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A Simple Measurement of Torsional Rigidity of Paper

by A. ARAD

Aging of paper is tested, among other ways, by measuring changes in its physical properties. Most measurements of physical properties require expensive instruments and thus, remain confined to larger research laboratories.

I believe that simple testing has place in the smaller workshops, too. Simple tests, although not accurate enough for theoretical research, can help the restorer in developing new methods or modifying existing ones, and serve also as indications for what might be termed »quality control« over materials. Naturally these tests should be *relative* in order to be useful.

Torsional Rigidity – Definitions

The following test for torsional rigidity has been chosen for two reasons: first, it is easy to perform and requires no expensive instrumentation. Second, it is useful for comparing adhesives, foils for lamination etc., and is reasonably sensitive to aging.

A body with a moment of inertia I hanging on a strip which has a length L, thickness d, and width b, if displaced from its state of equilibrium (Fig. 1) will oscillate with a period p and the relation:

$$p = 2\pi K \sqrt{\frac{LI}{N}}$$

is fulfilled, where N is the torsional rigidity and K depends on d, b and (to some extent) the angle of displacement α.

When α, I, d, b, are constant it follows that: $N = \bar{R}\frac{L}{p^2}$, where $\bar{R}$ is the appropriate constant (for the simple rigidity n: $n = \frac{48\pi^2}{db^3} \times \frac{IL}{p^2}$).

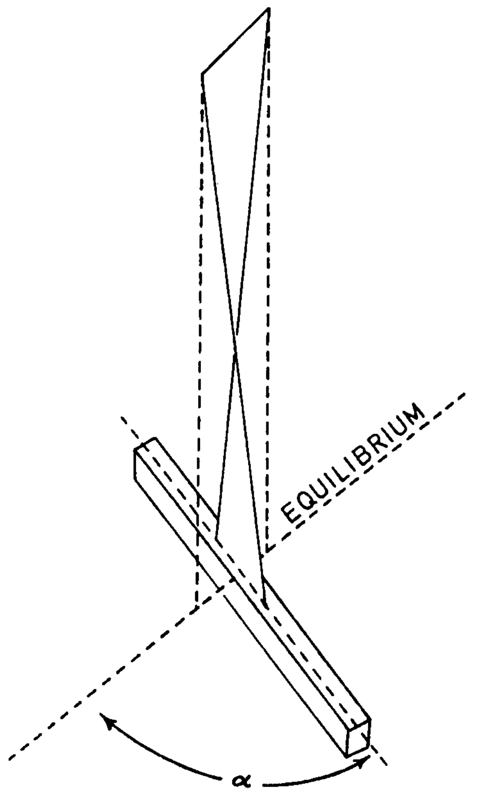

FIG. 1

For purpose of *relative* measurements on the *same* paper we can define torsional rigidity M by:

$$(1)\ M = \frac{L}{p^2} \times 10 \quad \text{(L in cm. and p in sec.)}$$

(The factor 10 was chosen experimentally so that the results may be conveniently read).

As rigidity depends very much on thickness, we may want to modify it (In order to compare rigidity of materials disregarding their thicknesses).

And so we define the rigidity factor S by:

$$(2)\ S = \frac{M}{d} = \frac{L}{p^2 d} \quad \text{(L in cm., p in sec., d in mm.)}$$

d was chosen because of theoretical reasons.

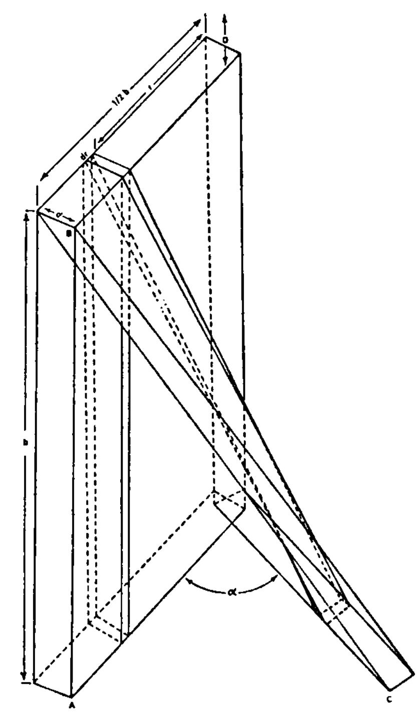

FIG. 2

DERIVATION OF THE FORMULA

Fig. 2 describes a half a strip which is displaced from its equilibrium by a small angel α. (The figure is greatly exagerated for the sake of clarity). 0 is the axis of rotation. The thickness of the strip is d, its length is L, and its width b.

Assuming that no change of volume occures in the strip, we denote the *modulus of simple rigidity* by n.

Consider now a thin strip whose face is a longitudinal section of the paper-strip, which has a distance of r from axis 0, and has a thickness of dr. It is sheared through the angel ABC i.e.

$$\frac{AC}{AB} = \frac{r\alpha}{L}$$

The stress over the lower part of the strip is, thus

$$\frac{r\alpha n}{L}$$

and the moment is, therefore:

$$\frac{r^2\alpha n}{L}$$

This is the moment about 0 per unit area of the lower end. The chosen strip contributes thus a moment of:

$$\frac{r^2\alpha nd}{L}\,dr$$

As the calculation is for a half a strip the whole restoring couple will be:

$$2\int_0^{b/2}\frac{dn\alpha}{L}\,r^2dr = \frac{dn\alpha b^3}{12L}$$

The restoring couple 0 per unit twist C, is:

$$C = \frac{dnb^3}{12L}$$

A body having a moment of inertia I suspended at the end of the strip will, when displaced, so that the period p:

$$p = 2\pi\sqrt{\frac{I}{C}}$$

By substituting C we get:

$$p = 2\pi\sqrt{\frac{12}{\text{u}nb^3}}\sqrt{\frac{IL}{n}}$$

This obviously is the first formula written in the paper.

By squaring and manipulating we get another form to express the simple rigidity modulus, from which all the constants and factors mentioned in the paper may be exactly computed:

$$n = \frac{48\pi^2}{db^3}\times\frac{IL}{p^2}$$

Experimental

Fig. 3 gives a rough sketch of the instrument which was built. Dimensions were purposely omitted as each instrument will suffice as long as the following points are remembered:

a. The measurements are only relative, i.e., the results should be used only for comparison.

b. Care should be taken to deflect the hanging body always at the same angle (which should not exceed 45°) and in such a way that no »parasitic« oscillations occur.

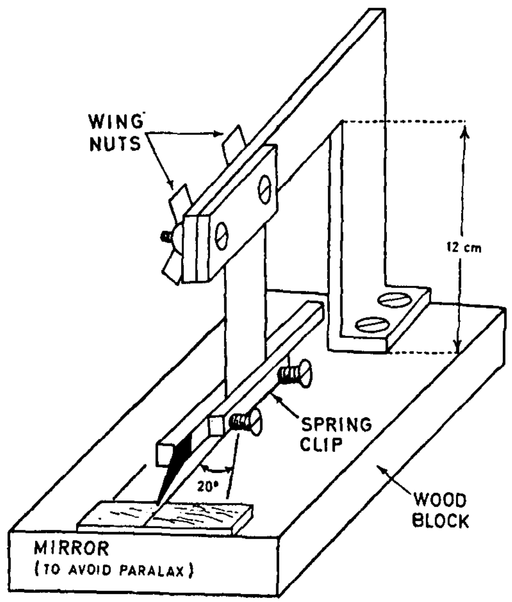

FIG. 3

Measurements of period was done using a simple stopwatch and measuring the time needed for 10 oscillations.

Each result is an average of 10 readings.

Table 1 shows measurements for 10 samples of paper from the same batch.

Sample	M	Deviation
1	62.00	1.64
2	66.27	2.63
3	60.61	3.03
4	64.00	0.36
5	57.92	5.72
6	64.00	0.36
7	66.27	2.63
8	65.04	1.40
9	66.27	2.63
10	64.00	0.36
Average	63.64	2.08

L = 8.0 cm
d = 3.3 cm
relative variance 3.2 %
maximum deviation 9.0 %

The results indicate reasonable repeatability.

Table 2 shows dependence of period on length.

L	M	Deviation
10	54.05	2.25
9	57.69	1.39
7	53.69	2.61
8	57.85	1.55
6	57.69	1.39
5	56.82	0.52
Average	56.30	1.94

relative variance	3.40 %
standard deviation	1.92 %
variance coefficient	3.40 %
maximum deviation	4.00 %
amplitude	7.40 %

The results indicate that between 5 and 10 cm. length, the formula (1) can be safely applied.

Examples

a. Comparison of two adhesives

For comparing two adhesives A and B, two strips of paper were glued together with each of the adhesives after drying M and S were measured:

Adhesive	A	B
M	49.59	41.09
S	58.32	33.77

The result can be interpreted by stating that B is less rigid.

The use of S was necessary because it is difficult to make the two »sandwiches« of the same thickness.

b. Torsional rigidity dependence of paper-direction

Two different papers A and B were measured in machine and cross direction i.e. once when the length coincides with the machine direction, and once perpendicularly.

The results were the following:

	M_A	M_B
Machine	31.45	20.83
Cross	23.81	15.77

It follows, as expected from theoretical considerations, that the paper is more rigid when the length of the strip coincides with the machine direction. It also proves that this system of measurements is sensitive enough to detect differences due to different directions of the same sheet of paper.

There might be a need to define *»overall rigidity«* – R and this might be done by the formula:

$$R = \frac{1}{2}\sqrt{M^2_{Cross} + M^2_{Machine}}$$

c. Aging of paper

A printed newspaper was aged for 3 hours at 110° c. and afterwards reconditioned to room environment. The results are the following:

		Unaged	Aged
Machine direction	M	18.31	19.41
Cross direction	M	8.31	15.49
	R	10.05	12.42

It follows that the rigidity in the cross direction is more strongly affected by aging than in the machine direction. It also proves that even a short period of aging is easily detectable by the method.

Procedure

For most papers used for writing and printing the following suggestions may be useful:

a. Strips, 2 cm. wide, should be cut for measurements.

b. A body with a moment of inertia of ca. 1000 g cm^2 should be used (e.g. thin rod with a length of 10 cm. and mass of 120 g).

c. Length of paper strips should be between 5 and 10 cm. In fact it should exceed that, so that the free length between the clips should be the required.

d. Each result should be an average of 10 readings.

e. The hanging part should be displaced no more than 45° and preferably 20°, always at the same angle, and gently as possible so that no parasitic oscillations occur.

Conclusion

This method of testing is reasonably accurate and shows satisfactory repeatability. It can be used for comparing adhesions, laminations, foils, etc., and is also indicative for aging tests.

As the needed instrument can be easily made and is not expensive, the method is useful to small laboratories and workshops.

Abstracts

It is desired to provide small laboratories with inexpensive physical tests for properties of paper. Such a test is the test for torsional rigidity, M. M, which is a relative measure is defined by: $M = \frac{L}{p^2} \times 10$, where L is the

length of the tested strip and p is the period of its oscillation when a thin rod is suspended from it, displaced from equilibrium and released.

Experiments indicate that:

a. The offered method is reasonably repeatable.

b. The offered method is sensitive enough to distinguish between machine and cross direction rigidities.

c. The offered method is reasonably sensitive to aging. Overall rigidity is

also defined by: $R = \frac{1}{2}\sqrt{M^2_{Cross} + M^2_{Machine}}$

The method can be used for comparing papers, adhesives, foils etc., with respect to their rigidity and requires no complicated or expensive instruments.

Желательно проводить в небольших лабораториях недорогостоящие физические испытания для определения качества бумаги. Таким испытанием является определение жесткости при кручении M. Относительная величина M определяется как $M = \frac{L}{p^2} \times 10$, где L равно длине испытываемой полосы, а p – периоду ее колебания при свободном движении подвешенного к ней и перемещенного с положения равновесия тонкого стержня.

Опыты показывают, что:

а/ предлагаемый метод может быть многократно повторен;

б/ предлагаемый метод достаточно чувствителен для определения различий между жесткостью в продольном (по полотну) и поперечном направлениях;

в/ предлагаемый метод удовлетворительно чувствителен к старению.

Общая жесткость определяется как:

$$R = 1/2\sqrt{M^2_{\text{попереч.}} + M^2_{\text{продольн.}}}$$

Этот способ применим для сравнения жесткости бумаг, гуммированных лент, фольги и т.д. и не требует сложной и дорогостоящей аппаратуры.

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Reflections on the Stability of Paper

by WILLIAM K. WILSON

Introduction

Rags make paper,
Paper makes money,
Money makes banks,
Banks make loans,
Loans make beggars,
Beggars make
Rags.

This quotation from an anonymous 18th Century author is not quite as true today as when it was written. Paper is still made from rags, but rag papers represent only a small part of the total world production of paper.

The chain reaction of rags, paper, money, banks, loans, beggars, rags started receiving considerable competition in the latter part of the 19th Century. Paper was made in increasing quantities from wood as well as a host of materials such as bagasse and esparto grass; in 1886 a book on paper manufacture listed more than 950 materials from which paper might be made.[1] These developments were essential to the production of the large quantities of paper required for an expanding economy and a broadening educational system; but they brought with them major problems of paper deterioration, and the archivist has been plaqued by these problems ever since.

Composition of Paper

Rags used for papermaking consist almost exclusively of cellulose of various chain lengths. A typical wood, on the other hand, might contain about 29 percent lignin, 43 percent cellulose, 27 percent of other carbohydrate materials and 1 percent extractives[2] (page 95). These figures may vary within wide limits.

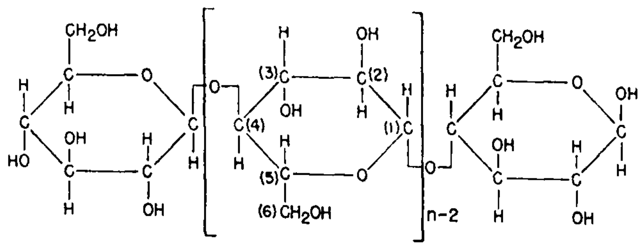

FIG. 1. Generally accepted formula of cellulose chain.

The generally accepted formula of a cellulose chain is shown in Fig. 1. Cellulose may be considered a condensation polymer of glucose with one molecule of water split out for each glucose unit. Thus, a molecule of anhydroglucose is bracketed in Fig. 1 as the monomer unit of cellulose. It should be noted that the anhydroglucose units alternate »up and down« in cellulose; when they do not alternate the product is not cellulose but starch. Thus, the building unit of cellulose is the disaccharide cellobiose, and the building unit of starch is maltose.

The »other carbohydrate materials« in wood vary with the wood species, and may include several sugar monomer units such as xylose, galactose, arabinose, glucose and rhamnose. Xylose usually is the most abundant. These units exist in the so-called hemicellulose fraction.

In spite of millions of dollars of research effort, the structure of lignin is not known. It appears that »the lignin macromolecule is built of monomers of phenylpropane type, containing a varying amount of methoxyl groups«[2] (page 185).

Casey has classified pulping processes according to yield[3] as shown in Table 1. The so-called high-yield pulps have increased greatly in popularity in the last few years. These pulps are made by cooking only enough to reduce the wood chips to fibres without removing nearly as much lignin as is removed during a conventional cook (sulfite or sulfate). The bleaching of high-yield pulps is accomplished by reagents that destroy the color but do not remove large amounts of lignin.[4]

Variables that Affect Stability

During the bleaching of rag pulp and during the cooking and bleaching of wood pulp, functional groups other than hydroxyl and terminal aldehyde

are formed on the cellulose. These functional groups are aldehyde, ketone and carboxyl formed at random on the cellulose chains. These »manufactured« functional groups play an important role in the stability of paper, especially if they occur in the hemicellulose fraction.

Papermaker's alum (aluminum sulfate) usually is added during the papermaking process for a variety of reasons, one of which is to precipitate rosin (impure abietic acid) onto the fibres. The alum reacts with rosin to form an insoluble aluminum salt of uncertain composition as well as with the carboxyl groups on the cellulose. One result is the production of an acid, the amount of which depends in part on the amount of aluminum and of sulfate that is taken up by the fiber. Although many man-years have been spent on research, the role of alum in the papermaking process and its effect on stability of paper is not completely understood.

How can a permanent record paper be characterized? The most important single factor probably is absence of acidity. The anhydroglucose units in cellulose are joined together by acetal linkages that are sensitive to acid hydrolysis, but are stable in alkali. Therefore, an alkaline filler is helpful in the preservation of paper. Calcium carbonate has been found to increase the stability of paper under accelerated aging.[5, 6] In 1939, the Institute of Paper Chemistry reported the results of the analysis of a book several centuries old, the leaves of which were in varying states of preservation. The leaves that were well preserved had a calcium carbonate content about 2 percent, while those in the poorest condition contained no calcium carbonate.[7]

Lignin is not a particularly unstable material except when exposed to light. Specimens of wood exist that are several centuries old, and some samples of newspaper several decades old are in excellent condition. But if a newspaper is left in the sun for even an hour the color change is pronounced.

Functional groups such as aldehyde, carboxyl and ketone on the anhydroglucose ring in cellulose, or on the rings of other sugar units in the non-cellulosic carbohydrates in wood pulp can be very important to the stability of paper. Their exact role is unknown. Paper may discolor during storage, but the causes may not be evident. A small amount of chlorinated lignin, however, is known to cause severe yellowing.[8]

Because of the large number of factors that contribute to the instability of paper, there is no simple correlation between the acidity, expressed as pH, and stability toward either accelerated aging or natural aging. Even paper on the alkaline side may decrease in pH during an accelerated aging procedure and show much less stability than expected. Therefore, it is important that a suitable accelerated aging procedure be developed for evaluating the relative stability of paper.

A question frequently asked, but never completely answered is, whether rag paper is more permanent than wood pulp paper. Unfortunately comparison of old papers cannot give the answer because both types of paper have not been made for the same length of time. Some rag papers have endured for centuries but the oldest commercial wood pulp paper produced by modern cooking and bleaching methods is only about a century old. However, experimental papers have been made from wood pulp that compare favorably with rag papers in strength and in permanence, as predicted by accelerated aging.[9] A wood pulp paper and a rag paper, made by starting from high quality materials, have been tested by the Institute of Paper Chemistry at intervals over several years with no appreciable change except in folding endurance.[10] High-grade rag and wood pulp papers stored at the National Bureau of Standards for almost 30 years indicate comparable stability for both types.[11] Both wood pulp papers and rag papers may cover the complete spectrum of quality.

What environmental conditions are important in the preservation of papers? Damage to records by acid pollution of the atmosphere, high temperatures, variations in atmospheric humidity, dust, and light is well known. Paper is degraded directly by light, and, in addition, is unstabilized and undergoes a post-irradiation effect.[12] »Light« is defined here as skylight filtered through ordinary window glass. The effect of light in the visible and near ultraviolet is much less pronounced in the absence of oxygen; so the reaction in air is most likely an oxidation induced by light, i.e., photoxidation.[12]

The effect of variations in atmospheric humidity on the permanence of paper is not clear-cut, but humidity changes probably cause stresses that result in deterioration of fiber bonding. At low humidities, paper is brittle and more susceptible to physical damage. High humidity is conducive to mold growth. Thus the relative humidity usually recommended is 50 percent ± 10 percent.

Some Approaches to Research on Stability of Records

Research on the stability of record materials requires a combination of looking at the past and projecting into the future. The former approach is

used to learn why an artifact has survived for several centuries. Predictions of probable stability may be made on the basis of information concerning composition and performance of materials in accelerated aging situations. A few attempts have been made to combine accelerated aging in the laboratory with longterm storage,[10, 11, 13] but it is very difficult to commit a laboratory to an experiment spanning many years. Methods of evaluation frequently change so radically that those originally used may be outmoded 30 years later.

One approach to accelerated aging is to determine whether the activation energy of the degradation process changes with temperature. This approach has been used with plastics and with paper. [13, 14, 15, 16] In order for this method to be applicable, a plot of some function of degradation against the reciprocal of the absolute temperature should give a straight line, and the plots should be parallel for similar materials. This approach must be used with caution.

A big challenge in the development of accelerated aging tests to predict stability is to prescribe the number of variables to be included in the selection of samples. Forty years ago all that was thought to be necessary (through ignorance) was to select a few papers made from each type of pulp available such as rag, sulfite, sulfate, soda, or combinations of these. Today we are aware of so many variables in papermaking that to prepare samples and conduct experiments to evaluate all of them would take a lifetime.

One approach that shows considerable promise in the evaluation of the stability of paper is differential thermal analysis (DTA).[17] A specimen of paper and a specimen of an inert material are heated at a constant rate in a metal block. By means of thermocouples the temperature differential between the paper specimen and the inert specimen is continuously recorded. Typical traces for a cellulose with a carboxyl content of 40 milliequivalents per 100 grams are shown in Fig. 2. The traces show distinct differences depending on whether the carboxyls are in the acid form or in the form of calcium or aluminum salts.[18] As with many instrumental methods, the data are more meaningful after a considerable background of information has been obtained.

It has been shown that the extensional stiffness (initial slope of a load elongation curve) increases with accelerated aging of some papers, and that cross-linking appears to occur.[19] From this it follows that the embrittlement in paper may not necessarily be due to depolymerization.

Information on the changes that actually occur in paper during degradation must be developed before real progress can be made in preparing specifications for stable papers.

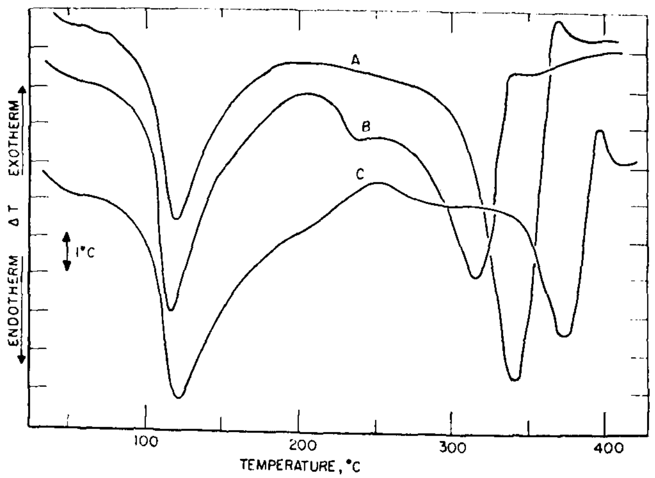

FIG. 2. Differential thermal analysis traces* of a modified cellulose with a carboxyl content of 40 meq/100 grams.

* Run in nitrogen at a heating rate of 20° C. per minute.

A Carboxyl in acid form.
B Carboxyl as aluminum salt.
C Carboxyl as calsium salt.

Table 1. Pulping processes classified according to yield[3]

	Yield, %
Mechanical pulp (groundwood)	90–95
Chemigroundwood	85–90
Cold Soda	85–90
Semichemical	65–80
High yield sulfite and sulfate	50–65
Regular sulfite, soda and sulfate	40–50

Abstracts

Variables in the composition of paper are discussed in relation to stability, and new approaches to research on preservation of records are described.

Key-words: Degradation, paper, preservation of records, records, stability.

Обсуждается устойчивость разных форм состава бумаги, и описываются новые подходы к исследованиям хранения документов.

Существенные слова: Понижение качества, бумага, хранение документов, документы, устойчивость.

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The Chemical Laboratory for Hygiene, Conservation and Restoration of Damaged Written Materials

in the National Library »Cyril and Methodius« – Sofia

by STELLA ALKALAJ

Founded in 1956, the Chemical Laboratory initiated the conservation and restoration of library and archival materials.

Today the laboratory has chemical, biological and restoration aspects; its staff consisting of a chemist – in – chief, a biologist, three restorers, a restorer – bookbinder, and six disinfectors.

The National Library possesses rich collections including valuable manuscripts, archival materials, rare books and printed editions of national importance, totalling 1 500 000 archival units, 5000 manuscripts and more than 2000 Renaissance books. After five centuries of the Ottoman yoke, wars and national disasters, these materials were in a very bad condition – rotten from damp, eaten by mould and insects, torn and broken, with the text illegible in places.

The damage had to be stopped, and a means found for a rapid and scientifically well-established conservation and restoration.

The well-known classical methods for strengthening and completing the missing parts of written materials demand patient, slow, and highly qualified hand-work: following the complicated contours of the ruptures by letting a suitable light pass through. Although well established at the time, these methods did not satisfy our demands because of their low productivity, the use of papers different from the original, and the necessity of additional strengthening with gelatine or other solutions, with Japanese paper or by lamination, all leading to changes violating the original materials.

The method of tearing is rather unsafe; it demands great skill and ... courage. For these reasons it is used mainly for work on comparatively well preserved materials, on papers containing textile fibers and with a text resistant to the various treatments. Lamination is not suitable for work with unica, although it provides a perfect solution to the problem of the restoration of newspapers, magazines and contemporary editions, and may be used for work on partly disintegrated valuable materials, but only as an extreme measure.

These considerations made us search for and finally find a solution to the requirements necessary when working with original materials, which at the same time ensured rapid and high-grade conservation and restoration of the enormous number of »ill« manuscripts and archives from the special collections of the library waiting for treatment.

In the process of studying the literary sources, we found a publication by Ju. P. Njuksha, who developed a laboratory method for filling up the missing parts with paper fibres. The idea is not new and has been applied in different places for the manual repair of holes by using a spoon to spread an even layer on the holes in the leaf, which is placed upon a piece of water absorbing felt.

In the years 1961 and 1966 two new variants of a leaf-casting camera and a casting installation were developed in the National Library. These were improved constructionally and technologically by the addition of equipment for the complete work leaf-casting camera holender and a hydraulic press.

Principally the method consists of the following: the damaged sheet of paper is placed upon a bolter surface and a diluted filamentous material is sucked through the surface, thus filling the missing parts of the leaf with layers of threads.

This leaf-casting method makes possible the restoration of objects which are not manually restorable – the oldest and most damaged written materials are torn into separate fragments which can be bound together without violating the text.

The method is very suitable for manuscripts damaged by insects as the small holes can be filled in uniformly and almost unnoticeably. In addition it can be successfully applied when restoring works of art on a paper basis. Work with homogenous paper threads justified our hopes for great durability, as was demonstrated in preliminary experiments with samples undergoing artificial aging at 100° C for 72 hours. The results indicate that the materials restored by leaf-casting method have greater resistance.

The possibility of restoring the document, if necessary, to its initial state is an important advantage to the method. The greatest advantage however, is the enormous improvement of the quality of production.

The ordinary preliminary treatment is given at first. Basically this is the same everywhere, but it is carried out by different means in the different

laboratories, namely: disinfection, disinfestation, mechanical and chemical cleaning and neutralization.

An analysis follows to establish the qualitative composition of the filamentous material of the object. The results are rather uniform: paper containing only textile threads, a mixture of textile threads and wood cellulose in different proportions, paper containing only wood cellulose and a mixture of wood cellulose and a ligneous mass again in different proportions. The quality of the textile threads and the cellulose varies of course, and that is important in accurate work.

A laboratory holender allows the mixing of different raw materials in various proportions. For example: cotton, linen, hemp, silk, cellulose. Toning the paper pulp to suit the shade of the old paper can be carried out at will. To complete the missing parts of the document by additions having the same thickness, a simple calculation should be made taking into account the weight of the original paper, the number of missing parts, and the concentration of the paper pulp in the tank. These calculations and the qualitative analysis of the paper are rarely carried out if work is to be done on large manuscripts on paper of uniform composition and size. A planimeter can greatly simplify this work.

The »old« and the »new« papers are soldered together with a glue applied according to the quantity of the dry substance. Unstable texts are fixed with a thin layer of a polyamide solution that strengthens the rotten paper and successfully fixes the old inks and Indian ink. Contemporary inks are difficult to fix in this way.

The process of leaf-casting is a matter of seconds. The capacity of the casting camera can be fully utilized if there are adequate drying rooms and production is organized as follows: one restorer fixes the text, makes the calculations and prepares the paper mixture; the second performs the leaf-casting, while the third takes charge of the drying. The remaining processes – disinfection, cleaning, neutralization, cutting, pressing and arranging – can be assigned to other persons. This organization permits a distribution of the tasks according to the qualifications of the staff.

The method has a number of shortcomings of which the most important are:

1. The size of the working surface (650–480 mm) restricts the casting of materials of larger size, (when working with small sizes, 2, 4, 6 and 8 sheets can be worked upon simultaneously provided that the thickness and the quality of the paper are identical.).

2. Manuscripts with unstable texts can only be treated after fixation is carried out, stabilizing the work by roasting and hot drying.

3. So as to obtain a uniform mechanical durability of the restored leaf, correct calculations are not only necessary but also preliminary strengthening of the paper by appropriate solutions or, if suitable, a lamination of the sheet after the casting.

4. Since water is involved in the process, Barrow's method of neutralization cannot be used.

The leaf-casting method has been in constant use in our laboratory since 1961. Classical methods of restoration are only applied in cases of insignificant damage and where texts cannot be fixed.

Unfortunately there are only three restorers, and thus we cannot fully utilize the capacity of the casting camera, although flowproduction has been partially introduced.

More than 10 000 of the most badly damaged sheets, manuscripts and archival materials in the collections have been restored in 11 months with 6-hour working day.

Regular investigations of the restored materials show that they have preserved their initial condition for a period of 7 years in a depot which was not air-conditioned until the beginning of this year.

Our experience has been successfully applied in 3 other institutes in this country. A number of improvements have facilitated work with the casting cameras.

A number of problems are still to be settled in the Chemical Laboratory for Hygiene, Conservation and Restoration of Written Materials. An improvement of the conservation and restoration processes can be acquired by producing a suitable laminator, a new disinfection and disinfestation vacuum camera, and by increasing the number of staff and enlarging the laboratory. This will make it possible for us to handle the mass produced material which wears out rapidly because of the low quality of contemporary paper.

Abstracts

The article traces the development of the laboratory which was founded in 1956. Today it has well established restoration activities with chemical, biological and practical fields of work.

PLATE 1.
The damaged sheets being laid on the bolter surface covered by a piece of natural silk-cloth.

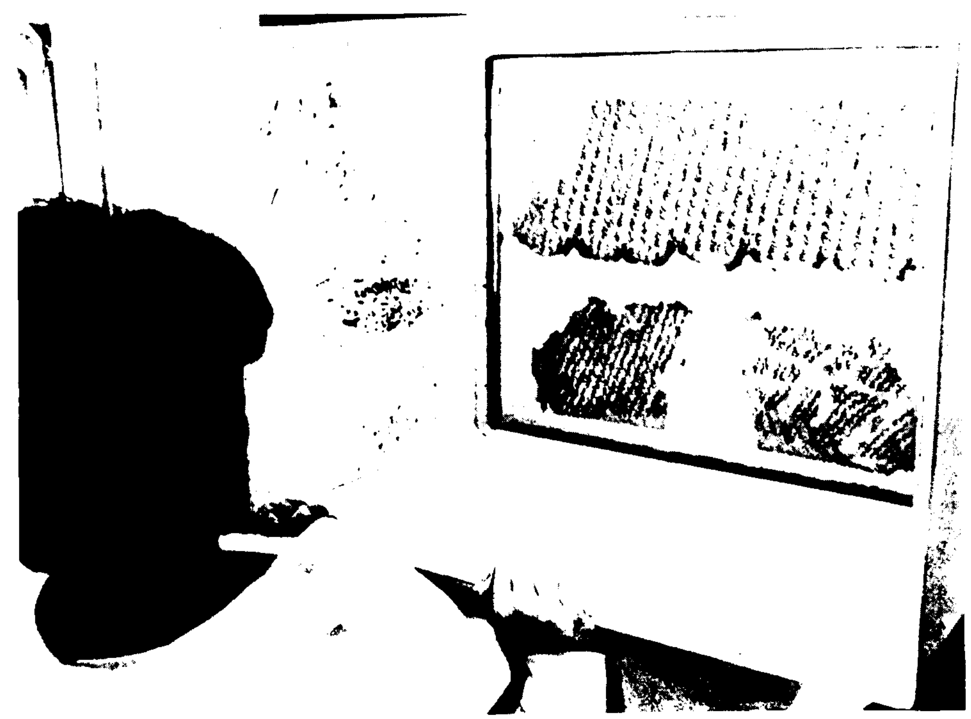

PLATE 2. The sheets after restoration (still lying on the silk-cloth).

lod lige Herre en fattes noge aa Slottets, som paa de øvri ander liggende Bygningers ud og indvortes Forbedring, lod og i Aaret 1741 gandske af nye forfærdige den Søndre Slots-Broe, paa de gamle derunder befindtlige muurede Piller.

commodes Roïale: Sa non plus d même, & y ont rapc par dehor ridion piliers

Endelig maa jeg melde noget om de yndige og prægtige Haver, som findes ved dette Slot.

Il f peu fu dins, q

Her ere tvende Kongelige Haver, den saa kaldede gamle Have, og det nye Verk, begge ere efter Danckwerths Beretning af Hertug FRIDERICH den Tredie anlagte og indrettede; den gamle nemlig Sønden, og den nye Norden for Slottet. Den gamle Have ligger noget afsides fra Slottet, saa at den paa den af dets Situation her forestillede General-Grundtegning, en haver kundet komme tilsyne; samme er af en vidt-

Il y l'un e tre le deux DER Danc midi, c du château le vieux jar château, representé nous donn

The existence of much damaged material necessitated a search for new means and methods of restoration that would meet modern requirements and ensure rapid and satisfactory restoration of the many »sick« manuscripts and archival materials from the special collections of the library.

During the search, we found a publication by Ju. P. Niksha, who had devised a laboratory apparatus for filling in the missing parts of damaged materials.

In 1961 and 1966 2 improved versions of the apparatus in question were constructed at the National Library of Bulgaria, including an appliance for grinding cellulose, cotton, hemp, flax, silk; a drying-camera; and a hydraulic press.

The article describes the apparatus and the techniques used to fill in the missing parts of the damaged documents by means of coating the damaged sheet with a pulp of paper threads; these can be of different material depending on the substance of the original to be repaired. Preliminary treatment of the materials to be restored and the organization of the whole process are also mentioned.

This method ensures the restoration of even the worst damaged material which may be repaired without impairment of the text. The process is particularly applicable for material with numerous holes. Works of art on a paper basis may also be restored by this process.

Finally some shortcomings of the process are described which prevent its universal application.

LITERATURE

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Methods of Strengthening the Damaged Leather of Old Bindings

by I. K. BELAYA

Work on the strengthening of damaged leather was initiated in our laboratory because many bindings of rare old books, which were of considerable historical value, had been damaged.

When investigating old bindings a difference in their state of preservation is apparent. In some bindings the fundamental properties of the leather are still preserved; in such cases it is our task to inhibit further destructive processes. In other bindings the softness and elasticity of the leather is preserved but it has lost most of its strength and is very fragile; and in other cases the leather has become very dry, hard and brittle. The surface of such bindings is disfigured by fine, deep cracks and when the leather is removed from the binding covers it breaks and easily disintegrates to powder — sometimes the outer layer disappears. In such cases, neither moistening nor greasing will restore the original elasticity and strength of the leather.

To strengthen such leather and make it more elastic a binding substance should be applied to it. Certain high polymeric synthetic substances will strengthen the leather of old books when applied to the surfaces of their damaged bindings. The same polymers can be applied to various leather objects in museums. These polymers remove surface defects, renew the skin and lengthen its lifetime. A method for the conservation and restoration of leather bindings developped at our laboratory has been published in various works in the years 1954–1959.

Basically this method consists of the conservation of the leather by means of fatty substances which prevent the leather from drying out and protect it against oxidation and from mechanical pulverization.

The variety of synthetic polymers increases annually, but only some of them are suitable for the strengthening of leather. First and foremost are such polymeric substances as albumin and collagen, whose structure is as close as possible to the fundamental constituents of the leather. In addition, they possess good properties of adhesion and cohesion which give a strong, elastic film, and do not damage the leather during long-term preservation.

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We have studied the effect on leather of polyamide (polyamide no. 548, polyamide no. 54, and the methylol polyamide glue PFE–2/10) for the purpose of strengthening damaged bindings. Further, we have studied derivatives of cellulose (a 15 % solution of ethyl cellulose with ethyl alcohol, a 10 % solution of sodium salt of carboxymethyl cellulose, and a 2,5 % water solution of methyl cellulose), as well as groups of polyvinyl gums (a 15 % water solution of polyvinyl alcohol, a 10 % solution of polyvinyl butyral with ethyl alcohol, and a 10 % solution of polyvinyl acetate emulsion).

In addition we have studied the effect on leather of phenolformaldehyde resins, butadiene-styrol latex and polyurethan resins in cyclohexanone (a polyurethan varnish, obtained through the interaction of polyisocyanate and castor oil). For our experiments we used both new and old russet-tanned leather.

In our earlier work we used an artificial aging treatment. Samples of leather were subjected to ultra-violet rays from a mercury-quartz lamp (PRK–2 type) for 10 hours. However, the results obtained hereby did not seem very convincing, and so we investigated more stable irradiation conditions and irradiation of samples of new, unprocessed leather for different periods (10, 100, 200, and 500 hrs.).

According to several authors, the fundamental cause of the changes in leather due to age is the oxidation of the albumin in the leather. This oxidation is primarily indicated by the formation of ammonium nitrogen. Ultraviolet rays promote oxidation of leather albumins. Therefore, several authors feel that irradiation of leather with ultraviolet rays is the most effective method of aging its albumins.

Data concerning the physico-mechanical analysis of the above-mentioned samples following upon irradiation are given in table 1.

These data show that the greatest changes in the strength and hardness of the leather took place after 500 hrs. irradiation. Thus, the strength of the leather after 500 hrs. irradiation decreases from 3.20 kg/mm² to 2.37 kg/mm², i.e. the hardness is doubled. We therefore increased the duration of irradiation of the samples before and after processing, at first to 400 hours and then to 500 hours. On the basis of data obtained from long-term irradiation, we formed our conclusions regarding the effect of the various forms of processing on leather.

We feel the physico-mechanical analysis of leather to be particularly important because the fundamental quality of leather is determined by the strength of its fibres, (confirmed by Professors N. V. Chernov, C. G.

TABLE 1

Physico-mechanical properties of new russet-tanned leather after various periods of aging

Type of processing	Average thickness (mm)	Average breadth (mm)	Average cross-section (mm²)	At a tension of 1 kg/mm²		Fractures observed on outer surface		Load at rupture (kg)	Limit of strength (kg/mm²)	Elongation at rupture (mm)	Relative elongation (%)	Module of elasticity (kg/cm²)	Hardness (kg)
				Load (kg)	Elongation (mm)	kg	mm						
Non-processed (control)	0.806	10.0	8.04	9.04	12.0	21.6	22.0	25.7	3.20	25.9	23.9	457	36.5
10 hours' irradiation	0.824	9.9	8.20	8.20	11.9	22.1	22.2	25.9	3.17	26.3	23.8	458	37.4
100 hours' irradiation	0.818	10.0	8.15	8.15	12.0	21.7	23.0	25.3	3.11	27.3	23.9	460	37.4
200 hours' irradiation	0.821	10.0	8.18	8.18	12.0	17.0	22.2	22.8	2.67	27.2	24.0	481	34.2
500 hours' irradiation	0.815	9.9	7.98	7.98	6.5	16.1	15.8	18.9	2.37	20.6	13.1	932	74.6

Table 2

Physico-mechanical properties of new russet-tanned leather after various forms of processing and artificial aging

Type of processing	Average thickness (mm)	Average breadth (mm)	Average cross-section (mm²)	At a tension of 1 kg/mm²		Fractures observed on outer surface		At rupture		Limit of strength (kg/mm²)	Relative elongation (%)	Module of elasticity (kg/cm²)	Hardness (kg)
				Load (kg)	Elongation (mm)	Load (kg)	Elongation (mm)	Load (kg)	Elongation (mm)				
Control (before aging)	0.826	9.55	7.88	7.88	15.65	10.12	18.82	13.93	27.75	1.74	31.30	319	25.10
Control (400 hours' irradiation)	0.824	9.61	7.91	7.91	17.69	9.81	20.73	12.19	29.10	1.55	35.38	281	22.40
2 % oak tanning agent + 5 % PFE (before aging)	0.833	9.56	7.99	7.99	17.30	12.72	24.68	15.41	31.80	1.94	34.61	288	22.40
2 % oak tanning agent + 5 % PFE (400 hours' irradiation)	0.817	9.45	7.71	7.71	17.61	10.29	22.00	13.25	30.90	1.69	35.23	284	21.90
15 % polyvinyl alcohol (before aging)	0.815	9.83	8.01	8.01	15.30	14.90	24.57	18.35	31.60	2.26	30.75	325	26.00
15 % polyvinyl alcohol (400 hours' irradiation)	0.835	9.56	7.99	7.99	16.53	3.06	2.95	16.98	32.57	2.10	32.85	304	24.20

Povarnin, A. N. Mikhailov and others). G. I. Kutyanin writes »when the samples of derma to be compared have the same, or almost the same, microstructure (before processing), but different physico-mechanical properties (after processing), it is evident that the difference is due to changes in the (inner) structure of collagen, formed as a result of some kind of processing of the samples. Thus corresponding changes take place in the micro-structure of the derma.«(Kutyanin, page 4). When processing damaged leather with high-polymeric synthetic substances, the fibres of the leather are glued, and thus the leather becomes stronger and partially harder. Therefore polymeric substances with sufficient elasticity should be applied.

We have previously discovered that processing old russet-tanned leather and old parchment with polyamide glues gives a considerable improvement in the physical properties of such leather and parchment. Polyamide glues are of special interest, as these high-polymeric substances have a chemical structure similar to the albumin of leather.

Polyamides may be described as compounds with recurrent amide groups (CO–NH) between long hydrocarbon radicals. The similarity between the chemical structure of polyamides and natural albumins (wool, silk and leather collagen) is shown by their ability to absorb water, their hygroscopicity, their air-penetrability, and their interaction with acids and alkalies.

Just as wool and collagen, leather polyamides react with basic chromium salts and vegetable tanning agents. We used the latter to strengthen damaged leather by introducing into it a binding agent (a polyamide glue), and for tanning a vegetable tanning agent was introduced.

Besides these properties, polyamides are characterized by good adhesion and cohesion.

All these properties lead us to feel that polyamide glues are the substances best fitted for the strengthening of damaged leather in bindings and old parchments.

To strengthen damaged leather in bindings we applied a 5 % and a 10 % solution of the methylol polyamide glue PFE–2/10 mixed with various vegetable tanning agents, and for parchment we used a 1 % solution and a 3 % solution of PFE–2/10 without a tanning agent.

Willow, oak, chestnut, spruce, nut and quebracho were the vegetable tanning agent used. From these were prepared 2 % solutions in 80 % ethyl alcohol, mixed with the glue PFE–2/10. The glue content of the mixture was 1 %, 3 % and 5 % respectively.

Our experiments indicated that the best results are obtained with most old binding leather when a 5 % solution of PFE–2/10 is applied.

A description of our method is given below: Groups of leather samples (according to the classical method composed of an asymmetric fringe) were processed with solutions of tanning agents mixed with the glue PFE–2/10. The outer surface of the skins as well as the flesh side were processed, and after 6 months' suspension in air, skins were subjected to physico-mechanical testing.

Some of the samples were subjected to artificial aging, i.e. irradiation by a mercury-quartz lamp (PRK-2) at a distance of 30 cm, for 400 and 500 hours.

The temperature of the surface to be irradiated was 40–42° C. and the relative humidity of the air was 50–65 %. After conditioning the samples at 18–20° C. with a relative humidity of 60–65 % for 48 hrs., the physico-mechanical properties of the leather were determined.

A physico-mechanical analysis (determination of the breaking load, the elongation at rupture, and the tension in 1 kg/mm², as well as of the module of elasticity and hardness at stretching) was carried out on a Shopper dynamometer with automatic recording of the indicators.

We also tested leather surfaces for pulverization by means of Khorkin apparatus.

For these tests we prepared special samples according to the specifications for this instrument. Samples of old russet-tanned leather were greased by a method developed by us, and then coated with a 10 % solution of PFE–2/10. Afterwards they were processed with a 2 % solution of a vegetable tanning agent mixed with a 5 % solution of PFE–2/10.

The tests showed that the surface of damaged leather is strengthened by such processing. More than 50.000 rotations of the instrument do not destroy the processed surface, but make it even smoother and more compact.

We also determined the cubic content of acid and the pH of the processed russet-tanned parchment leather before and after artificial aging. Processing with a tanning agent mixed with methylol polyamide neither increases the cubic content of acid nor the pH. Neither are there any increases after artificial aging. Data from the physico-mechanical analysis of new russet-tanned leather after different processing and artificial aging (400 hrs. irradiation with PRK–2 lamps at a distance of 30 cm, as indicated in table 2) show that the strength of the control samples is reduced after artificial aging. The strength is decreased from 1.74 kg/mm² to 1.55 kg/mm², and the hardness is decrased from 25.10 kg to 22.40 kg.

After processing with a 2 % vegetable (oak) tanning agent mixed with a 5 % solution of PFE–2/10 the strength of the leather is increased to 1.94 kg/mm², and the hardness is decreased from 25.10 kg to 22.40 kg.

After artificial aging, the strength is slightly reduced but is still greater than the strength of the control samples. The hardness is decreased to 21.90 kg.

Besides processing with the methylol polyamide glue PFE–2/10, we tested the effect of a 15 % solution of polyvinyl alcohol on the leather. Processing with polyvinyl alcohol increases the strength of leather; however, its hardness is increased.

Table 3 gives data on the effect of a 15 % solution of polyvinyl alcohol on old russet-tanned leather. The strength of the leather after processing with polyvinyl alcohol was increased by 30 %. However, we did not succeed in restoring the elastic properties lost by processing with polyvinyl alcohol.

We also studied the effect on leather of polyurethan glue, the simultaneous effect of polyamide glue and polyurethan glue, and the effect of phenol-formaldehyde tar of butadione styrol latex, and of a water solution of methyl cellulose. All these polymers strengthen leather.

Table 4 gives the data on the effect of polyurethan tar, of a methylol polyamide glue followed by coating with polyurethan tar, and the effect of a methylol polyamide glue together with vegetable agents. The strength of leather processed with polyurethane tar is increased from 1.67 kg/mm² to 1.97 kg/mm², and the hardness is also increased.

Polyurethan tar penetrates leather well, and it forms a smooth, lustreless surface. After artificial aging (500 hrs. with PRK–2 lamps), the strength of processed leather is increased and the hardness is somewhat reduced. No cracks form on the outer surface of the leather when stretched on a dynamometer after processing and irradiation.

However, if the leather has been previously processed with a methalol-polyamide glue (ground 10 % PFE–2/10) and then with a polyurethan tar, it obtains a shining, varnished, and very smooth surface. After such processing the strength is increased, the hardness is increased and, what is most important, no cracks are formed on the outer side of the leather, when stretched on a dynamometer.

Processing with a 5 % PFE–2/10 mixed with a 2 % solution of a vegetable tanning agent (willow or chestnut) increases the strength of the leather and slightly increases its hardness, but to a lesser degree than processing with polyurethan tar.

Data from long-term artificial aging show that after processing of russet-tanned leather with the polyamide glue PFE–2/10 + a 2 % solution of a vegetable tanning agent, the leather must be greased in order to reduce its

Physico-mechanical properties of old russet-tanned leather after processing and artificial aging

TABLE 3

Name of process	Average thickness (mm)	Average breadth (mm)	Cross-section (mm²)	At a tension of 1 kg/mm²: Load (kg)	At a tension of 1 kg/mm²: Elongation (mm)	At rupture: Load (kg)	At rupture: Elongation (mm)	Limit of strength (kg/mm²)
Control (before aging)	0.865	9.62	8.31	8.31	—	5.05	5.45	0.60
Control (400 hours' irradiation)	0.855	9.79	8.39	8.39	—	5.19	8.20	0.62
15 % PVS (before aging)	0.803	9.98	8.02	8.02	—	6.82	7.90	0.82
15 % PVS (400 hours' irradiation)	0.828	9.87	9.66	9.66	—	6.18	4.25	0.73

Physico-mechanical properties of new russet-tanned leather after processing and artificial aging

TABLE 4

Name of process	Average thickness (mm)	Average breadth (mm)	Average cross-section (mm²)	At a tension of kg/mm²: Load (kg)	At a tension of kg/mm²: Elongation (mm)	Fractures observed on outer surface: kg	Fractures observed on outer surface: mm	Load at rupture (kg)	Elongation at rupture (mm)	Limit of strength (kg/mm²)	Relative elongation (%)	Module of elasticity (kg/cm²)	Hardness (kg)
Control (before aging)	0.839	9.6	8.06	8.06	23.3	10.2	26.7	13.1	32.8	1.67	46.4	239.3	18.9
Control (500 hours' irradiation)	0.824	9.6	7.92	7.92	17.7	9.9	20.8	12.2	29.2	1.55	34.5	349.9	28.2
Polyurethan tar (before aging)	0.841	9.6	8.08	8.8	6.1	No cracks on outer surface		15.9	14.3	1.97	13.0	933.9	74.5
Polyurethan tar (500 hours' irradiation)	0.828	9.4	7.87	7.87	6.2	14.8	14.2	15.3	15.5	2.07	12.4	957.0	71.5
10 % PFE–2/10 + polyurethan tar (before aging)	0.829	9.4	7.72	7.72	4.3	No cracks on outer surface		14.4	13.1	1.86	8.5	1362.6	105.0
10 % PFE–2/10 + polyurethan tar (500 hours' irradiation)	0.841	9.6	8.11	8.11	4.4	No cracks on outer surface		15.7	13.4	1.94	8.8	1412.1	113.0
5 % PFE–2/10 + 2 % willow tanning agent (500 hours' irradiation)	0.830	9.6	7.94	7.94	10.9	10.5	16.1	12.9	21.3	1.63	21.8	590.5	46.9
5 % PFE–2/10 + 2 % chestnut tanning agent (500 hours' irradiation)	0.826	9.69	8.00	8.00	11.9	9.0	12.3	12.8	19.6	1.54	23.9	674.1	54.2

TABLE 5

Physico-mechanical properties of new russet-tanned leather after different processing and artificial aging

Name of process	Average thickness (mm)	Average breadth (mm)	Average cross-section (mm^2)	At a tension of 1 kg/mm^2		Fractures observed on outer surface		Load at rupture (kg)	Elongation at rupture (mm)	Limit of strength (kg/mm^2)	Relative elongation (%)	Module of elasticity (kg/cm^2)	Hardness (kg)
				Load (kg)	Elongation (mm)	kg	mm						
Control (before aging)	0.805	10.0	8.04	8.04	12.0	21.6	22.0	25.7	25.9	3.20	23.9	457	36.5
Control (500 hours' irradiation)	0.815	9.9	7.98	7.98	6.5	16.1	15.8	18.9	20.6	2.37	13.1	932	74.6
Phenol-formaldehyde tar (before aging)	0.826	10.0	8.24	8.24	11.0	24.6	21.9	26.1	23.6	3.09	21.6	514	42.3
Phenol-formaldehyde tar (500 hours' irradiation)	0.815	9.9	8.09	8.09	10.6	22.1	22.1	24.4	24.3	3.03	21.2	529	42.6
Butadine-styrol latex (before aging)	0.847	9.9	8.35	8.35	11.6	No cracks on outer surface		24.8	25.9	3.00	23.2	503	41.9
Butadine-styrol latex (500 hours' irradiation)	0.832	9.9	8.21	8.21	8.5	No cracks on outer surface		26.0	24.3	3.19	17.1	649	52.6
Methyl cellulose (500 hours' irradiation)	0.840	10.0	8.36	8.36	7.8	20.2	18.8	22.6	21.7	2.71	15.5	780	64.5

hardness. Greasing should be carried out in accordance with the instructions for the softening of russet-tanned and chromium binding leather published in the manual: *Gigiena i restavratsiya bibliotechnykh fondov*, Moskva 1964, pp. 94–97.

Our data on the effect of phenol-formaldehyde tar of butadinestyrol latex and of methyl cellulose on new russet-tanned leather are given in table 5. Processing with these polymers easily reduces the strength of the leather and slightly increases its hardness; when processing by aging, samples processed with these polymers are slightly more resistant than control samples, whose strength falls abruptly, and whose hardness is doubled.

Solutions of methyl cellulose prove to have a negative effect on leather. After aging, the strength is considerably reduced, and the hardness is increased.

CONCLUSIONS

1. The most effective method of strengthening the damaged leather binding of old books is processing with a 5 % solution of the methylol polyamide glue PFE–2/10 mixed with a 2 % solution of a vegetable tanning agent, followed by a greasing with a smear hoof oil.

2. A 10 % solution of methylol polyamide glue and tanning with a 2 % solution of a vegetable tanning agent should be used to strengthen damaged leather, whose strength cannot be determined on a dynamometer. Organoleptically strong and elastic leather can be obtained after such processing and greasing.

3. Varnished skin may be restored by using polyurethan tars. Polyurethan tar dissolved in cyclohexanone and applied to leather previously processed with a 10 % solution of PFE–2/10 gives a glossy, even a varnished surface.

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Repair and Conservation of Palm-leaf Manuscripts

by ALFRED S. CROWLEY

1. Problems

The Department of Oriental Printed Books and Manuscripts in the British Museum has a large collection of palm-leaf manuscripts, the greater part of which comprise the Nevill collection of over 2.000 manuscripts in Pali, Sinhalese and Tamil which were acquired at the beginning of the century. The problem of the repair and conservation of these manuscripts has been an ever-present one aggravated by the need for economy in storage space which originally led to the palm-leaves being stored in boxes. These were made for the purpose but have proved unsatisfactory as they often contained several manuscripts, which necessitated frequent handling of all the palm-leaves in order to find the one required by a reader. Damage was also caused by storing different sizes in one box since manuscripts comprising many leaves pressed heavily on others of only a few leaves. In addition, single manuscripts have been acquired in the past in a rolled-up state which, up to now, have defied all attempts to straighten them without splitting. As Bhowmik in his article[1] emphasizes, palm-leaf has poor resistance to wear and tear and is easily damaged by constant handling. Therefore it became increasingly obvious that the Department would have to take urgent steps not only to re-house the palm-leaves but to repair those requiring it in such a way as to ensure their durability and legibility after lamination (Plate 1) in order that they could be studied safely and without restriction by scholars. The timely appointment of a Conservation Officer in the Department has meant that experiments on palm-leaf material following those of Bhowmik and Nordstrand[2] have been carried out in an effort to provide a satisfactory solution to the problems.

Difficulties have arisen in attempting to apply the methods advocated both by Bhowmik and Nordstrand. The former advocates the hot lamination process (pressing at 27° for 2 minutes) and the latter the use of silk gauze. Cold lamination is preferable as the long-term effect of heat on the fibres of palm-leaf is not known. Bookbinders' paste used in the application of

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silk gauze is not to be recommended as the paste tends to dry out, break down and become brittle. Moreover, its main ingredient being starch, the use of paste in damp climates renders the manuscripts liable to attack by mould and insects. This present article is concerned with a study of methods of cleaning, repairing and conserving palm-leaves by the use of modern materials and techniques available.

2. Materials

Caution: Owing to the toxic nature of some of the materials a fume cabinet should be used.

a. Cleaning

i. Distilled water.
ii. I. I. I. trichloroethane [e.g. Genklene].
iii. Ethyl alcohol [i. m. s.].
iv. Ol. camph. rect. (alb.) [Oil of camphor].

b. Re-inking Incised Texts

Lamp black and oil of camphor.

c. Repairing

i. Paper-backed veneer.
ii. *Kozo-shi* paper.
iii. Acrylic emulsion adhesive (e.g. Spynflex).

d. Lamination

i. Tissue coated on one side with adhesive acrylic rubber protected by a layer of silicone paper.
ii. Acrylic emulsion adhesive (e.g. Spynflex).
iii. Release-coated paper.
iv. Diluted paraffin wax emulsion (e.g. Waxoll P. A.).

e. Repair of Boards

i. Acrylic resin (e.g. Perspex).
ii. Polyester resin paste (e.g. Bondapaste).
iii. Dowels.
iv. Silk cord.

3. Methods Used in Treating and Repairing Palm-leaves

Caution: All cleaning and re-inking must be carried out before lamination.

a. Cleaning (i.e. removal of surface dirt).

Caution: Surface-written and incised texts must be dealt with by separate methods as distilled water will lift the ink from surface-written texts and must *not* be used on them.

i. Surface-written texts. The cleaning agent, I. I. I. trichloroethane is applied by rubbing with a swab of cotton wool over both sides of the leaf *following the line of the grain.* Alcohol mixed with oil of camphor (to replace the natural oils) to the ratio of 100 ml. alcohol : 5 ml. oil of camphor is then applied by stroking it on with a sablehair brush. Ten leaves can be cleaned at a time as by the time the tenth leaf has been cleaned, the first is sufficiently dry to rub with a cloth to distribute evenly any surplus oil which may remain on the surface after the spirit has evaporated.

ii. Incised texts. The best results in cleaning incised leaves were obtained with distilled water using a cloth rubbed hard (but with care) *across the grain* (Plate 2).

b. Re-inking Incised Texts

The time-honoured method of applying lampblack and oil of camphor still proves to be the most satisfactory. They should be mixed together until the desired shade is achieved. Incisions vary in depth and the degree of blackness required for one manuscript may be too light for another and vice versa. The mixture is applied over the entire leaf (Plate 3) and left overnight, after which the surplus can be cleaned off with alcohol.

c. Repair of Damaged Leaves

As it is not always possible to use palm-leaf as a filler for holes in disintegrating leaves, two thicknesses of a natural wood paper-backed veneer with a layer of *kozo-shi* paper in between, the whole being stuck together with an acrylic emulsion adhesive, has proved an excellent substitute of the required thickness. The most suitable paper-backed wood veneer has proved to be birch (light sycamore/maple shade). Two layers of veneer are placed back to back with one layer of *kozo-shi* paper between them stuck together with the adhesive, pressed in a small hand press and then cut to the shape of the repair area (Plate 4). It is easier to prepare the material in advance so that pieces can be cut out of the main sheet as required.

One complete leaf is taken from the manuscript as a pattern for the position of the cord-holes and the size of any other leaves of the same manuscript which may need the edges built up. The complete leaf is traced round on a sheet of white paper and the position of the cord-holes indicated (Plate 5). Each damaged leaf needing repair is laid, in turn, on the prepared sheet of veneer (the whole being put on a sheet of paper so that it can easily be turned on the bench) and cut round the area required with a marquetry knife in order to obtain the correct size of veneer.

d. *Lamination*

i. Total Lamination

The special tissue used for laminating palm-leaves is coated on one side with adhesive acrylic rubber which, in turn, is covered with a layer of protective silicone paper. Other adhesives would be difficult to apply as brushing would cause further disintegration and spraying would blow the particles away, whereas this tissue can be laid directly on the damaged leaf. The palm-leaf is laid on the bench and the tissue is cut to allow an overlap of 3 mm. all round before the silicone paper is removed. The tissue is laid, adhesive-side down, on the palm-leaf and pressed well with the hand to eliminate air bubbles. The leaf is then turned over and the prepared pieces of veneer inlaid (Plate 6). The silicone backing is then removed from the second piece of tissue and applied in the same way as the first piece. The entire leaf is brushed with acrylic emulsion adhesive (Plate 7), not on account of its adhesive properties, but in order to fill the tissue fibres to prevent light refraction and thus aid photography. The leaf should be placed between release-coated paper (Plate 8) and put in the press immediately the adhesive has been applied. Speed is most important at this stage because if the acrylic emulsion adhesive is allowed to dry before the leaves are pressed it is not absorbed into the interstices of the tissue. After five minutes the laminated leaf is removed from the press and diluted paraffin wax emulsion is applied to both sides of the laminated leaf with cotton wool. This acts as an anti-blocking agent (Plate 9). The leaf is put once more between release-coated paper and returned to the press for another five minutes. When it is finally taken out of the press the leaf is not pulled from the paper – the paper is always pulled from the leaf. Finally, the surface of the leaf is rubbed with a dry cloth to spread any excess wax evenly. The surplus tissue is removed from the edge of the leaf and the cord-holes by using a knife and a straight-edge. This form of lamination makes the leaf extremely flexible, legible and safe to handle (Plate 10 a, b, c). The tissue is rendered transparent by the application of the acrylic emulsion adhesive so there is no question of the text being obliterated. Should the leaf need restoring to its former state for any reason, the tissue can be removed with chloroform without causing damage. As the whole process is a cold one there is no danger of heat-damage.

ii. Partial Lamination

i. Cracked or Broken Leaves

In cases where there is a straightforward crack or break not causing holes, filler material is not required. By using three layers of adhesive tissue of varying widths on both sides of the leaf legibility is not affected although the strengthening of the leaf is absolute (Fig. 2). The first layer should be 6 mm. wide, in order to allow nearly 3 mm. on each side of the break or crack, and the other two layers should be proportionately wider. The acrylic emulsion adhesive is applied to the laminated parts *only*, by brush. The same process is followed from this stage as in total lamination.

ii. Leaves With Single Holes

The wood veneer is prepared in the same way as for the total lamination method and cut to the size of the hole (Fig. 3[I]). The cut piece is laid on the adhesive side of tissue from which the silicone paper has been removed (Fig. 3[II]). Another piece of adhesive tissue is taken but the silicone paper is not removed. This second piece of tissue is laid, silicone-side down, on the wood veneer which is already tissued on its other side (Fig. 3[III]). The whole is then cut round, *i.e.* tissued veneer and silicone-backed tissue, leaving an overlap of 3 mm. of tissue all round the veneer on both sides (Fig. 3[IV]). The top piece of tissue and silicone paper is removed (Fig. 3[V]). The palm-leaf to be repaired is placed over the veneer (Plate 11a and b) so that the holes to be filled fit exactly over the repair piece (Fig. 3[VI]). The silicone paper is peeled from the second piece of tissue (Fig. 3[VII]) and the latter is laid, adhesive-side down, over the repair and the whole pressed firmly together with the fingers (Fig. 3[VIII]). Finally the acrylic emulsion adhesive is applied to the tissued and repaired area and the process continued as in total lamination.

e. Boards

i. Repair of Existing Boards

The side of the board is drilled and wooden dowels inserted, leaving the ends of the dowels extended. A polyester resin paste is used to build up the damaged area and then sanded down to obtain the required shape.

ii. Replacement of Boards

Where no boards exist, acrylic resin answers the purpose very well as it can be cut to the required size, polished and cord-holes drilled into the sides.

iii. Cords

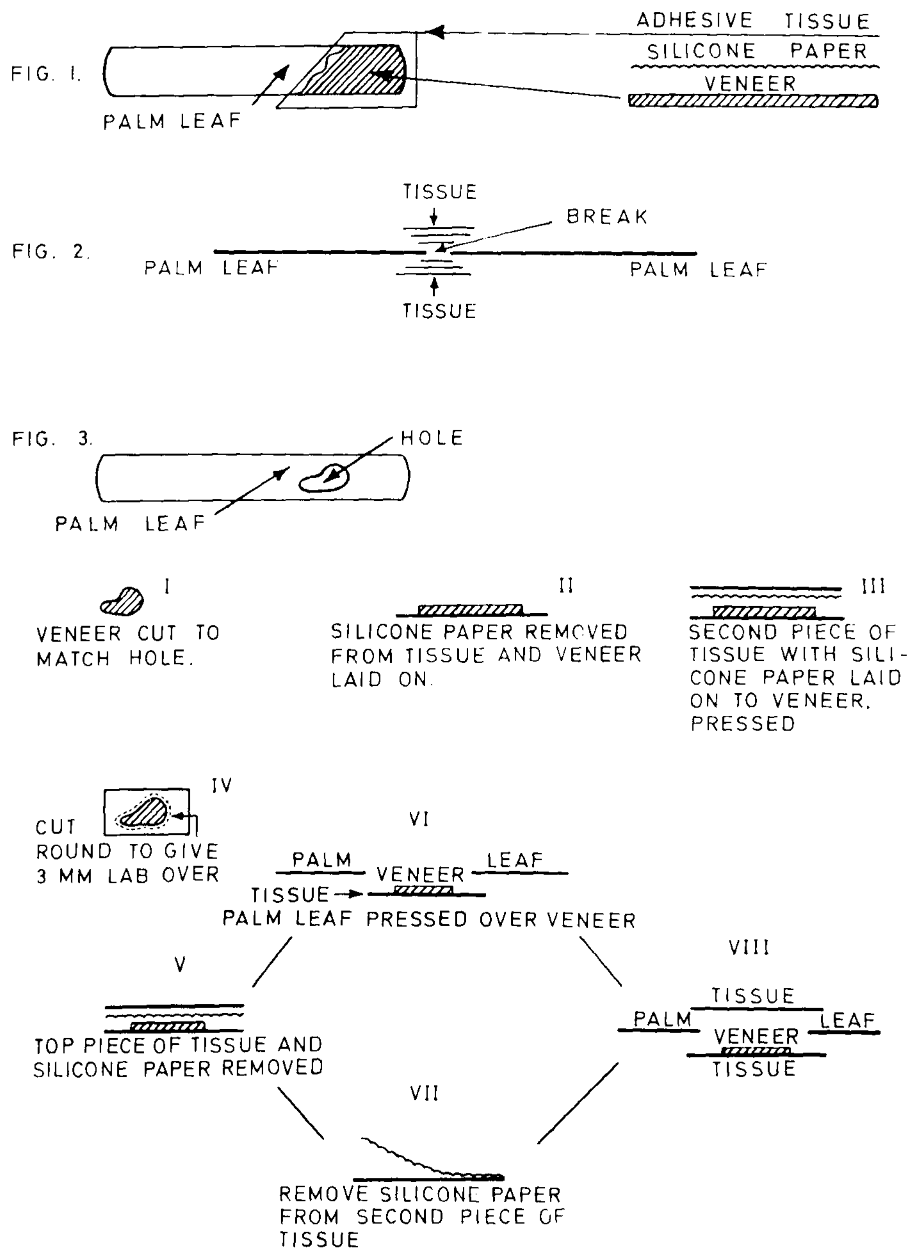
Where necessary silk cord is used to thread the leaves and boards together.

4. De-acidification

This question needs further study and research into it is continuing. At the moment it is thought likely that the inner fibres of the palm-leaf cannot be affected by acidity although a surface layer from the atmosphere may need attention. It is hoped that further research will find the answer to any problems that may exist in this area.

5. Storage

It is hoped that the Department's collection of palm-leaf manuscripts will eventually be stored in cabinets or cupboards in shallow sliding



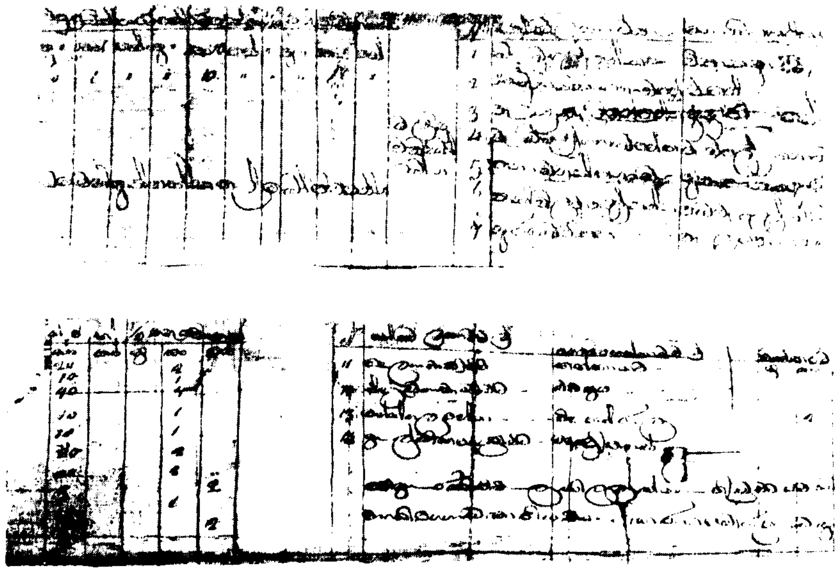


PLATE 1. Legibility after lamination.

PLATE 2. Cleaning incised texts.

PLATE 3. Re-inking (applying lamp-black and oil of camphor).

PLATE 4. Cutting repair material and shape of repair area.

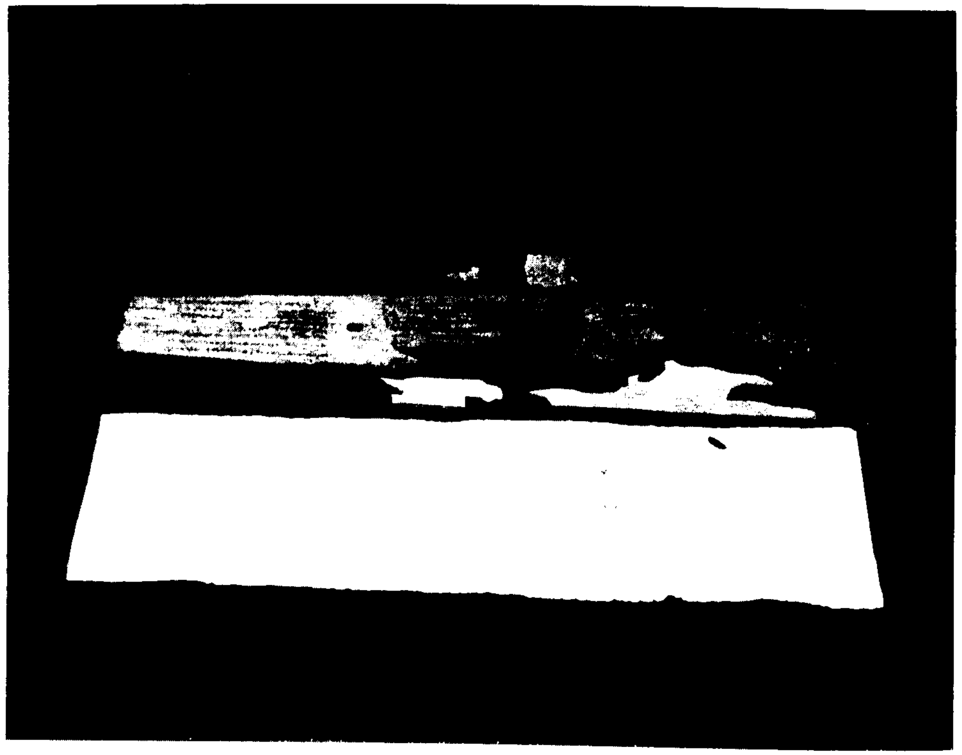


PLATE 5. Pattern of leaves and cord-holes.

PLATE 6. Inlaying pieces of veneer.

PLATE 7. Applying acrylic emulsion adhesive.

PLATE 8.
Palm-leaf being put between release-coated paper before pressing.

PLATE 9. Applying diluted paraffin wax emulsion after pressing the first time.

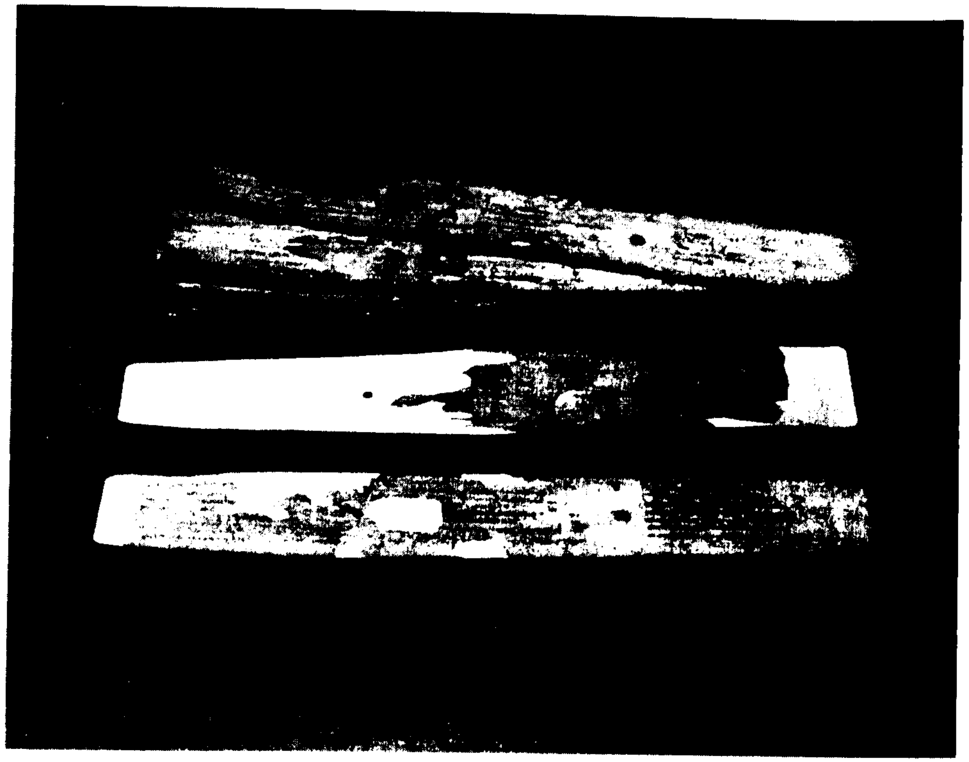


PLATE 10 a. Disintegrating leaves before and after lamination.

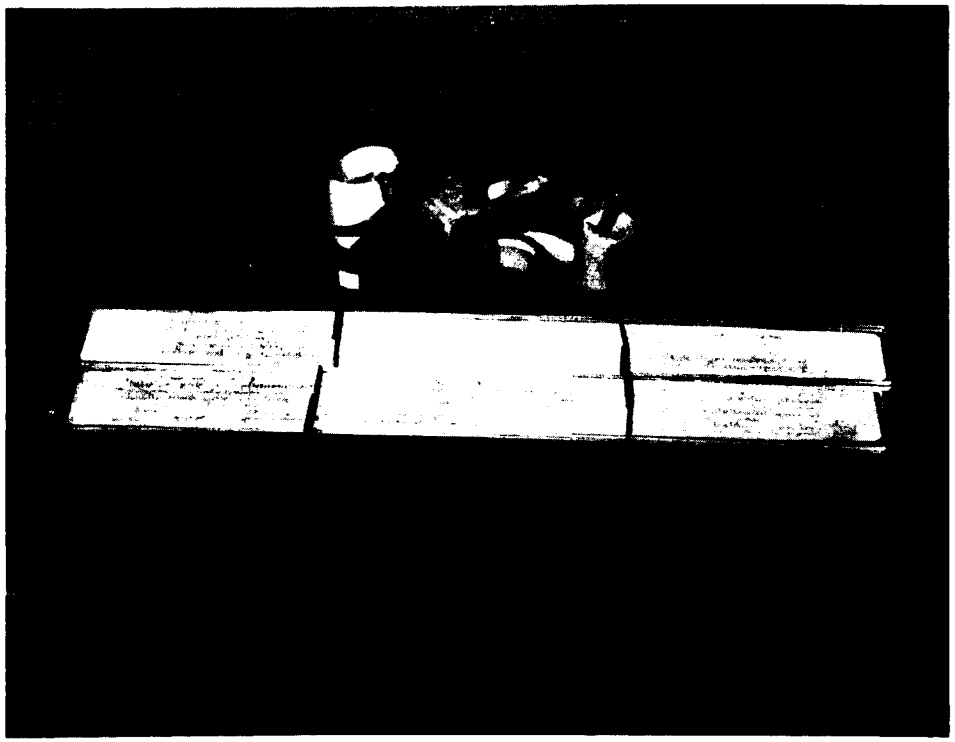


PLATE 10 b. Rolled leaves before and after lamination.

PLATE 10 c. Showing flexibility of laminated leaf.

PLATE 11 a. Partial lamination of a holed leaf.

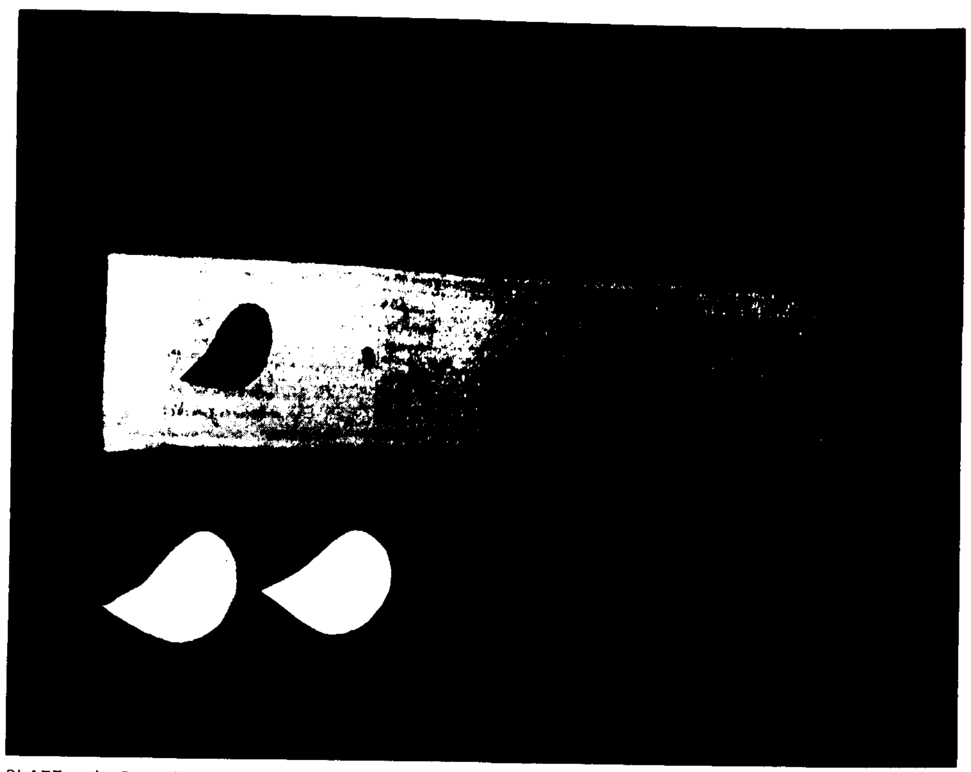


PLATE 11 b. See plate 11 a.

drawers. Manuscripts will be housed in single rows ensuring easy access and elimination of damage due to handling or pressure. It is visualised that the majority of the drawers will be some 44 to 60 cm. long but space for exceptionally long leaves will have to be made in a special cabinet.

ACKNOWLEDGEMENTS

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MATERIALS AND SUPPLIERS

1. Ol. camph. rect. alb. (oil of camphor) B. P. C.
2. I. I. I. trichloroethane (e.g. Genklene grease solvent as supplied by Solvoline Lubricants Ltd., 24, Reginald Square, London, S. E. 8).
3. Tissue coated one side with acrylic rubber adhesive (as supplied by Coated Specialists Ltd., Chester Hall Lane, Basildon, Essex).
4. Paper-backed wood veneer (e.g. shade 221, as supplied by Aga-Veneers Ltd., 62, Carter Lane, London, E. C. 4.).
5. *Kozo-shi* paper (as supplied by Berrick Bros., 22, Kirby Street, London, E. C. 1.).
6. Acrylic emulsion adhesive (e.g. Spynflex as supplied by National Adhesives, Slough, Bucks).
7. Diluted paraffin wax emulsion (e.g. Waxoll P. A. as supplied by R. G. Robinson Laboratories Ltd., Nursery Lane, Forest Gate, London, E. 7.).

8. Release-coated paper (as supplied by Samuel Jones Co. Ltd., Butterfly House, 11, Dingwall Road, Croydon, Surrey).
9. Polyester resin paste (e.g. Bondapaste as supplied by Bondaglass Ltd., 55, South End, Croydon, Surrey).
10. Acrylic resin (e.g. Perspex [I. C. I.]).
11. Diamond polishing compound (as supplied by Canning and Co., Greenhill Cresent, Holywell Industrial Establishment, Watford, Herts).

Abstracts

Damage to the leaves as well as illegibility has made it essential to find a safe method of repairing palm-leaves. Methods used in Copenhagen and Baroda are not entirely satisfactory because on the one hand the use of silk gauze with book-binders' paste tends to make the leaf more brittle and difficult to read or photograph and on the other the long-term effect of hot lamination is not yet known. It was therefore decided to experiment with modern synthetic adhesives and cold lamination methods to determine whether these could be used on palm-leaves to solve special difficulties such as splitting and crumbling, as well as the problems posed by incised texts. It was found that only a very flexible adhesive could be used and of those available only an adhesive coated tissue used with an acrylic emulsion adhesive had the desired properties. Experiments carried out to test the effect of cleaning agents on ink proved that *surface-written* texts could be effectively cleaned by using I. I. I. Trichloroethane followed by an application of ethyl alcohol (ind. meth. sp.) mixed with ol. camph. rect. (oil of camphor) in the proportion of 100 ml. ethyl alcohol : 5 ml. ol. camph. rect. in order to replace the natural oils. *Incised texts* are best cleaned with distilled water which cannot be used on surface-written texts as it removes the ink. For re-inking faded incised texts the best agents were still found to be lamp black and oil of camphor.

For repairing holed leaves a paper-backed natural wood veneer proved better than palm-leaf as a filler, using two thicknesses with a layer of *kozoshi* paper between. In the lamination process a diluted paraffin wax emulsion is used as an anti-blocking agent after the initial pressing between release-coated paper. Total lamination is carried out in cases where there are a number of holes and the leaf appears to be on the point of disintegration. Where there is a single hole, break or crack only that part of the leaf need be laminated.

The methods used render palm-leaves legible, pliable and resistant to the normal wear and tear of handling. To complete the work existing boards can either be repaired with wooden dowels and a polyester resin paste or else replaced by acrylic resin boards. Silk cord can be used to string the boards and leaves together.

Повреждения пальмовых листьев и связанная с этим неразборчивость письма вызвали необходимость найти надежный метод их восстановления.

Методы, применяемые в Копенгагене и в Бароде, не вполне удовлетворительны, так как, во-первых, применение шелковой газовой ткани и переплетного клея делает листья более хрупкими и затрудняет чтение и фотографию, а во-вторых, влияние горячего подслоения при продолжительном хранении еще не известно. Поэтому было решено испытать на пальмовых листьях новые синтетические связывающие вещества, применяя холодный способ подслоения для предотващения специфических повреждений, как например, появления трещин и крошения, а также во избежание затруднений, связанных с выгравированным текстом. Оказалось, что возможно только применение связывающего материала, обладающего высокой пластичностью, и что из имеющихся в наличии материалов только покрытая акриловой эмульсией ткань обладает требуемыми свойствами.

Опыты, проведенные с целью определить воздействие очищающих средств на чернила, показали, что *листья с написанным на поверхности текстом* можно эффективно очищать 1, 1, 1-трихлорэтаном с последующей обработкой этиловым спиртом (денатурированным при помощи метилового спирта) в смеси с очищенным камфорным маслом в пропорции 100 мг. этилового спирта на 5 мг. камфорного масла (заменяющего содержавшееся в листе масло).

Листья с выгравированным текстом лучше всего очищаются дистиллированной водой, которую нельзя применять для листьев с написанным текстом, так как она смывает чернила.

Для восстановления поблекших выгравированных текстов наилучшими средствами признаны ламповая сажа и камфорное масло. При восстановлении продырявленных пальмовых листьев предпочтительно применять для заполнения отверстий не новый пальмовый лист, а подслоение фанерой, подклеенной бумагой, причем берутся две толщи однослойной

фанеры с прослойкой бумаги из бумажной шелковицы (бруссонеции) между ними. Для предотвращения слипания при подслоении применяют эмульсию из разбавленного парафина после первичного сжатия между листами бумаги с невпитывающим покрытием. К подслоению под весь лист прибегают лишь при наличии большого числа дырок и когда непосредственно грозит распад листа на куски. Если есть всего одно повреждение (дырка, трещина или перелом), подслаивают только поврежденную часть. Применяемый способ делает пальмовый лист удобочитаемым и пластичным и увеличивает его сопротивление нормальному износу и разрыву при пользовании.

В завершение, ранее наложенные борты можно укрепить при помощи деревянных шпонок и полиэфирного смолистого клея или заменить бортами из акрилового листового материала. Борты и листья можно скреплять тонким шелковым шнурком.

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The Design of Book Stacks and the Preservation of Books

by KEYES D. METCALF

Stacks used for the housing of books in the United States were designed until fairly late in the 19th century with two primary objectives in mind: to store the books and to fit them suitable into the architectural concept of the building. There was apparently no attempt to deal with the question of book preservation. Librarians had not yet become worried about that problem, at least not worried enough to try to do anything about it, and the same could be said of architects.

One of the building designs in use in the larger libraries which had valuable collections was a great central hall or court used for the main reading area with a skylight overhead for natural light. (Libraries were generally closed at sunset and not lighted artificially.) Galleries rising one above the other, sometimes as many as six in all, were placed on two or more sides of the court. Each gallery was divided into alcoves by shelving running at right angles to the outer walls toward the reading area. There was generally space enough between the book shelves for a table for readers in each alcove. A window on the outside wall for light and air and an aisle either next to that wall or along the side of the alcove adjacent to the central court completed the basic plan. A good example of this is still to be found in the Peabody Institute Library in Baltimore. The Astor Library in New York City was another. The appearance was striking architecturally, and an attempt to take advantage of the basic architectural concept can be seen at the Washington Square Library of New York University which is now under construction. From the point of view of 19th century architects and librarians, the height of the court helped to keep the space at the bottom cool in the summer, but the rising hot air resulted in overheating at the top of the great court and in the upper galleries in summer and often in the winter also. In winter the excessive dryness from the required heating had an unfortunate effect on the books.

In the last third of the 19th century more concentrated (not compact in the modern use of the term) stacks began to be built, as book collections in libraries increased in size. Following the completion of the new buildings

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of the Boston Public Library and the Library of Congress in the last decade of the century, multi-tier, cast iron stacks more or less shut off from other parts of the building, might be said to have become standard for the larger university, public and state libraries. It had become evident that there were ventilation and book deterioration problems which should be coped with. It was decided that books needed to be ventilated in order to avoid hot stagnant air in humid summer which too often resulted in the formation of mold, and in the concentrated multi-tier stacks, slits were provided at the aisle side of each double-faced stack range. This kept the air moving because heat rises automatically. These slits were at first horizontal in form, but as might have been expected, call slips, pencils and small books often fell through them to the floor below or down even more than one level, and so in the larger Widener Building in the Harvard College Library and elsewhere vertical instead of horizontal slits came into use.

As another aid to ventilation the shelves themselves, which previously had been constructed of wood, began to be made of steel with what might be called parallel bars with spaces between them. These bars were made with two or more bends into an upturned angular ⊓ in order to strengthen them. The shelves let the dust filter down from above, as well as permitting the air to move upwards, and with the ventilation slits between floors, they made the whole stack into one great chimney with resulting fire risks, and as had been the case with the earlier central halls with row after row of galleries. The temperature increased as you went higher. In the Widener 10-level stack the temperature increased approximately one degree Fahrenheit for each level from the bottom to the top during severely cold or severely hot weather. This was uncomfortable for the occupants, as well as a fire hazard, and librarians finally came to realize that the inevitable heat and the dust and pollution in the atmosphere of our cities, where most libraries were placed, resulted in book deterioration. Air filtering to remove the dust and forced ventilation came into use, although it was far from being entirely effective.

By the time of the First World War leading American librarians, notably William Warner Bishop of the University of Michigan Libraries, and Harry Miller Lydenberg of the New York Public Library, began not only to talk about paper and binding deterioration but tried to do something about it. In 1924 the New York Public Library compared many volumes brought over from Russia at the end of the 19th century with copies of the same books acquired 25 years later. It found that paper in the earlier purchase was often in bad physical condition, not from frequent handling because

Russian material was comparatively seldom used in those days, but apparently from the atmospheric conditions under which it had been stored, while the identical volumes that had been housed in Russian buildings, where there had been little air pollution or heat, were still in prime condition. Something should be done, particularly in libraries with difficult-to-replace research collections.

During the following decades various steps have been taken to prevent or at least delay paper deterioration and damage to bindings (which resulted from polluted air, too little humidity and too much heat in the winter, and too much humidity in the hot damp American summers) through the installation of some kind of air conditioning.

During the same period changes were made to minimize fire risks. What is hoped will be a reasonably successful reduction of hazard from fire should come from the adoption of stricter building codes. In many states codes now make it unlawful to open up more than two floors together without fire partitions between them. In some places the square footage size of any area without fire walls is restricted to as low as 15.000 square feet. In some a mezzanine which is over more than a tird of the floor below it must be cut off by glass or in some other way from other areas. Open stairwells without solid partitions and doors around them were generally not allowed to run for more than one floor without fire doors. Book stacks no longer have ventilation slits and they have fire prevention doors at the stairs between each floor or at least between every other floor.

In their zeal to prevent losses from fires, fire insurance companies advocated the use of sprinkling systems throughout libraries and tried to insist on them in book stacks and elsewhere before insurance contracts were signed. However, the American Library Association through its Library Technology Project arranged for a study of the problem and published: *Protecting the Library and Its Resources: A Guide to Physical Protection and Insurance. Report on a study conducted by Gage-Babcock and Associates, Inc.;* LTP No. 7, Chicago: American Library Association, 1963, 322 pages. As a result of this study and publication, insurance policies are now available for libraries without sprinklers in the book stacks, but many new library buildings install in their place heat and smoke detectors which it is believed will do as much or more to prevent fire and at the same time avoid water damage which can be as serious or more so.

In connection with water damage it might be noted that at the Houghton Library for Rare Books, Harvard University was more afraid of water, not only of water from sprinklers, but from leaks from the roof, from plumbing and heating installations of any kind, than from fire. When it was built in 1940 and 1941 aprons were installed under every water pipe which would catch any leaks, run the water to a sink where an alarm is sounded. At the sink there is a series of faucets, and by opening them one at a time they would show exactly where the leak was to be found. All the pipes were arranged so they could be gotten at with the least possible dismantling of the structure.

Prevention, or at least the reduction, of water and fire damage still left the greater problem of paper deterioration which may well be the most serious one in American libraries today. Before describing what has been done in connection with building construction in order to delay this deterioration, something should be said about book and manuscript paper. Until a century ago the great majority of paper used was made from rags, and there seemed to be little deterioration even under the prevailing housing conditions. This was in spite of the fact that the library designs described earlier encouraged rather than delayed paper deterioration. There had been some use during the first half of the 19th century of esparto grass and other substances than rags which have a far shorter natural life than well-made rag paper. But there was little or no apprehension on this account.

In the 1860s and 1870s the demand for paper became so great that sources other than rags became essential, and the use of wood pulp on a large scale began, at first in many cases by mixing it with rags during the manufacturing process. The results seemed to be satisfactory, costs were reduced, and paper became more plentiful by the middle of the 1870s, and a large share of that used in newspaper publishing in the United States was made of wood pulp. The whole process of paper making was mechanized for the sake of economy. Chemicals of various kinds, such as alum that left an acid residue, were added to speed up the process and were not completely washed out in the processing. At the same time similar additives were used in some of the rag paper that was being manufactured. Librarians and publishers still failed to realize what the wood pulp and the chemicals would mean in terms of paper life.

But by the second decade of this century, newspapers only 15 years old were badly faded in many libraries and almost unusable because of brittleness. In the New York Public Library newspaper reading room the janitorial staff had to sweep up the paper fragments which were spoken of as »*Post Toasties*«, a popular cold breakfast food, a number of times a day. Attempts to improve the situation by pasting a thin but strong Japanese tissue on both sides of each sheet of the New York City papers, dipping

them in various substances and other methods within the library's financial means when used on a large scale proved futile, although the first mentioned method postponed disintegration for perhaps 15 years.

The newspaper preservation problem was solved, however, in the early 1930s with micro-reproductions of one type or another. These came into use in a few libraries at that time and by 1950 were in common use throughout the country. But wood pulp newspapers were not the only printed material that deteriorated in American libraries. Wood pulp magazines, which some may believe not to be worth preserving except as samples to show one phase of the current society, were as fragile as newspapers, but because of smaller size are put under less strain when used. To all intents and purposes, they are hopeless in their original form as far as permanent preservation is concerned, unless new methods of dealing with them are found. The same holds to a lesser extent for material as valuable as parts of the British Sessional Papers and Roll Series, the first edition of the Oxford English dictionary; some sections of these were printed on poor paper with wood pulp or acid residue. These were far from being the only important publications that have deteriorated rapidly and the prospective loss of this material now or later is very serious.

Much of the material published throughout the world, particularly during the two world wars, was in bad condition by the 1960s or earlier because of poor paper and poor atmospheric conditions. While it is possible today, through the offset process and with other technical methods recently developed, to reprint more easily than ever before, this cannot be carried out for the great bulk of printed material in the large research collections because of the tremendous scale of the problem. Recent studies indicate that the great majority of all material published between 1900 and 1950 will be practically unusable by the year 2000. The situation just described dawned on the library world very slowly over a period of some fifty years. But as the result, there has come into use microforms and reprinting on a large scale.

Research to find ways to produce more permanent papers, slow up the deterioration of material already printed and to learn more about its condition has been financed on a large scale for the last fifteen years by the Ford Foundation financed Council on Library Resources. It became evident that much could be done toward lengthening the useful life of poor paper by better housing, which is the primary subject of this article, and gradually over a period of forty years the changes described below have come into use.

1. There has been the already described reduction in fire and water hazards in library buildings through the adoption of stricter building codes, heat and smoke detectors, and methods of preventing floods from leaks of one kind or another.

2. Stack construction has prevented to a large extent physical damage to bindings and the contents of printed and manuscript material, by avoiding sharp edges and corners on which books could be torn if there was careless handling, and by improving the design of book supports used to keep bound and unbound material standing upright. If the books are allowed to lean over, the bindings are damaged and sometimes torn. If they are shelved too tightly, pulling them off the shelf or reshelving them strained the bindings. If book supports have narrow edges that the books are pushed against, damage inevitably results. At least one library has resorted to the use of concrete or brick blocks covered with heavy brown paper, and in later years with library buckram; these cost no more than modern steel book supports and by some are considered safer. The shortage of a high quality, non-professional library staff has handicapped efforts in this direction and perhaps nullified the physical design improvements that have been made.

3. Realization was reached that natural light, that is, sunlight, particularly if it is intense as it often is, contains harmful ultra violet rays. Not too many years ago library book stacks were planned for use by natural rather than artificial light. This was, of course, particularly true before electric lights were available. These rays from sunlight faded bindings, and when a book was open tended to fade the paper rapidly and hastened its deterioration by combining with the sulphur in polluted atmosphere and the acid residue in so much of modern paper. The problem was multiplied during the »all-glass« age during which many libraries were built in the 1940s and 50s. Fortunately, that age has now passed for most of us as far as new construction is concerned, and a smaller amount of window area is used and much of the remaining glass is treated in one way or another so as to reduce the dangerous rays that come from bright sunlight.

4. It was also learned that incandescent, fluorescent and mercury vapor lamps produce ultra violet rays which are harmful to books and bindings and that these lamps should be protected by baffles or plastic that will filter out most of the harmful rays. This is the case especially if rare and difficult-to-replace books that are used for exhibition purposes are housed in a brightly lighted room; the higher the intensity of the light, the greater the potential damage, other things being equal.

5. The final and perhaps the most serious problem in connection with stack construction has arisen in connection with its atmospheric conditions. Recent studies of paper have indicated that temperatures above the freezing mark tend to hasten the deterioration of paper, particularly modern paper with its residue chemicals. We are not ready to keep our book stacks at the freezing point, but the higher the temperature, the more rapid the paper deterioration, and some attempts are now being made to lower book stack temperatures in our great research libraries, although this discourages their use in the United States where open access stacks are considered of great importance, and where we seem to prefer overheated rooms. With low temperatures it is not feasible to install carrels for readers in the stacks, something that has become an almost a universal practice in recent years. It is not known what developments there will be in this connection in the years immediately ahead, but many librarians hope that further research will indicate that temperature in the upper 60s Fahrenheit will be found to be reasonably suitable.

Heat is not the only deteriorating factor in atmospheric conditions. An excess of humidity, which we have in a large part of the United States during the summer months tends to develop mold, to say nothing of foxing. Dehumidification is expensive but has been made available in many American libraries. In the winter, with our tendency to heat libraries to 75 degrees Fahrenheit, the resulting lack of humidity tends to dry out paper and make it brittle. This has resulted in humidification installations in many libraries during the heating season. It is believed that a relative humidity of from 45 to 50 per cent is most suitable, although at least one study has indicated that far lower humidity is not harmful and may be useful. But we do know that to shift from high to low humidity or in the other direction results in warping and damage to bindings and paper.

Humidity conditions in the winter may result in two additional problems. Large expanses of glass and a relative humidity as high as 45 per cent will, when the weather is much below the freezing point, result in the congealing of water on windows from which it later runs down and does damage. This can be overcome by the use of expensive double glass. With low humidity static electricity is produced by walking on the wall-to-wall carpets which in the last decade have come into common use in libraries. Theoretically, it is possible to use a spray that will prevent the static or to put wires in the carpet fiber that will carry it away or to use natural or artificial fibers which do not produce as much static. But the fact remains that this has presented a serious problem principally in libraries with carpets or those with the glass stack floors which were in common use early in the century, if the humidity is brought to the point where the books do not suffer from too much dryness.

Another atmospheric problem is the fact that forced ventilation with either outside or recirculated inside air inevitably results in dust entering the book stack and other library areas and settling on the books. Even the finest dust is abrasive in character and tends to harm them, as well as making them unpleasant to handle. Hands become dirty, and rub off and soil the paper. The sharp particles of dust damage it. To avoid both problems, ventilation systems in this century have generally included air filters to catch the dust before it enters the library. For many years mechanical filters which catch the dust by passing the incoming air through oil or water were the best available. In recent years at considerable expense electrostatic filters have been used in a few libraries, particularly where rare and irreplaceable material was housed. They remove finer dust than the mechanical filters, but on rare occasions this system has broken down, and if the forced ventilation continued, the dust that had accumulated on the filters has been pushed in tremendous quantities into the stack area, much to everyone's dismay. As a final resort, mechanical and electrostatic filters have been used together occasionally, but this adds considerably to the already expensive installations.

The problem of atmospheric conditions might well be summed up by saying that libraries have found that keeping a reasonably uniform temperature, preferably as low as the library patrons are willing to endure, is useful in both winter and summer; that humidification in the former and dehumidification in the latter is desirable; that forced ventilation and air filtering is a basic requirement. Construction to accomplish this adds 10 to 15 per cent or even more to the cost of a library, but is considered well worth it in a library that has any great amount of irreplaceable and rare material for the sake of the collections, to say nothing of its occupants.

Before the Second World War there were comparatively few air conditioned installations in American libraries, except for a limited number in the deep south, and practically none that could be called completely satisfactory. Twenty years ago libraries in the northern part of the country rarely considered that air cooling or humidification control were necessary, although it had become standard practice in the southern part of the country. Its use has gradually moved northward, encouraged whenever there is an unusually hot summer, it reached the border states between the north and the south in the early 50s, and during the present decade it has

become common or standard practice throughout practically all of the United States and in a number of libraries in Canada. The quality of air conditioning has improved steadily and is a boon to the books and, of course, to the readers.

It is obvious that great progress has been made in recent years toward the preservation of books and binding which, due to the increased use of poor paper and leather, has become an exceedingly serious problem. Library building design in the United States until well into this century failed to take into account the deterioration of the collections to be housed. New library buildings, particularly those built since the Second World War, have provided in many cases:

1. A reduction in water and fire hazards.
2. Improved atmospheric conditions which should lengthen paper life.
3. Better book stack design which reduces damage that results from handling material in connection with library services.
4. Lightning installations which minimize damage from ultra-violet rays which derive from both natural and artificial light sources.

There are these problems which the above improvements have not solved but which are outside the scope of this article:

1. Inexpensive methods to preserve indefinitely material on poor paper already on hand.
2. The damage which results from careless handling of material by library personnel and readers.
3. The use of more permanent and long-lived paper for printed and manuscript material worthy of preservation which is used in the future.
4. The financial problem. The cost of correcting the situation inherited from the past and to provide for future needs.

ABSTRACTS

Paper deterioration was not recognized as a library design problem in the United States until long after the use of harmful chemicals and woodpulp in paper processing for newspaper and other publications became common. Architects and librarians failed to understand that there was a connection between building design and book preservation. By 1915 many publications had deteriorated so badly that forward looking librarians were trying to

do something about it. Microreproductions and new methods for reprinting helped but did not solve the problems. But it was realized that the following changes in building design would help:

1. Temperature and humidity control, forced ventilation and air filtering.
2. Stack construction without sharp edges and improved book supports.
3. Changes in window patterns and lighting fixtures for protection from ultraviolet rays.
4. Building construction which reduces fire and water hazards.

These four advances are in regular use but paper and binding deterioration will continue until:

1. Less expensive methods to preserve material now on poor paper are found.
2. »Permanent« paper is used for material to be preserved.
3. Damage from careless handling of material by library personnel is prevented.
4. The financial problem involved in the changes already in use and the proposed advances is solved.

Порча бумаги долго не связывалась в США с проблемой проектирования библиотечных зданий даже после всеобщего применения вредных химикалий и древесной целлюлозы в производстве бумаги (газетной и пр.). Архитекторы и библиотекари не признавали наличия связи между проектированием библиотечных зданий и сохранностью книг. В 1915 г. много фондов было настолько повреждено, что передовые библиотекари стали предпринимать профилактические меры. Микрокопии и новые способы перепечатывания внесли улучшение, но не разрешили этой проблемы. Пришли к заключению, что целесообразны следующие изменения в проектировании библиотечных зданий:

1. поддержание требуемой температуры и влажности, продувочная вентиляция с фильтрированием воздуха;

2. создание полок без острых краев, а также качественных подпорок для книг;

3. изменение расположения и конструкции окон и арматуры освещения для защиты от ультрафиолетовых лучей;

4. строительство зданий, предотвращающее опасность в случае пожара и наводнения.

Эти четыре нововведения сейчас уже всюду применяются, но бумага и переплеты перестанут портиться лишь когда:

1. будут найдены менее дорогостоящие способы защиты существующих фондов на плохой бумаге;

2. войдет в употребление «вечностойкая» бумага для подлежащих сохранению текстов;

3. удастся предупредить порчу фондов, вызванную небрежным отношением библиотечных работников;

4. будет разрешена финансовая проблема, связанная как с уже введенными изменениями, так и с предложенными на будущее прогрессивными мероприятиями.

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La restauration des documents au VI° Congrès international des archives (Madrid, 1968)

Au Congrès international des archives de Madrid, une section spéciale avait été prévue pour l'étude des questions relatives à la restauration des documents et, de fait, une séance de discussion eut lieu sur ce thème le 3 septembre. Cependant-bien que la réunion dût s'achever par le vote d'une motion – il ne s'agit que d'un échange de vues entre les congressistes intéressés par la question. Le sujet, en effet, n'avait fait l'objet ni d'une enquête préalable, ni de la rédaction d'un ordre du jour. D'autre part, le président désigné, M. Bhargava (Inde), étant absent et le nom de Mr. Ellis (Royaume-Uni) n'ayant été donné que par erreur comme étant celui du secrétaire de la section, M. de Font-Réaux (France) assura au pied-levé la direction des débats avec l'assistance d'un bureau improvisé.

En ouvrant la séance, le président évoqua la mémoire de W. J. Barrow et rappela tout ce que la science de la restauration des documents devait au maître de Richmond, prématurément décédé.

A partir de cet hommage, la discussion s'ouvrit sur le *laminator* de Barrow, puis porta sur les autres dispositifs et méthodes employés dans les divers pays représentés. Au cours du débat, intervinrent M. Battelli (Vatican), l'abbé Beaudin (Canada), Miss Darlington (Royame-Uni), Mme Durand, MM. Durye et de Font-Réaux (France), M. Jägerskjöld (Suède), M. Pérotin (Nations Unies), Mlle Scufflaire (Belgique), MM. Titileanu et Ungureanu (Roumanie), ainsi que plusieurs congressistes allemands, américains et hongrois. C'est dire que la réunion fut fort vivante, même si elle n'apporta pas de révélations. Les appareils classiques (Barrow, Henneke), les méthodes manuelles (Langwell, Kathpalia), les expériences hongroises, roumaines, vaticanes, etc., les matériaux de revêtement (acétate de cellulose, polyéthylène), la question de la désacidification (préventive ou curative, liée ou non à la restauration), les problèmes particuliers posés par le parchemin aussi bien que par le papier pelure moderne, ceux de la coupure et de la reliure des documents, etc., furent successivement envisagés, de même que les considérations financières et le travail en série pour le traitement des masses de documents. De l'ensemble de ces interventions se dégagea progressivement l'idée que la diffusion des informations (toujours précieuse) ne suffisait plus et qu'il fallait constituer une commission spéciale permanente au sein du Conseil international des Archives ou, du moins, organiser des colloques dans le même cadre. Le groupe de travail ainsi souhaité aurait pour première tache d'établir sans complaisance un bilan objectif des expériences réellement faites; il devrait ensuite préparer une planification concertée tant de la recherche fondamentale que des études à conduire sur quelques points majeurs (comme le traitement des masses de papiers); il devrait être triparti (conservateurs d'archives, ingénieurs spécialistes et techniciens practiquant effectivement la restauration) et agir en liaison avec les autres corporations intéressées par la restauration des documents, notamment celle des bibliothécaires. Une motion explicitant ces voeux fut adoptée à l'unanimité, reprise par la commission de synthèse et adoptée ultérieurement par l'Assemblée générale du Congrès.

Yves Pérotin
Genève

Note: N'ayant rempli que la fonction de »secrétaire de séance«, l'auteur de cette note précise qu'elle n'a pas le caractère d'un compte-rendu officiel et n'engage aucune responsabilité.

Information About the Meeting of Specialists in Conservation and Restoration of Written Materials (Sofia, 1968)

A conference of delegates of the Socialist countries represented at the International Co-ordinating Centre for Library Building and Equipment was held in Sofia from September 16th to 20th, 1968.

As a result of a visit to Bulgaria by Mr. Gawrecki and Mr. Skřivánek from the State Library of ČSSR and also as a result of further mutual cooperation, it was decided to submit a basic report to the conference on the following subject: »Concepts and Pressing Tasks in the Field of Preservation, Conservation and Restoration of Library Holdings.« This report was prepared by Mrs. Stella Alkalaj, Chief of the Restoration Laboratory of the »Cyril and Methodius« National Library, in collaboration with Mr. Günther Müller, Chief of the Restoration Atelier of the University Library of Jena (German Democratic Republic), Mr. Ladislav Skřivánek, Chief of

the Restoration Section of the State Library of Czechoslovakia, and Mr. Gawrecki, former chief of the Technical Department of the same library.

The report provides a general survey of the nature, characteristic features, and structure of the written materials preserved and kept in libraries, of damaging factors, and of requirements which must be observed to ensure a proper and long-lasting conservation. A critical analysis is made of the existing methods of conservation and restoration, of present apparatus and devices for decontamination, killing insects, lamination, air-conditioning, sunlight filtering, etc. Suppliers of these devices and of synthetic films, lacquers and other materials needed for library conservation and restoration are also listed.

The sections dealing with urban requirements and considerations for determining location for the stack-room, and a model scheme for the working processes in the restoration department were prepared by Mr. Gawrecki.

Presented in this form, the report has served its purpose adequately, namely the purpose of informing the participants of the present situation and problems of conservation and restoration – as connected with library building and equipment. It is clear that an appropriate and well organized scientific conservation of library materials is impossible without prior knowledge of nature and particulars of these materials. This should be considered as a starting-point for a rational and suitable disposition of the stack-room and restoration department and their modern equipment. With no knowledge of the materials to be preserved, the architectural and constructional work cannot be satisfactory carried out, nor a complete conception and development of the projects. This problem is particularly stressed in the report, and is considered to be the main task of architects and builders who, of course, are expected to work in close collaboration with specialists in library restoration.

The conference provided an opportunity for the first meeting of colleagues engaged in conservation and restoration of library materials. It was attended by the following persons: Mrs. Galina S. Rožkova, Chief of the Department for Book Hygiene, Conservation and Restoration of the Lenin Library in Moscow; Mrs. Lola Hasznoz, Chief of the Restoration Department of the State Archives in Budapest; Mr. Ildiko Czelder, from the Restoration Section of the National Library »Scechenyi« in Budapest; Mr. Ladislav Skřivánek, Chief of the State Library of Czechoslovakia; Mr. Poul A. Christiansen, editor of the journal »Restaurator«, Copenhagen; and Mr. St. Kubiak, Director of the University Library in Poznan.

Bulgaria was represented by Mrs. Stella Alkalaj, Mrs. G. Sâjkova, biologist in the »Cyril and Methodius« National Library, and Mrs. D. Kileva and Mrs. R. Dobrevska on behalf of the State and Scientific Archives.

During the course of the two sessions, restorers from several countries commented on the four additional co-reports (by Hasznos, Czetler, Kubiak, Rožkova), and reported on their own methods of work with some displays of pictures and sample materials. These activities were followed up by discussions, and the personal contact that was established among the delegates contributed to a better mutual understanding and a useful exchange of experience, which will undoubtedly improve future work.

The methods of restoration of the »Cyril and Methodius« National Library were demonstrated on the spot and aroused the interest not only of specialists but also of others.

Materials and pictures from Bulgaria, Czechoslovakia and the German Democratic Republic were displayed on six exhibition stands showing their methods of restoration and the condition of the materials before and after restoration. Many brochures from suppliers of restoration equipment were also displayed.

In addition, the conference discussed the question of the co-operation and participation of conservators in the future work of the International Coordination Centre for Library Building and Equipment. The Bulgarian delegates suggested that the following subjects should be included in the resolution of the conference:

1. Preparation of model schemes for the working processes in the conservation and restoration department including a report and wellestablished schemes for large, medium and small libraries having a restoration service with or without a scientific section.

2. Critical examination of the existing equipment and of its use and location in the restoration department.

We hope that these crucial problems will be thoroughly examined by all the specialists who will attend the future, i.e. the fifth, International Conference of the Co-ordinating Centre for Library Building and Equipment.

The conference in Sofia may be considered a most opportune and useful initiative in stimulating mutual work and collaboration among engineers, architects and conservators. It will undoubtedly raise the level of restoration techniques and extend the scope of constructional planning, so as to enable libraries to improve the execution of their basic task – the preservation and conservation of valuable materials for the coming generations.

Stella Alkalaj
Sofia

Deterioration and Preservation of Library Materials (Chicago, 1969)

The annual conferences of the Graduate Library School of the University of Chicago, since the series was instituted more than thirty years ago, have emphasized those topics of major importance to the library community. That the subject matter of the 34th annual conference was, »Deterioration and Preservation of Library Materials,« is indicative of the concern which librarians today feel for the preservation of the materials over which they have custody.

This year's conference held, as in the past, at the Center for Continuing Education on the University of Chicago campus, opened with remarks on the timeliness of the topic by Don R. Swanson, dean of the Graduate Library School, and Howard R. Winger, of the Library School Faculty.

Edwin E. Williams, associate university librarian, Harvard University, presented the first paper on the »Deterioration of Library Collections Today.« Citing the great difference in the permanence of library materials between the clay tablet libraries of Assurbanipal and the paper records of modern libraries, Mr. Williams noted the continuing concern for the longevity of the written record which has been felt through the years since the invention of paper, and observed that as early as 1221, Frederick II of Germany had issused a decree forbidding the use of cotton pulp paper for royal documents and requiring all previous legal documents on pulp paper to be transferred to parchment within two years. In discussing the deterioration of library materials in today's libraries, Mr. Williams leaned heavily on the report prepared for the Association of Research Libraries by Gordon R. Williams of the Center for Research Libraries, but observed that there has been little action to date to implement the recommendations of the report, in large part because of the magnitude of the problems involved. The suggestion that research libraries ought to give up their deteriorating materials to a national preservation collection, the enormity of the costs involved in establishing and maintaining such a collection, the problems of possible indemnification of libraries for relinquishing their copies, and the fact that it is not always easy to demonstrate the crisis of book deterioration have each contributed to the fact that the library world has been slow to accept the recommendations of the ARL study.

Mr. Williams closed his remarks by observing that the library community must take it clear to those who will ultimately provide the funds for a national preservation program that the real purpose of preservation is

»dissemination.« The objective is not preservation for the sake of preservation, but the need to preserve the written record in order that it may be available for future generations.

Following Mr. Williams' opening paper, Bertie L. Browning, senior research associate at the Institute of Paper Chemistry, discussed »The Nature of Paper,« noting, among other things, that paper consumers, i.e., librarians, archivists, and keepers of records, want to know how long the paper in their books and documents will last. In commenting upon this concern for the permanence for longevity of paper, Dr. Browning stated that oven aging at elevated temperatures was the test most frequently used to predict paper permanence. His well illustrated talk included several graphs depicting the behavior of paper under specified conditions. One chart of particular interest to librarians illustrated the importance of durability as well as strength by showing the differences between two papers with equal rates of deterioration but different initial strengths as measured by folding endurance. In the case of the paper with low initial strength, a state of deterioration at which it was no longer usable was reached many years before the same stage of deterioration was reached by the high initial strength paper.

Dr. Browning was introduced by John Darrow, assistant vice president of the American Paper Institute who reported that the Institute had recently produced a paper, to be sealed in a time capsule, which would last a thousand years.

Carl J. Wessel, senior vice president, John T. Thompson and Co., presented the final paper on the first day of the conference on the subject »Environmental Factors Affecting the Permanence of Library Materials.« Mr. Wessel discussed humidity and temperature conditions in various cities of the United States; produced data to show the type and amounts of atmospheric pollutants in the same cities, noted the components of light and those portions of the spectrum which are most important in the degradation of library materials, and commented upon microbiological agents in the atmosphere which affect books and other materials.

In discussing the control of these several factors Mr. Wessel noted that librarians have not established criteria or specifications for the air conditioning in libraries. He noted also that usable cost data for various levels of air conditioning are not readily available. He did provide figures showing the cost of various types of filtering systems.

The conference reconvened on Tuesday morning to hear a paper prepared by George T. Eaton of the Photographic Research Division, Research

Laboratories, Eastman Kodak Company, entitled »Problems in Preserving Photographs and Photographic Films, including Microforms.« Owing to Mr. Eaton's illness this paper was read by John Barnes, also of the Eastman Research Laboratories. Mr. Eaton noted that there were few experts in the preservation of photographic media. After observing that color film is not yet sufficiently developed to make it acceptable for archival use, Mr. Eaton stated that permanence in photographic media is dependent upon: (1) the stability of the support medium (paper, film, glass), (2) control of the processing operation, and (3) the nature of the storage environment. In restoring deteriorated photographs, copying of the faded prints is usually the most satisfactory procedure.

»Alkaline Printing Papers: Promise and Performance« was presented by Joseph Thomas, vice president for research, S. D. Warren Company. Dr. Thomas observed that despite numerous modern inventions, the printed image on paper was still the real workhorse for the transmission of information. World War II was a major stimulus in the development of new uses for paper and today the manufacture of paper ranks as the 11th largest industry in the United States. In printing papers, the end use must be reflected in the characteristics of the sheet. Although the need for permanence in printing papers has long been recognized there has been lots of talk but little action until, in Dr. Thomas' words, W. J. Barrow lit a fire under the subject. Rag papers used to be considered permanent, but it was early discovered that this was not true if the sizing were acid. Edwin Sutermeister, of the S. D. Warren Co., was one of the early pioneers in the development of acid-free paper. These early alkaline papers were largely the result of Sutermeister's attempts to find a use for calcium carbonate, which was a by-product of the papermaking process. In experimental work, papers made with this »lime-mud« were found to resist deterioration when »acid« samples did not.

In 1950, the development of Aquapel, a new sizing material compatible with alkalinity, provided an economical means of producing alkaline printing papers. The Warren Company now produces a wide range of such papers, many of which are available abroad through licensing of Warren's manufacturing procedures. Dr. Thomas noted that paper technologists must depend on accelerated aging at elevated temperatures as a means of evaluating paper permanence, but questioned whether dry heat was appropriate for such aging. Although Dr. Thomas noted agreement with Barrow that a pH of 6.5 was a minimum for an alkaline type paper, he did not concur that initial strength characteristics needed to be fixed.

Greer Allen, manager, Printing Department, the University of Chicago, was the discussant for Dr. Thomas' paper. In his comments Mr. Allen described his own experience with alkaline printing papers, noting that there was a direct relationship between acidity and the clarity of halftone illustrations and that alkaline papers do not ordinarily print as well when half tones are involved. Other printing problems had been identificed in his shop and he suggested that instructions on the proper handling of permanent/durable paper would be useful to both printers and binders. Mr. Allen also observed that the average printer »couldn't care less« about the permanence and durability of the paper he uses and suggested that the printer must be shown that permanent/durable paper is important to the customer.

»Publishing on Permanent Papers« was discussed by Leonard Shatzkin, vice president for manufacturing, research and development, McGraw-Hill Book Co. The publisher's objective is to have the reader notice the paper of the book as little as possible. At the same time, the paper must have the proper color, the right opacity, a certain bulk and softness, flexibility enough to make the book lie flat and other characteristics. Publishers are now conscious, Mr. Shatzkin reported, that the life expectancy of many papers is not as great as it should be. Mr. Shatzkin gave credit to William J. Barrow and to the Council on Library Resources for the great impetus given to the improvement of book papers during the last few years. The present reluctance to use permanent/durable paper is caused by four problems: (1) permanence and durability are not the only requirements of book papers, (2) acidity is not the only factor of importance in the decay of paper, (3) neutral paper is more costly, and (4) a wholesale shift to alkaline papers would disrupt the industry. Despite these problems Mr. Shatzkin noted that a number of mills are in the process of shifting to permanent or to permanent/durable type papers, so better book papers will be more readily available in the future.

In his role as the discussant for Mr. Shatzkin's paper, Forrest F. Carhart, Jr., director of the Library Technology Program of the American Library Association, said that he wished Mr. Shatzkin had emphasized the need for a high initial strength as well as low acid content in book papers. Mr. Carhart noted also that a questionnaire recently submitted to the industry revealed that there is substantial unused mill capacity which could be utilized for the production of long-life papers. It was also clear from the questionnaire that cost differentials between standard book papers and the long-life papers were »minor or non-existent.«

With regard to the printability of permanent/durable book papers, a test by LTP of eight different papers of this type had indicated that these papers were very acceptable. He believed the basic problem in the use of permanent/durable papers was that most printers were simply reluctant to change. Mr. Carhart suggested that librarians must take the responsibility for telling publishers and printers of the need and of the criteria for permanent/durable book paper.

Harold Tribolet, manager, Department of Extra Binding, R. R. Donnelly and Sons Co., presented the final paper of the second day of the conference on the subject of »Binding Practices as Related to the Preservation of Books.« Mr. Tribolet reviewed the history of bookbinding including the development of the case bound book. He noted that the designer should not be solely responsible for planning a new book but that the bookbinder should be consulted as well. He noted also that most edition bindings were suitable for private use, but could not withstand use in circulating collections.

Kenneth Soderland, associate director for preparations, University of Chicago Library, who served as discussant for Mr. Tribolet's paper, noted that research libraries generally have three classes of binding: (1) rare books, (2) intermediate books – not valuable enough to be restored like rare books but too good to be given the standard treatment reserved for (3) run-of-the-mill materials which form the bulk of the collections. He questioned whether most libraries had the resources to provide book binding or restoration treatment for a large number of these intermediate materials. Mr. Soderland thought that generally there were only two choices aside from oversewing: (1) to use adhesive binding, or (2) to hand sew. He also noted his concern for the permanence of many binding materials such as the fabrics used, the end sheets, the thread, and the adhesive.

The final day of the conference opened with a paper entitled »New Approaches to Preservation« by Richard Daniel Smith, fellow, Graduate Library School, the University of Chicago. Mr. Smith reviewed some of the problems in the field of preservation and noted that all causes of paper deterioration must be considered when planning a preservation program, including such factors as atmospheric contamination and the oxidative effects of light. Deacidification alone, he stated, does not decrease attack on paper by mold or other biological agents. A sound preservation program, he suggested, should include: (1) a suitable and effective deacidification treatment incorporating a benign buffering agent, (2) a paper strengthening treatment, and (3) an effective method of storing books in air tight envelopes.

Mr. Smith noted that various means of deacidifying books had been used or were coming into use, including both organic and inorganic agents. He described the general nature of problems encountered in the use of aqueous solutions and noted that non-aqueous treatments with organic solvents might permit the treatment of whole books or whole libraries.

The »Chicago Process,« developed by Mr. Smith in his studies, had, he believed, the advantages of both the organic and inorganic methods. This process, utilizing magnesium methoxide as the deacidifying agent, will be fully described in the forthcoming published accounts of the conference, but it may be reported here that it appears to make possible the deacidification of whole books.

Mr. Smith observed that it appears feasible to incorporate a suitable biostat in the deacidification solution which will inhibit mold growth and insect attack. He also suggested the possible use of a resin strengthening process which showed promise for the treatment of books not yet brittle. For long-term storage, Mr. Smith suggested that a clear plastic film be used to protect books from atmospheric pollutants, dust particles, water damage, and the like.

William K. Wilson, chief, Paper Evaluation Section, U. S. National Bureau of Standards, the discussant for Mr. Smith's paper, noted the great increase in work on preservation in the last few years, including the appearance of two new journals in the field. Mr. Wilson observed that Mr. Smith's work was done on one book (one title), but that work using many volumes with different types of paper, inks, illustrations, etc., was needed. He expressed the hope that Mr. Smith would find the funds to conduct a small pilot project for further testing. Such testing should reveal the effects of different solvents, the optimum time of treatment, the cost per unit treated, and the effects of various solvents on various book materials. He believed that many of the problems he visualized would probably be related to the solvents employed, not to magnesium methoxide, the deacidifying agent.

The final paper of the conference was prepared by James Henderson, chief of the Research Libraries, and Robert G. Krupp, chief, Science and Technology Division of the Research Libraries, the New York Public Library. In Mr. Henderson's absence, the paper was read by Mr. Krupp. Addressing themselves to the problem of the »Librarian as Conservator,« the authors reviewed the historical interest in preservation shown by

librarians and their efforts to effect greater longevity of library materials. They noted that the librarian was, of necessity, responsible for any preservation program his library might undertake. A major problem exists today in the lack of personnel trained to conduct and carry forward a successful preservation program. They suggested the need for a more effective library organization for preservation and thought that ALA might expand its interest in this field.

Paul Banks, conservator of the Newberry Library, the discussant for their paper, observed that the paper was so well prepared it was hard to be critical. He observed that the preservation programs discussed by Messrs. Krupp and Henderson were largely applicable to research libraries. He suggested that preservation might have a wider application, especially when one views books as artifacts with records of their own history and with their own aesthetic values. He noted also that book conservation as such had not been defined but should be considered as consisting of two elements – preservation and restoration. The book conservator requires some knowledge of science and must be able to translate the scientist's findings into practical programs. Moreover, the successful book conservator needs a knowledge of the history of the book and book structures, a thorough knowledge and understanding of the library and its functions, a bent for engineering, and a high degree of administrative ability. The head librarian cannot be a trained conservator, but he must have a trained and dedicated person to head this activity.

Following the conclusion of the final paper, Verner W. Clapp, consultant, Council on Library Resources, summarized the conference. Mr. Clapp observed that a conference devoted to preservation was long overdue and that those present should be grateful to the University of Chicago for the opportunity to meet together and discuss these important topics. He noted that nearly every speaker had mentioned the need for specifications and standards. He also observed that a good way to nail down what you have is to have a manual of practice. He expressed hope that the LTP series on preservation of library materials would fill such a need. As regards training, he noted that he could add little to what Messrs. Henderson, Krupp, and Banks had already said, but he did believe that library school students should have much more exposure than they do to this important aspect of library work. He also mentioned the need for a newsletter to keep librarians abreast of developments.

The conference was, in this reporter's view, a significant contribution to the field of book and paper conservation, and will undoubtably lead to an increased awareness of the importance of preservation and of the number of problems yet to be resolved.

As is customary, the papers of the conference will be first published in the *Library Quarterly* (January 1970) and later in a hardbound edition.

Frazer G. Poole
Washington

News and Activities

Conservation of Library Materials Research

The Council of Library Resources Inc. of Washington D.C. has awarded a grant of 75,000 dollars to the Imperial College of Science and Technology, London, over the next three years for research on the scientific aspects of conservation of library materials. This will enable a small group to be established to carry out work in close association with the Royal College of Art, under the joint direction of Peter Waters, (Royal College of Art, London) and J. C. Lewis (Imperial College, London), and will be closely connected with the problems of book restoration arising from the flood in Florence in 1966, particularly those of the Biblioteca Nazionale Centrale (BNCF).

In the period immediately after the flood, it was realised that the traditional methods of book restoration could not cope with a problem of this magnitude and it was decided to set up a system of restoration, integral with the library with a team led by Peter Waters.

As the immense task of restoring the valuable pre – 1840 books of the Magliabecchi and Palatine collections – some 110,000 volumes in all, began, a great number of problems came to light requiring further research. Indeed the flood had, in the most drastic way possible, concentrated attention upon many of the technical problems existing in other libraries.

Already feasibility studies are under way of the methods adopted by librarians in assessing the state of the collections in their care, based on the experiences of the directors in Florence.

1. Specific technical problems to be undertaken will include the improvement and development of methods of strengthening and deacidification *en masse* of the paper of post-1840 books, to counter the damaging chemical effects of air pollution and the processes of paper-making of the period, extending the pioneering work of the late W. J. Barrow.

2. Investigations will also be made into the problems of mud-rentention in the paper fibres, the methods of resizing, effects of fungicides, bleaching, the use of adhesives and the development of special mending papers. Improvements in test methods will also be undertaken for materials such as paper, vellum and leather.

3. The research that will be carried out at Imperial College will not only concentrate on the treatment and preservation of library materials, but will also be concerned with methods of restoration and the construction of books. Techniques, materials and equipment used in conservation will be evaluated and developed, with a special emphasis placed on the scientific basis of traditional methods, so that the gap that at present exists between scientists and restorers can be narrowed by the publication of booklets on working techniques and standards.

4. Thus, whenever a suitable stage of development has been reached, a pilot scheme will be undertaken in the workshops of the BCNF to evaluate these new techniques, with the full cooperation of the Istituto di Patalogia del Libro in Rome.

Whilst the main effort will be directed to helping the BNCF, it is intended that the lessons learnt from this flood will be passed on to other libraries. Close cooperation with libraries will be welcomed and help or advice offered in planning surveys of material requiring conservation, whilst the publications resulting from this work will be made readily available to practical restorers.

Finally it is hoped to foster international co-operation in the scientific work and to establish co-operation between practising conservators.

Editorial Notice

It has been decided to publish four issues per volume of the journal RESTAURATOR. This means a better service to the subscribers and the authors and has been made possible thanks to the international appreciation of RESTAURATOR.

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