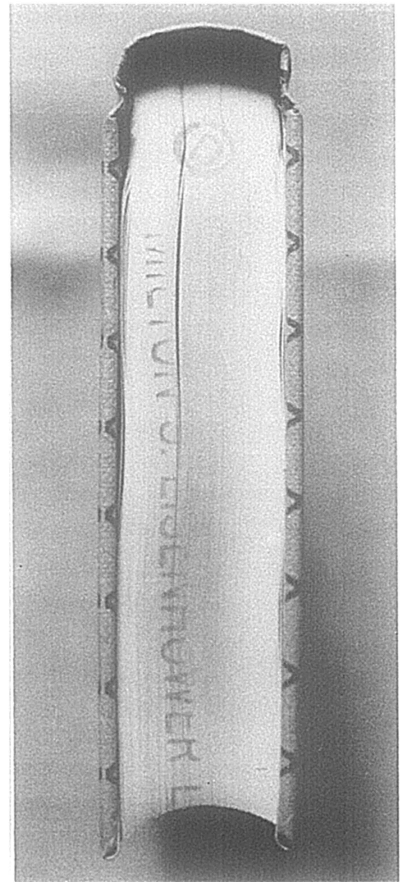

Fig. 5 DEZ: Edge Burn Effect

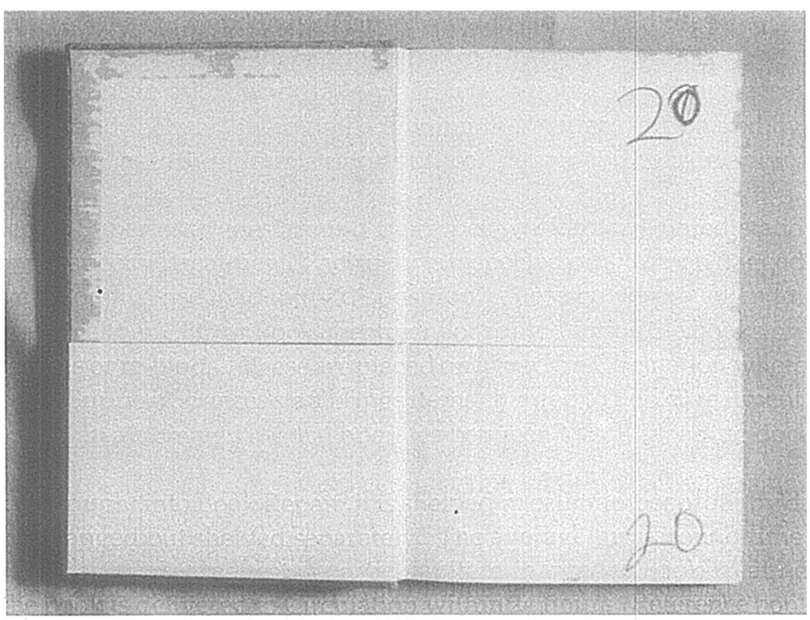

Fig. 6 DEZ: Turn-in Staining Effect

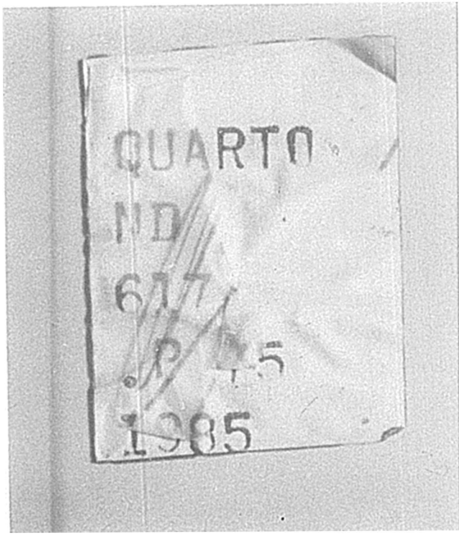

Fig. 7 DEZ: Selin Label Effect

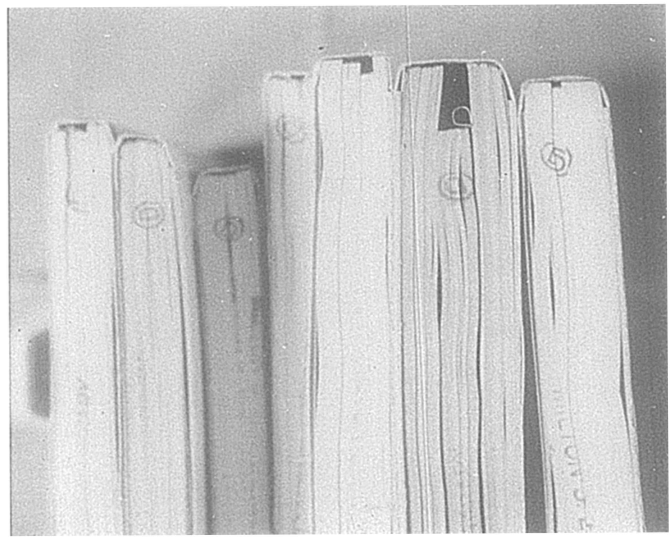

Fig. 8 DEZ: Brittle Adhesive Effect

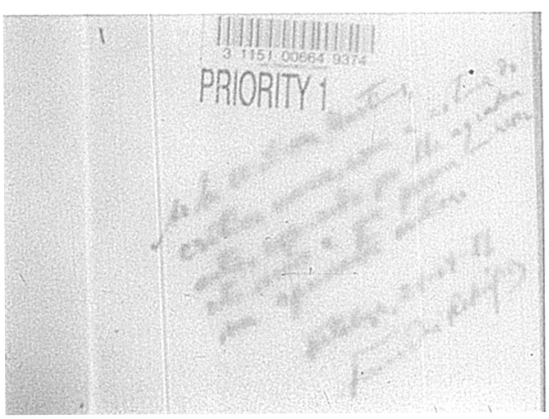

Fig. 9 MG-3: Ink Feathering Effect

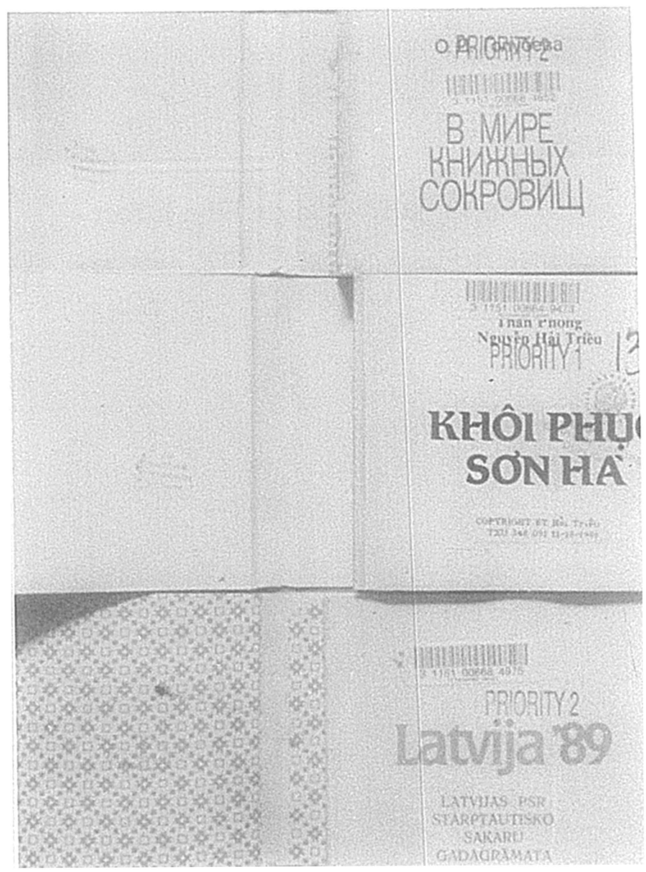

Fig. 10. MG-3: Dissolving Adhesive Effect

Fig. 11 MG-3 Selin Label Effect

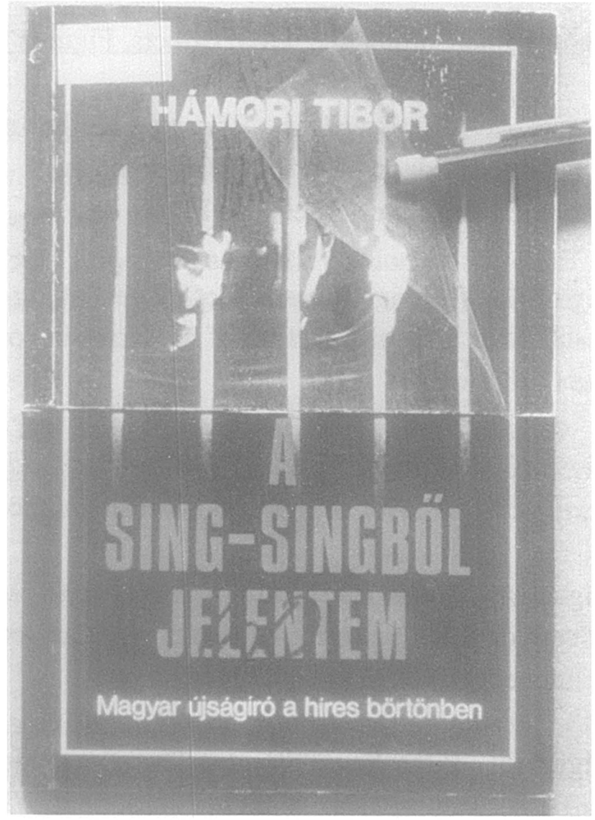

Fig. 12 MG-3 Plastic Film Effect

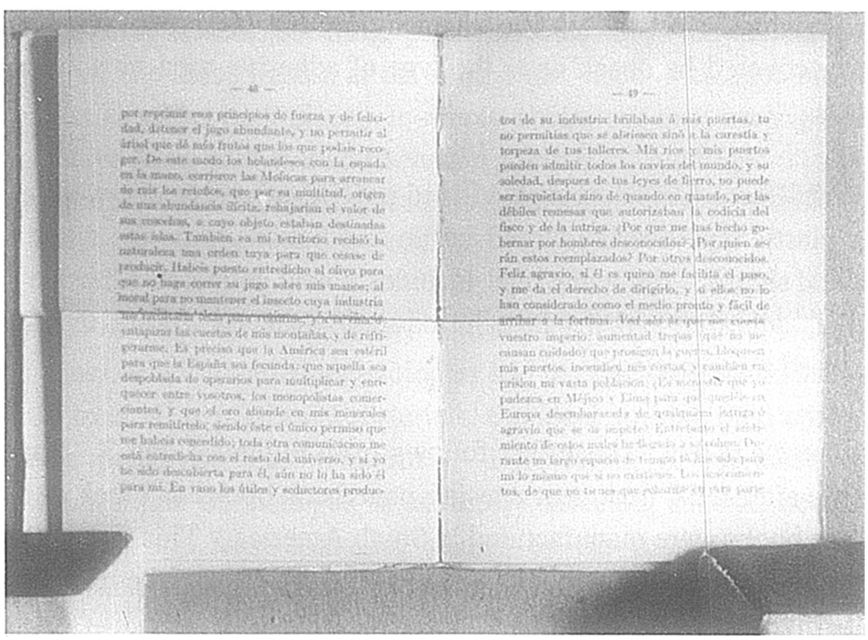

Fig. 13 MG-3 Page Discoloration Effect

Photograph Comments: DEZ Effects, Figures 1-8[2]

Figure 1: Adhesive Effect. The original hot melt adhesive melted and bubbled beyond the top and bottom edges of this 1950s paperback. The adhesive also expanded, pushing apart the textblock and cover. (See also Figure 3.)

Figure 2: Flaking Cover Effect. The flaking seen on this paper covered hardback may be the result of an adverse reaction of a pyroxylin (or some other) coating on the covering material to the DEZ process.

Figure 3: Adhesive Effect. The hot melt adhesive bubbled and expanded, pushing apart the textblock and cover of this 1960s softbound book. (Similar to Figure 1.)

Figure 4: Plastic Film Effect. Most clear plastic-like films protecting the printing and paper covers of some paperbound books were affected by delamination or bubbling, or, in this case, brittleness and flaking.

Figure 5: Edge Burn Effect. The speculation for this effect is that the book was not dried sufficiently/appropriately before treatment. The excess moisture in the paper, attempting to migrate out of the book, encountered DEZ gas at the edges of the textblock, causing this chemical burn, due to the pyrophoric nature of diethyl zinc gas.

Figure 6: Turn-in Staining Effect. This staining may be due to a pyroxylin (or some other) coating on this paper covered hardback or to the type of adhesive used to adhere the covering material to the boards.

Figure 7: Selin Label Effect. All Selin labels affixed to DEZ-treated books were affected in this manner. The clear plastic tape overlay turned brittle and flaked, while the white tape substrate buckled, puckered, and shrank. The white tape includes a heat activated adhesive for affixing it to book covers. This adhesive and the heat introduced/generated during the DEZ treatment process probably caused this reaction.

Figure 8: Brittle Adhesive Effect. This effect follows from Figures 1 and 3. Normally flexible adhesive turned brittle after DEZ treatment causing paperback books to break at opening points during use. (All these books were manufactured in South America.) This figure also illustrates a method to mark/stamp mass deacidified books easily on the top edge of the textblock. The mark is a capital "D" in a circle.

Photograph Comments: MG-3 Effects, Figures 9-13[2]

Figure 9: Ink Feathering Effect. The CFC solvent used in the MG-3 process to carry the chemical to the books caused the ink of this inscription to feather and smear.

Figure 10: Dissolving Adhesive Effect. The CFC solvent may have caused a portion of the cold melt adhesives of these paperbacks to dissolve at the cover-to-text attachment, releasing their covers.

Figure 11: Selin Label Effect. In a number of cases the Selin label adhesive dissolved slightly and a brown residue accumulated around the edges and tops of the labels. In other cases only the clear tape overlay bubbled.

Figure 12: Plastic Film Effect. Plastic film used to protect the printed covers of paperbacks bubbled up and released easily from their covers.

Figure 13: Page Discoloration Effect. This effect was caused by too much solvent remaining in the paper after treatment. In most cases the page became slightly translucent/transparent.

Note: Some but not all of the process effects illustrated above and listed in Charts 1 and 2 had low incidence occurrence, as low as one instance during the entire Hopkins testing program. In other instances, 100%, or nearly 100%, of the items tested in the testing program were affected in a particular way: for example, odor, cockling, paper discoloration. Low incidence occurrence is linked to the number of like items treated at the same time. Low incidence occurrence does not negate in any way that an effect took place. It simply points out that, among other things: 1) a variety of materials have been used in manufacturing publishers' bindings; 2) the deacidification of some of these materials will be problematical; 3) these materials are probably not deselectable beforehand; and 4) that damage will result from their treatment.

As you have seen, as of May 1991 and based entirely on empirical evidence from the Johns Hopkins test runs, mass deacidification technologies had not been refined to the point where they would transparently treat all paper-based materials, the ideal so long held and hoped for by the library and archives preservation communities. Deselection or pre-selection of items for treatment, those which might be damaged or adversely affected, seemed necessary in order to obtain the best possible and least damaging results on the remaining but diminished pool candidates for mass deacidification. It is doubtful, based on my experience at the time, that DEZ or MG-3 would have been able to treat more than a limited spectrum of the wide variety of books and other paper-based materials which libraries and archives collect, house, and preserve.

Evaluating the Empirical Data

While gathering empirical data on the test runs I realized that simply listing the effects of treatments and compiling statistics about them alone would not wholly determine the viability of any particular mass deacidification process to a library. As a result, I developed a decision making model which can be used by an institution's administration and preservation staff for reviewing the empirical data to determine the acceptability of one or more treatment effects on an institution's materials. (Refer to Chart 3.) I characterize this decision making model in two ways. First, it is a vehicle to assess and perhaps quantify possible risk, that is, damage, to collections materials. In this way it is a risk management tool. Potential benefit may be weighed against potential risk. Second, the model serves as a means to establish a minimum level, or a threshold, of acceptable damage to materials. This threshold, although not indicated on the chart, can be expressed as a percentage or minimum number of items damaged in some way or in particular ways per shipment or per year. An institution would have to decide, based on the entire range of possible undesirable and destructive treatment effects, what extent of collection damage it would tolerate as a result of mass deacidification treatment. Some damage translates into increased expense because of the cost of additional handling and of remediation, to repair or replace this items.

Conclusion

Conservators and preservation administrators cannot make recommendations or decisions based on faith and hope. Promotional materials provided and promises made by mass deacidification vendors, anecdotes about treatment effects and empirical and scientific test results, uninterpreted or incomplete test data, both apparent and nonapparent physical damage and process defects, and the actions of institutions and the opinions of colleagues cannot be used as the sole sources of information by which important collections preservation decisions are made. Open and public access to and distribution of test results and analyzed data will allow institutions with interest in this technology to make decisions regarding its efficacy for the deacidification and preservation of their collections as well as for the health and safety of their staff and users. In addition, continuing unknowns about available and future technologies should not discourage us from using and benefitting from mass deacidification services, rather they should encourage us to seek more information and become more informed consumers before committing ourselves to any imperfect process. This informed consumer approach will help those whose decisions will permanently affect the usefulness and life of the collections they were hired to manage, develop, preserve, and conserve.

References and Notes

1. Two of these references were not available to me at the time of the AIC Annual Meeting. Full citations for all the references follow:

CIC Task Force on Mass Deacidification. Mass Deacidification: A Report to the Library Directors. N.p.: Committee on Institutional Cooperation, 1992.

Institute of Paper Science and Technology. Physical Properties of Library Books Deacidified by Akzo Chemicals, Inc. Report to The Library of Congress...in response to No. RFP90-32. Project 3717, Report 2. Atlanta, GA: IPST, 1991.

Institute of Paper Science and Technology. Physical Properties of Library Books Deacidified by FMC Corporation. Report to The Library of Congress...in response to No. RFP90-32. Project 3717, Report 1. Atlanta, GA: IPST, 1991.

Institute of Paper Science and Technology. Physical Properties of Library Books Deacidified by Wei T'o Associates, Inc. Report to The Library of Congress...in response to No. RFP90-32. Project 3717, Report 3. Atlanta, GA: IPST, 1991.

Institute of Paper Science and Technology. Physical Properties of Library Books Untreated Control Books. Report to The Library of Congress...in response to No. RFP90-32. Project 3717, Report 4. Atlanta, GA: IPST, 1991.

MacInnes, Andrew N., and Andrew R. Barron. "A Spectroscopic Evaluation of the Efficacy of Two Mass Deacidification Processes." Cambridge, MA: Harvard University, [1992].

Sparks, Peter G., ed. A Roundtable on Mass Deacidification. Washington, DC: Association of Research Libraries, 1992.

2. Not all process effects presented at the annual meeting are illustrated in this paper.

Chart 1: Effects of Treatment: Breakdown by Binding Format

	Paperback	Hardback	Periodical	Pamphlet	TOTALS	% of all items shipped
Total items in shipment	510	482	121	49	1162	100.00%
.......Percentage of all materials shipped	43.89%	41.48%	10.41%	4.22%		
Total items affected (exclusive of odor, cockling, and paper yellowing)***	329	257	35	29	650	55.94%
.......Percentage of binding type	64.51%	53.32%	28.93%	59.18%		
.......Percentage of all materials shipped..x	28.31%	22.12%	3.01%	2.50%		
Total items affected which may require remedial treatment	261	102	11	20	394	33.91%
.......Percentage of binding type..x	51.18%	21.16%	9.09%	40.82%		
.......Percentage of all materials shipped..xx	22.46%	8.78%	0.95%	1.72%		
Evidence or effects of mass deacidification treatment on bound materials						
Delamination						
.....Cover *	108	6	8	1	123	10.59%
.....Pastedown *	1	0	0	0	1	0.09%
.....Plastic film *	47	7	0	1	55	4.73%
.....Pressure-sensitive cloth *	0	0	0	1	1	0.09%
.....Pressure-sensitive tape	1	4	0	0	5	0.43%
.....SELIN label */**	93	66	0	17	176	15.15%
.....Stamping ink/foil color *	0	1	0	0	1	0.09%
Ink Feathering						
.....Ball point pen ink	12	10	0	0	22	1.89%
.....Non-Hopkins library property stamp ink	15	17	2	0	34	2.93%
.....Text paper printing ink *	1	2	0	0	3	0.26%
Color shifting or discolorations						
.....Cover color	76	58	11	8	153	13.17%
.....Endsheet/pastedown/inside cover	2	93	3	0	98	8.43%
.....Non-Hopkins library security label	0	3	0	0	3	0.26%
.....Text paper yellowing		Many items affected				
Other chemical or process effects						
.....Adhesive effects						
..........Adhesive embrittlement *	12	0	0	0	12	1.03%
..........Spine adhesive expansion/meltdown *	21	1	3	0	25	2.15%
..........Stiff adhesive	35	8	5	0	48	4.13%
.....Chemical burn	7	1	0	0	8	0.69%
.....Chemical residues or deposits						
..........Covers	16	24	2	0	42	3.61%
..........Sticky cover *	18	7	0	0	25	2.15%
..........Text paper	13	8	2	0	23	1.98%
.....Cockling		Many items affected				
.....Cracked or flaking cover coating *	0	9	0	0	9	0.77%
.....Curled paper cover *	1	0	0	0	1	0.09%
.....Incomplete page treatment *	7	5	0	0	12	1.03%
.....Odor		Almost all items affected				
.....Polyester clouding *	0	0	0	1	1	0.09%
.....Staining						
..........Pastedown turn-in	0	7	0	0	7	0.60%
..........Pastedown	1	4	0	0	5	0.43%
.....Sticking/blocking pages *	1	0	0	0	1	0.09%
.....Vinyl covering shrinkage *	1	1	0	0	2	0.17%
Other						
.....Missing item *	0	0	0	1	1	0.09%

* Effect which may require remedial treatment: replacement, repair, commercial rebinding.

** Not all items were affixed with SELIN in every test run. In the third Akzo test run, 100% of the books affixed with SELIN labels sustained label damage.

*** Almost 100% of the books exhibited odor, cockling, and paper yellowing every shipment.

Note 1: Materials selected for these trial treatments represented bound materials in the Milton S. Eisenhower Library's general collections and conformed to the Library's selection policy for mass deacidification.

Note 2: No totals are provided at the bottom of this chart because many items exhibited multiple effects.

Chart 2: Effects of Treatment: Breakdown by Vendor

	Akzo	% of all Akzo materials shipped	% of all materials shipped..x	FMC	% of all FMC materials shipped	% of all materials shipped..xx	TOTALS	% of all materials shipped
Total items in shipment--hardbacks, paperbacks, periodicals, pamphlets	667	100.00%	57.40%	495	100.00%	42.60%	1162	100.00%
Total items affected (exclusive of odor, cockling, and paper yellowing)***	291	43.63%	25.04%	359	72.53%	30.90%	650	55.94%
Total items affected which may require remedial treatment	162	24.29%	13.94%	232	46.87%	19.97%	394	33.91%
Evidence or effects of mass deacidification treatment on bound materials								
Delamination								
.....Cover *	27	4.05%	2.32%	96	19.39%	8.26%	123	10.59%
.....Pastedown *	1	0.15%	0.09%	0	0.00%	0.00%	1	0.09%
.....Plastic film *	33	4.95%	2.84%	22	4.44%	1.89%	55	4.73%
.....Pressure-sensitive cloth *	1	0.15%	0.09%	0	0.00%	0.00%	1	0.09%
.....Pressure-sensitive tape	2	0.30%	0.17%	3	0.61%	0.26%	5	0.43%
.....SELIN label */**	68	10.19%	5.85%	108	21.82%	9.29%	176	15.15%
.....Stamping ink/foil color *	1	0.15%	0.09%	0	0.00%	0.00%	1	0.09%
Ink Feathering								
.....Ball point pen ink	0	0.00%	0.00%	22	4.44%	1.89%	22	1.89%
.....Non-Hopkins library property stamp ink	0	0.00%	0.00%	34	6.87%	2.93%	34	2.93%
.....Text paper printing ink *	0	0.00%	0.00%	3	0.61%	0.26%	3	0.26%
Color shifting or discolorations								
.....Cover color	73	10.94%	6.28%	80	16.16%	6.88%	153	13.17%
.....Endsheet/pastedown/inside cover	0	0.00%	0.00%	98	19.80%	8.43%	98	8.43%
.....Non-Hopkins library security label	0	0.00%	0.00%	3	0.61%	0.26%	3	0.26%
.....Text paper yellowing	16	2.40%	1.38%	Many	items	affected	16	1.38%
Other chemical or process effects								
.....Adhesive effects								
..........Adhesive embrittlement *	12	1.80%	1.03%	0	0.00%	0.00%	12	1.03%
..........Spine adhesive expansion/meltdown *	24	3.60%	2.07%	1	0.20%	0.09%	25	2.15%
..........Stiff adhesive	48	7.20%	4.13%	0	0.00%	0.00%	48	4.13%
.....Chemical burn	8	1.20%	0.69%	0	0.00%	0.00%	8	0.69%
.....Chemical residues or deposits								
..........Covers	37	5.55%	3.18%	5	1.01%	0.43%	42	3.61%
..........Sticky cover *	0	0.00%	0.00%	25	5.05%	2.15%	25	2.15%
..........Text paper	23	3.45%	1.98%	0	0.00%	0.00%	23	1.98%
.....Cockling	Many	items	affected	Many	items	affected		
.....Cracked or flaking cover coating *	9	1.35%	0.77%	0	0.00%	0.00%	9	0.77%
.....Curled paper cover *	0	0.00%	0.00%	1	0.20%	0.09%	1	0.09%
.....Incomplete page treatment *	12	1.80%	1.03%	0	0.00%	0.00%	12	1.03%
.....Odor	Many	items	affected	Many	items	affected		
.....Polyester clouding *	1	0.15%	0.09%	0	0.00%	0.00%	1	0.09%
.....Staining								
..........Pastedown turn-in	2	0.30%	0.17%	5	1.01%	0.43%	7	0.60%
..........Pastedown	1	0.15%	0.09%	4	0.81%	0.34%	5	0.43%
.....Sticking/blocking pages *	1	0.15%	0.09%	0	0.00%	0.00%	1	0.09%
.....Vinyl covering shrinkage *	1	0.15%	0.09%	1	0.20%	0.09%	2	0.17%

* Effect which may require remedial treatment: replacement, repair, commercial rebinding.

** Not all items were affixed with SELIN in every test run. In the third Akzo test run, 100% of the books affixed with SELIN labels sustained label damage.

*** Almost 100% of the books exhibited odor, cockling, and paper yellowing every shipment.

Note 1: Materials selected for these trial treatments represented bound materials in the Milton S. Eisenhower Library's general collections and conformed to the Library's selection policy for mass deacidification.

Note 2: No totals are provided at the bottom of this chart because many items exhibited multiple effects.

Chart 3a: Evaluation Model for Empirical Testing for Mass Deacidification

	Effect is		Effect is.						Effect is..	
	Reversible	Non-reversible	Non-damaging	Structurally damaging	Non-structurally damaging	Effect may require remedial treatment *	Effect requires materials processing change(s) in library **	Effect requires pre- or de-selection ***	Acceptable	Un-acceptable
Observable evidence or effect of mass deacidification treatment on bound materials										
Delamination										
.....Cover		x		x		x		x		x
.....Pastedown		x		x		x				x
.....Plastic film		x			x	x		x		x
.....Pressure-sensitive cloth		x		x		x	x			x
.....Pressure-sensitive tape		x			x				x	
.....SELIN label **		x			x	x	x			x
.....Stamping ink/foil color		x			x	x				x
Ink Feathering										
.....Ball point pen ink		x			x				x	
.....Non-Hopkins library property stamp ink		x			x				x	
.....Text paper printing ink		x			x	x				x
Color shifting or discolorations										
.....Cover color		x			x				x	
.....Endsheet/pastedown/inside cover		x			x				x	
.....Non-Hopkins library security label		x			x		x		x	
.....Text paper yellowing		x			x				x	
Other chemical or process effects										
.....Adhesive effects										
...........Adhesive embrittlement		x		x		x		x		x
...........Spine adhesive expansion/meltdown		x		x		x		x		x
...........Stiff adhesive		x		x					x	
.....Chemical burn		x			x				x	

* Remedial treatment may be required, such as replacement, repair, commercial rebinding, or second mass deacidification treatment, to correct effect of mass deacidification.

** In-house materials processing or shelf preparation procedures frequently introduce/add new materials into a book, i.e. labels and property stamps. Procedures may require revision to accommodate any potential damage which might occur to these new materials as a result of mass deacidification. For example, SELIN labels can be applied after treatment.

*** Binding materials likely to be affected by mass deacidification cannot usually be easily identified and preselected from possible mass deacidification treatment candidates. These problematical materials include: adhesives, plastic films, coatings, inks, and paper types (coated and uncoated).

Note: This chart reflects MSEL Preservation Department judgments (at the time) regarding the impact of the effects of mass deacidification on the selection, processing, use, life, and soundness of materials.

Chart 3b: Evaluation Model for Empirical Testing for Mass Deacidification

Observable evidence or effect of mass deacidification treatment on bound materials	Effect is: Reversible	Effect is: Non-reversible	Effect is.: Non-damaging	Effect is.: Structurally damaging	Effect is.: Non-structurally damaging	Effect may require remedial treatment *	Effect requires materials processing change(s) in library **	Effect requires pre- or de-selection ***	Effect is..: Acceptable	Effect is..: Un-acceptable
Other chemical or process effects (continued)										
.....Chemical residues or deposits										
..........Covers		x .			x				x	
..........Sticky cover		x			x	x		x		x
..........Text paper		x			x				x	
.....Cockling	x		x						x	
.....Cracked or flaking cover coating		x			x	x		x		x
.....Curled paper cover		x		x		x				x
.....Incomplete page treatment	x				x	x				x
.....Odor	x		x						x	
.....Polyester clouding		x			x	x	x			x
.....Staining										
..........Pastedown turn-in		x			x				x	
..........Pastedown		x			x				x	
.....Sticking/blocking pages		x		x		x				x
.....Vinyl covering shrinkage		x		x		x				x
Other										
.....Missing item		x			x	x				x

* Remedial treatment may be required, such as replacement, repair, commercial rebinding, or second mass deacidification treatment, to correct effect of mass deacidification.

** In-house materials processing or shelf preparation procedures frequently introduce/add new materials into a book, i.e. labels and property stamps. Procedures may require revision to accommodate any potential damage which might occur to these new materials as a result of mass deacidification. For example, SELIN labels can be applied after treatment.

*** Binding materials likely to be affected by mass deacidification cannot usually be easily identified and preselected from possible mass deacidification treatment candidates. These problematical materials include: adhesives, plastic films, coatings, inks, and paper types (coated and uncoated).

Note: This chart reflects MSEL Preservation Department judgments (at the time) regarding the impact of the effects of mass deacidification on the selection, processing, use, life, and soundness of materials.