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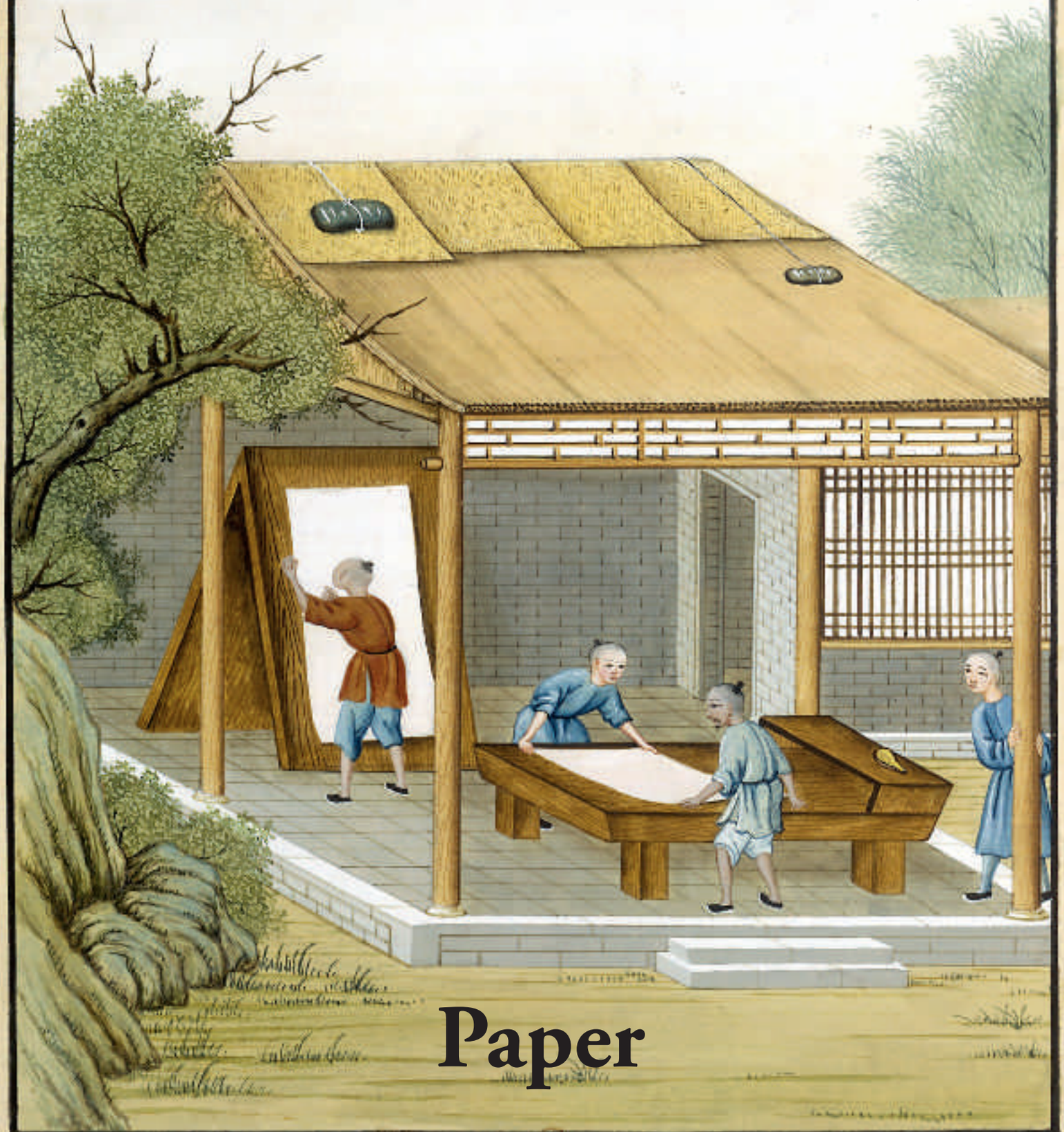

Paper

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International Preservation News
is a publication of the International Federation of Library Associations and Institutions (IFLA) Core Activity on Preservation and Conservation (PAC) that reports on the preservation activities and events that support efforts to preserve materials in the world's libraries and archives.

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Front cover:
Art de faire le papier à la Chine, 18th century.
Plate 17.
Shelf mark: Estampes Oe-110-FOL.
Courtesy of BnF.

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Paper

Chronicles of Preservation

Art de faire le papier à la Chine, 18th century.
Plate 14. Shelf mark: Oe-110-FOL.
Courtesy of BnF.

This issue of *International Preservation News*, starting with the so beautiful miniatures illustrating the "Chinese-style" manufacturing of paper, proposes you not a global survey of paper preservation in the XXIst century but rather some food for thought in this key period.

For centuries, our libraries and our archives have been full of paper: manuscripts, books, newspapers, prints, photos… then, we moved at the end of the last century into the "all-digital" era, marked in particular by great projects of collections conversion. We have only just begun to wonder about long-term preservation of digital data that paper seems to be back to the forefront of cultural heritage projects and economy, making new research in traditional preservation necessary. For instance, the great project of Manga Museum in Tokyo seems to put at the heart of debates the restoration and preservation of these "comics" fragile and little lasting paper.

That is why the PAC keeps a close eye on Professor Hervé Cheradame's promising works in deacidification. Paper strengthened but also recycled as shows Fenella France's report on the Library of Congress research. What about electronic paper and ink? Will they compete with traditional paper? The publication of short stories on Iphone and what this new tool promises in terms of communication prove how this field is continuously evolving, as Jali Heilmann describes it in his synthesis on this topic. Regarding digital printing, Rita Hofmann and Philippe Serenon come to the same conclusion that the choice of the type of papers and inks becomes more and more crucial for preserving photography. So paper is far from being abandoned and even new ones are likely to be elaborated.

This issue, starting with ancient China, also ends with an Asian perspective, Chinese and Japanese articles on more traditional problems.
As usual, I wish you an excellent reading and invite you to send us your comments.

The next issue, at the end of the year, will focus on "Disasters and emergency plans", as these last months have seen many catastrophic events, which may allow us to check if our emergency plans are efficient and to take stock of the situation.

Christiane Baryla
IFLA-PAC Director

Art de faire le papier à la Chine, XVIII[e] siècle.
Planche 16. Cote : Oe-110-FOL.
Avec l'aimable autorisation de la BnF.

« Laissez parler
Les p'tits **papiers**
A l'occasion
Papier chiffon
Puissent-ils un soir
Papier buvard
Vous consoler… »
Serge Gainsbourg
© Sidonie 1965

Derrière les très belles miniatures chinoises qui ouvrent aujourd'hui *International Preservation News* et illustrent la fabrication du papier « à la Chine », nous vous proposons non pas un tableau de la conservation du papier au XXI[e] siècle mais plutôt quelques pistes de réflexion en cette période charnière.

Depuis des siècles, nos bibliothèques et nos archives sont pleines de papier : manuscrits, livres, journaux, estampes, photographies… et nous avons entamé, à la fin du siècle dernier, l'ère du tout numérique, marquée notamment par de très grands projets de conversion des collections. A peine avons-nous commencé à nous interroger sur une conservation à très long terme des données numériques que le papier semble faire un retour en fanfare dans les grands projets patrimoniaux et dans l'économie. Nous forçant, entre autres choses, à renouveler les recherches dans le secteur de la conservation traditionnelle. Je citerai ainsi le très grand projet de Musée du Manga à Tokyo où semblent placées, au cœur des débats, la restauration et la conservation du papier très fragile et peu pérenne de ces « bandes dessinées ».

Aussi, c'est avec intérêt que le PAC suit les travaux prometteurs du Professeur Hervé Cheradame dans le secteur de la désacidification. Papier renforcé mais aussi papier recyclé comme le montre Fenella France à la Bibliothèque du Congrès. Quant au papier et à l'encre électroniques, représentent-ils un risque pour le papier traditionnel ? La publication de petits romans sur Iphone et toutes les promesses de ce nouvel outil en termes de communication nous prouvent que nous sommes là encore sur un terrain en évolution permanente : ce qu'explique Jali Heilmann dans une synthèse sur le sujet. Rita Hofmann et Philippe Serenon, en nous entraînant sur le marché de l'impression numérique, constatent que le choix des types de papier et d'encre devient crucial pour la conservation de la photographie. Nous ne nous dirigeons pas vers un abandon de ce support mais plutôt vers l'élaboration de nouveaux papiers.

Ce numéro, qui s'ouvre sur la Chine traditionnelle, se termine sur une note asiatique avec deux articles, chinois et japonais, sur des problématiques plus traditionnelles.
Comme toujours, je vous souhaite une excellente lecture, en vous invitant bien sûr à nous faire part de vos commentaires.

Le prochain numéro, en fin d'année, portera sur les « Catastrophes et les plans d'urgence », ces derniers mois ayant été particulièrement éprouvants dans ce domaine, nous permettant peut-être de vérifier l'efficacité de nos plans d'urgence et de faire le point sur la question.

Christiane Baryla
Directeur d'IFLA-PAC

Some Progress Towards a Multifunctional Mass Deacidification Process

by Hervé Cheradame
Emeritus Professor at the University of Evry, France

A` survey of the deacidification processes of worldwide use shows that they involve solvents of low solubility parameter. The new process based on aminoalkylalkoxysilanes (AAAS) involves the same type of solvents and brings other advantages such as paper strengthening, fongistatic properties, etc. It opens a new era of multifunctional mass deacidification processes.

I. Introduction

The deterioration of paper due to acid hydrolysis in books and archival material, and more generally of paper-based items, has been detected since the turn of the last century. Several degradation processes are possible, biological or chemical. The research work described below is mainly devoted to the latter. It has been known for a long time that cellulosic materials have a more limited lifetime when they are acidic than when they are alkaline. This faster degradation of acidic paper is demonstrated by an increase of its rigidity, becoming brittle and yellowing. For this reason, if the degradation is serious, the documents, papers and books, cannot be handled anymore. There is one main reason for this situation. Some cellulose based materials are more or less containing high yield pulps, that is to say produced in acidic conditions (1). This fact makes them sensitive to degradation following a progressive acidification due to internal or external causes. Among external causes it is to be cited the air pollution in the libraries, for instance by nitrogen oxides generated by car traffic in the cities. Paper ageing can also be caused by light, oxidation, etc., so that numerous research works have been devoted to the development of a universal procedure for archive assessment and library storage conditions (2).

"From these premises it became clear that the deacidification process to use in libraries and archives is to be varied as a function of the goals and of the situations."

The importance of possible destructions of the libraries and archives content must not be underestimated. For instance, a study of the national library of Japan showed that hardly half of the documents received during 1992 was printed on alkaline paper (3). All documents are not of historical value, and the higher the purchase value the higher the chance of being printed on a more expensive alkaline paper. However, it is clear that documents printed on acidic papers cannot be left, since they have been produced for more than one century. While their importance cannot be accurately evaluated, the proportion of documents in danger in some libraries can be higher than 40 %. Among them, it is generally accepted that only half of these documents deserves to be physically conserved (4).

Various deacidification processes have been investigated. It was thought that gas phase processes could constitute a solution to the problem, due to the ease of penetration of a treating gas between the pages of piling books. However, this is not the case and it is possible to show that due to the requirement of alkaline reserve deposition, processes operating in a liquid phase are to be preferred.

As for the liquid phase processes, two different situations have to be considered, whether aqueous or organic solutions are concerned. Thus, the use of aqueous calcium hydroxide must be mentioned since it currently gives a pH, after paper treatment, of around 8, with an alkaline reserve of more than 100 meq/kg. An improvement of the mechanical properties is observed as shown by the increase of the folding resistance (11). In order to deacidify, a calcium hydroxide concentration of 10-2 mole/L is apparently satisfactory. However, these solutions are not stable at open air, and give a precipitate of insoluble calcium carbonate. It must also be noticed that number of documents cannot be exposed to contact with water without damage (12). Similarly, treatment with aqueous barium hydroxide has been reported to give good results (11). Mechanical strength of the samples after treatment was higher than that of the blanks whatever the paper composition (11). Aqueous solutions containing magnesium salts such as magnesium acetate, carbonate or bicarbonate were reported to improve also the mechanical properties of paper. pH after treatment currently reached the range 9-9.5, and the alkaline reserve was around 0.8 % in weight of magnesium carbonate. The folding endurance was improved by a factor of 2 or more, according to measurements carried out at the Institut Royal du Patrimoine artistique of Bruxelles (Belgium) (11). It is to be noted that this improvement was obtained whatever the paper (wood pulp, chemical pulp, etc.) for a $Mg(HCO_3)_2$ concentration of 0.04 mole/L. However, a yellowing effect was sometimes observed.

Since water cannot be recommended as a solvent for a mass deacidification process, the characteristics of these processes in organic medium are to be examined. From these premises it became clear that the deacidification process to use in libraries and archives is to be varied as a function of the goals and of

the situations. However, most of the processes of worldwide use are based on the chemical properties of organo-magnesium compounds which do the chemical job, but which are ineffective as far as the physical properties are considered. This is why these deacidification processes do not impart any improvement of the mechanical properties of paper.

II. Brief overview on the mass deacidification processes and characteristics of their solvents

The loss of mechanical properties of acidic papers is the major reason of destruction of books printed on paper containing high yield pulp. It has been believed for a long time that the association of lignin and acidic conditions could be one of the main starting points for poor permanence performance of documents based on paper. It has been now recognized that the problem was to be assigned to the conditions of the paper production.

The Booksaver process (CSC) is used in Spain by the «Conservación de Sustratos Cellulosicos» Company. The active compound is the carbonated magnesium di-n-propylate dispersed in a fluorinated solvent, HFC 227 (1,1,1,2,3,3,3-heptafluoropropane). Due to this formulation, the treated items contain a small amount of n-propanol, which must be discarded before final storage. As a whole, this process consists in a deposition of magnesium carbonate in the paper porosity.

The Papersave process (Switzerland) is derived from the Batelle Institute in Frankfurt (Germany). The solvent is hexamethyldisiloxane (HMDSO $(CH_3)_3Si\text{-}O\text{-}Si(CH_3)_3$) and the active compound is a mixed alcoholate of magnesium and titanium, dispersed in the solvent at a ratio of about 10 % w/w. Operated at Wimmis in Switzerland by the Nitrochemie company, this is the European process which has the highest treating capacity. The quality control is very elaborated.

The ZFB papersave process is also derived from the Batelle Institute in Frankfurt (Germany). As the Papersave Swiss process, the solvent is hexamethyldisiloxane (HMDSO $(CH_3)_3Si\text{-}O\text{-}Si(CH_3)_3$) and the active compound is a mixed alcoholate of magnesium and titanium, dispersed in the solvent at a ratio of about 10 % w/w. It is operated at Leipzig.

The Bookkeeper process (USA) has been finalized by the Preservation Technologies Company at Cranberry Township (Pennsylvania, USA). In this process, paper is impregnated with a micronized dispersion of magnesium oxide in a perfluoroalkane solvent. This process is mainly used by the US libraries as a preventive treatment.

None of these processes brings an improvement of the mechanical properties of the paper substrate, and indeed there is no clear reason for any strengthening effect. It seems that a very modest effect was noticed in the case of the FMC mass preservation system (Magnesium butoxytriglycolate in heptane) (13). It has been observed that treatment in a gas phase process with a mixture of ammonia and ethylene oxide, so that ethanolamine is formed in situ in the paper web, the hydrogen bonding given by ethanolamine seems to be responsible for the increased interfiber bonding energy. However, the use of a mixture of these two dangerous gases, leading to a potentially carcinogenic compound, is not trivial.

From the mass deacidification point of view, something must be said about the solvents which can be used. Since aging generates degradation products which are located inside the paper web, a first requirement could be that the solvent must not dissolve these products. The main reason is that a part of these products are highly colored, and during the drying process they could migrate to the paper surface thanks to a chromatographic effect and their presence on the surface could be detrimental to the optical quality of the treated items. A possible answer to this requirement could be that a thermodynamic characteristic of the solvent "the solubility parameter δ" be as different as possible from the solubility parameter of these degradation compounds. Since these compounds must contain highly polar functions such as hydroxylic, carbonylic and carboxylic functions leading to solubility parameter of rather high value, it means that the solubility parameter of the solvent must be as low as possible. It is good to remember that this is the case of the solvents really in use in the industrial processes such as perfluorinated solvents and hexamethyldisiloxane. Of note is the fact that a low solubility parameter indicates a low cohesive energy density, that is to say a low boiling point under normal pressure. Of course this is precisely a second requirement that the solvent must be easily eliminated, i.e. must be of low boiling point. On the list of the possible solvents of low d value it has been discovered that tetramethylsilane could be interesting. This solvent is well known among the organic chemists, being of wide use as an internal reference in nuclear magnetic spectroscopy. However, in the case of the bookkeeper process there is no need to dissolve the treating product because it is a micronized magnesium oxide which obviously is not soluble in organic solvents. In the case of the process using aminoalkyalkoxysilanes which will be describe in more details below, these compounds are soluble in hexamethyldisiloxane or in tetramethylsilane, but their dimers obtained after hydrolysis and condensation seem to be not soluble and they are deposited on the paper surface as soon as they are produced during treatment. One disadvantage of hexamethyldisiloxane and tetramethylsilane is the flammability, while the disadvantage of the fluorinated solvent is the high cost and the environmental concern.

In the context of the process which will be dealt within the section III below, using aminoalkyalkoxysilanes (AAAS) as active deacidification agent, a comparison of the characteristics of the use of hexamethyldisiloxane and tetramethylsilane is given below. Two pieces of the same book were used and treated in a similar way respectively by two solutions of the same silane (AMDES) in the two solvents at the same concentration (10.3% w/w).

Table I.

Comparison of the characteristics of the use of HMDS and TMS in a deacidification process.

Nature of the solution	Drying time to 3 Torr	Silane uptake, %
10.3% (w/w) AMDES in HMDS*	240min	5
10.3% (w/w) AMDES in TMS*	45min	8.5

*AMDES = aminopropylmethyldiethoxysilane,
HMDS = hexamethyldisiloxane, TMS = tetramethylsilane.

From the table I, it is clear that drying a paper, when it is impregnated by a treating solution based on TMS, is much faster than when HMDS is used. TMS also seems to allow a higher silane uptake. These considerations are important in that TMS could be a solvent of choice for deacidification at an industrial scale, despite its high volatility and flammability.
It seems that this new solvent is more favorable to the constitution of strengthening network (Figure 1, see section III below).

Table II.

Comparison of the use of HMDS and TMS in a deacidification operation carried out on a book naturally aged, and treated by AMDES*.

Paper	Tensile Strength daN	Strain a Rupture %	Folding endurance	Dry zero span Resistance, Arbitrary units	Wet zero span Resistance, Arbitrary units
Witness paper, Average of 20 measurements	2.8	1.07	39	20	13.9
Treated paper, Average of 30 measurements	3.9	1.29	65	22.8	14.5

*AMDES = aminopropylmethyldiethoxysilane, HMDS = hexamethyldisiloxane, TMS = tetramethylsilane.

It can be seen that tensile resistance, strain at rupture and folding endurance are improved by the treatment of this aged paper coming from a book printed in 1923 and naturally aged. It is worth noting that these improvements are observed in the case of AMDES. This molecule contains only two ethoxysilane functions and consequently cannot give a polymer network by simple hydrolysis and condensation. This point is not yet fully understood and is still under discussion.

III. Some characteristics of a deacidification process using aminoalkyalkoxysilanes (AAAS)

Using this deacidification process based on AAAS is very simple. It was shown that the contact with 3-aminopropyltrimethoxysilane or similar silanes could efficiently deacidify and at the same time deposit an alkaline reserve (6,7). This new process trying to bring not only deacidification and the corresponding alkaline reserve but also paper strengthening and protection versus aging has been designed as described below.

Paper treatment by aminoalkylalkoxysilanes brought outstanding results in that not only did it produce, sometimes, even better mechanical properties after treatment than before, but also the folding endurance was clearly improved after artificial aging (Accelerated ageing, closed vessel 90°C (RH estim. 45-55%),14 days (ASTM D6819-02e2), hanging sheet configuration in climate chamber, 80°C/65% RH, 28 days (ISO 5630-3:1996), pollution chamber 50 ppm NO_2, 25°C/50% RH, 5 days (ASTM D6833-02E01)) comparing with the same characteristic before the accelerated deacidification treatment (8,9). It is assumed that this effect will be observed even at room temperature, upon long term storage. This effect constitutes a very important perspective in that this is the first time that a deacidification treatment will not only bring immediate improvement of the mechanical properties of the treated material (besides deacidification and alkaline reserve) but will also lead to a possible even better improvement on long term storage.

The reason for this effect is not yet well established. It cannot be assumed to be only related to the resistance to degradation of the aminoalkyalkoxysilanes itself, since the improvement was also observed with various compounds, some of them not being designed for a high resistance to degradation.
On the other hand, when the material containing aminoalkyalkoxysilane is heated, the reaction of the primary amino group with the cellulosic substrate of the aminoalkylalkoxysilanes can give a network firmly bound to the fiber surface thanks to the reaction of the amino group with the cellulose chain ends or the carbonyl groups produced by oxidation. In this chemical context, the simple esterification of silanol groups by the alcohol functions borne by the cellulose surface was questioned.

Esterification: $\equiv$ Si-OH + HO-R $\rightarrow \equiv$ Si-OR + H_2O

Similarly, a direct reaction between alkoxysilane functions and the same alcohol functions borne by the cellulose surface could also be invoqued (10).

Exchange: $\equiv$ Si-OR + HO-R′ $\rightarrow \equiv$ Si-OR′ + R-OH

"[T]his is the first time that a deacidification treatment will not only bring immediate improvement of the mechanical properties of the treated material (besides deacidification and alkaline reserve) but will also lead to a possible even better improvement on long term storage."

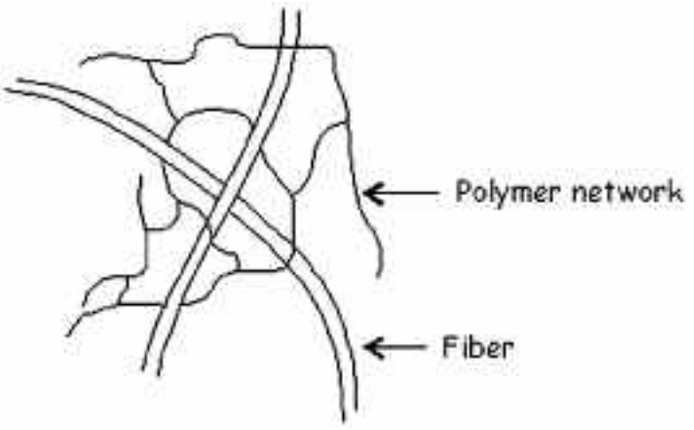

Figure 1. Strenghtening of cellulosic fiber network by an interpenetrating polymer network.

These two above reactions can lead to the formation of a polymer bound to fiber surface, and there is no need to invoke the reaction of the amino groups with carbonyl functions producing firm bonds with the paper surface. Indeed, the strengthening effect is observed even with modern papers of pure cellulose (cotton linters) not enough aged to contain significant amount of carbonyl groups. However, it is possible that this reaction can be observed in the case of aged or oxidized papers. This discussion shows that the situation is very complicated and that there can be several elementary mechanisms contributing to the strengthening effect of the presence of aminoalkylalkoxysilanes (AAAS) in the paper web. This new process using AAAS has been investigated, aiming at the determination of fongistatic properties of the treated papers. It was shown that these compounds introduced in papers clearly confer a protective action against fungal contamination (14), (Figure 2). This effect increases with increasing concentration of the silane inside the paper. It seems to be highly efficient when the silane is preferably functionalised with a primary amine group while other amine functions can also be used. The protection seems independent of the nature of the pulp, but this aspect is to be confirmed by more extensive studies.

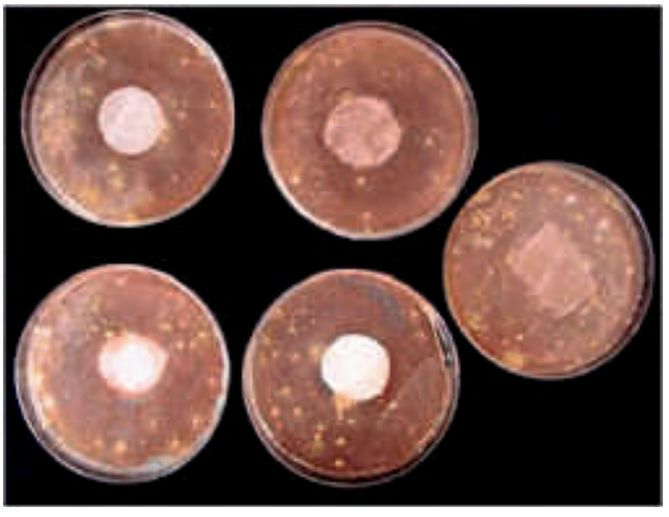

Figure 2. Dishes containing strains (aspergilus niger and paecylomices varioti) showing that the paper disk containing the highest amount of aminopropylmethyldiethoxysilane (AMDES uptake 5.6% w/w) exhibits the best protection versus contamination. The blank sample is rectangular on right (ref.14).

This process is simple to be used on industrial scale and can also be used for manual deacidification by spraying. The treatment process has been extensively described elsewhere (5-7) but the main characteristics are recalled hereby. The items are impregnated for 10 min. by immersion in a 10% (wt/wt) solution of aminoalkylalkoxysilane in the selected solvent, at room temperature. No preliminary drying is required. These solvents have been shown to be well adapted to the deacidification treatment. After waiting for a while to get rid of the excess solution, drying is effected in the same reactor under vacuum at room temperature or at a temperature not higher than 90°C, when necessary.

IV. Conclusion

The new mass deacidification process based on aminoalkyalkoxysilanes offers interesting characteristics:
- Efficient deacidification: surface pH in the range 8-10.
- Alkaline reserve deposition, equivalent to 1 to 2 $CaCo_3$ %.
- No page sticking problems on the books, and safe for most of the bindings, inks and glues.
- Outstanding paper strengthening effects (tensile strength, folding endurance…).
- Outstanding resistance to ageing.
- Fongistatic properties.
- Totally innocuous for library and archives staff, and for readers.
- Simple and low cost process (no preliminary drying).
- Environmentally safe process, using a "green" chemistry.

It is clear that the paper strengthening mechanism is not yet elucidated at the molecular scale and certainly deserves more investigation. In the same vein, optimization of the process is not yet achieved. For instance mixture of aminoalkyalkoxysilanes can bring synergistic effects and a superimposition of different actions. It must be considered that aminoalkyalkoxysilanes are constituting a very large family whose effects in paper-based materials are not still known. Concerning the safety of the process for printing inks for instance, the main limitations of all mass deacidification processes operating in organic solvents are due to the solvents which are in contact with the items to be deacidified. Fluorinated solvents or hexamethyldisiloxane are very safe in general. The process using AAAS is the first of the deacidification processes to be able to solve several problems in one treatment, being multifunctional. However, the universal process does not exist and librarians and archivists must be aware of the specificity of the system they will use.

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Cet article porte sur l'étude d'un traitement de masse des papiers acides. Le procédé en cours de développement, basé sur l'utilisation des aminoalkylalkoxysilanes (AAAS), est innovant dans la mesure où les AAAS permettent, outre la désacidification et le dépôt de la réserve alcaline nécessaire, un renforcement physique des fibres cellulosiques, qui se traduit par une amélioration significative des propriétés mécaniques du papier. Les causes exactes de ce renforcement sont toujours en cours d'étude. Il reposerait sur la formation d'un réseau de polymère interpénétré au réseau fibreux induite par une réaction chimique de polycondensation.

Ce nouveau procédé présente donc d'intéressantes propriétés résumées ci-dessous.

Il permet :

- la désacidification ;
- le dépôt de la réserve alcaline ;
- le renforcement du papier ;
- une meilleure résistance au vieillissement ;
- une protection antifongique ;
- d'éviter toute page collée.

De plus, il est :

- inoffensif pour la plupart des reliures, encres et colles ;
- totalement inoffensif pour le personnel et les lecteurs ;
- simple d'utilisation et bon marché (pas de séchage préliminaire exigé) ;
- inoffensif pour l'environnement (chimie « verte »).

Il est clair que le renforcement du papier n'est pas encore élucidé à l'échelle moléculaire, de même que le processus en lui-même n'est pas encore optimisé, en particulier pour les papiers très dégradés. Les aminoalkyalkoxysilanes constituent une grande famille dont on ne connaît pas encore tous les effets sur le papier. Ce procédé reste malgré tout le premier des traitements de désacidification capable de résoudre plusieurs problèmes en une seule opération. Cependant, il faut savoir qu'il n'existe pas de procédé universel : les bibliothécaires et archivistes doivent toujours être au fait de la spécificité du système auquel ils ont recours.

Recycled Paper Research at the Library of Congress

by Fenella G. France, Ph.D, and Matthew Kullman
Preservation Research and Testing Division, Library of Congress

Abstract

Current awareness of environmental issues has led to many countries implementing governmental mandates for recycling of materials. One area of focus in the USA is recycled paper with the issuance of Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention". This established specific requirements for Government purchasers of paper with Section 504 of this order defining minimum content standards for postconsumer recovered materials in printing and writing papers, 30 percent required from December 31, 1998. For libraries and archives where long-term storage and use of written materials and records are critical, the quality of the paper being manufactured with a recycled component is of concern for the longevity of these materials. The assessment of the archival quality, or permanence, of recycled paper is a current research focus at the Library of Congress Preservation Research and Testing Division where the impact of a range of factors on recycled paper are being investigated: percent content, quality, number of recycles and the effect of manufacturing processes on mechanical and chemical stability.

"For libraries and archives where long-term storage and use of written materials and records are critical, the quality of the paper being manufactured with a recycled component is of concern…"

Introduction

A joint resolution encouraging the use of "acid free permanent papers" was signed into law by President G.H.W. Bush in October 1990. Public Law 101-423, A Joint Resolution to Establish a National Policy on Permanent Papers (Section 3), states the following:

The Librarian of Congress, the Archivist of the United States, and the Public Printer shall jointly monitor the Federal Government's progress in implementing the national policy […] regarding acid free permanent papers and shall report to the Congress regarding such progress on December 31, 1991, December 31, 1993 and December 31, 1995.

Standardizing terminology was important since the terms *acid free, alkaline*, permanent paper and archival-quality paper were used somewhat interchangeably in 101-423. It was decided to use the more technically precise term *alkaline* rather than acid-free, and the term *permanent paper* rather than archival quality paper because it focuses on the required outcome – a long-lasting product. An acid free permanent paper was defined as:

- a fully bleached sheet with a pH of 7.5 or above,
- an alkaline reserve of 2 percent or more,
- a minimum folding endurance in either direction of 30 double folds (tested with a MIT folding endurance tester),
- a minimum tearing strength in either direction of 25 grams for a 30 lb paper and proportionately higher tearing strengths for heavier papers.

This definition of acid-free permanent paper aligns with the first specification for permanent paper, ANSI Z39.48-1984. This specification was developed by National Information Standards Organization (NISO) and gained strong support in the archival and library communities. NISO works closely with the International Organization for Standards (ISO) and the requirements of the standard, ISO 9706, "Information and Documentation - Paper for Documents - Requirements for Permanence," are commensurate with ANSI standard Z39.48-1992. ISO 9706 differs slightly from ANSI Z39.48-1992 in fiber content (lignin, ground woodpulp, and unbleached pulp) and tear resistance measurement. In 1995, ISO developed a standard for archival papers, ISO/DIS 11108, "Information and Documentation - Archival Paper - Requirements for Permanence and Durability." This was revised in 1999 with ISO 11798:1999, "Information and documentation - Permanence and durability of writing, printing and copying on paper - Requirements and test methods."

Development of Specification Standards for Permanent Papers

In July 1994 the *Government Paper Specification Standards* (No. 10) increased the number of permanent papers available for Government use by introducing four new permanent papers. Two of these incorporated a recycled component:

- JCP G40, Option A, 25 percent bond, white and colored (50% recovered material)
- JCP G60, Option A, 25 percent opacified bond, white and buff (50% recovered material)

A number of alkaline papers were added as option A to many existing specifications however the guidelines for the specification standards noted that option A should be specified if the printed product must have above average permanence.

Twenty one of the fifty United States have developed legislation and specifications for permanent paper. These include:

Arizona, Colorado, Connecticut, Florida, Illinois, Indiana, Kansas, Kentucky, Massachusetts, Missouri, Montana, Nebraska, New Mexico, North Carolina, Rhode Island, South Dakota, Tennessee, Virginia, Washington, West Virginia, and Wisconsin. However, there is still a large group of States that have not yet developed a policy on the issues of longevity of records through permanent paper specifications.

A number of countries have developed standards for permanent papers and other organizations involved in research include European Recovered Paper Association members such as Belgium, France, Germany, Hungary, Italy, Netherlands, Spain, Switzerland, and two organizations in the United Kingdom. More debate is required to achieve a consensus in regards to lignin content and other aspects of the specifications. In the 1990s the Canadian Government established a policy on the use of permanent paper CAN/CGSB-9.70, the result of a decade of research by the Pulp and Paper Research Institute of Canada and the Canadian conservation Institute (CCI). The policy addressed the increasing use of recycled paper and the resulting long-term challenges of preserving documents printed on acid paper. The research indicated that the composition of paper, in particular the presence of lignin or surface coatings could cause discoloration with age, even in otherwise stable paper. The Canadians made a distinction between mechanical and optical stability with the Canadian standard providing for a broad range of materials that could be used in the manufacture of permanent papers. There was significant resistance to the implementation of the standard due to the requirement that the papers should contain low levels of lignin.

In 1992 the American Society for Testing and Materials (ASTM) instigated a long-term research program to assess the aging of printing and writing papers. The research focus was to develop accelerated aging test methods that could be used to more accurately predict the stability of such papers to the effects of long term natural aging (Arnold 2003). Five laboratories were involved in this research and each investigated different test methods to assess how closely the accelerated aging test methods could replicate that of natural aging. These methods included elevated temperature, elevated light flux, and elevated concentration of common atmospheric pollutant gases. To assess the tests, both mechanical and optical properties were measured to determine the stability of fifteen specially produced papers. These test papers included acid and alkaline furnish and ranged from stone groundwood to cotton fiber. Part of this research was to address the continual use of new additives in the paper manufacturing industry, and assess the long-term stability and impact of the inclusion of both the additives and the quantity used. By establishing effective test methods modifications could be made to standards that define the *performance* characteristics of the paper. By understanding changes over time, these standards could be utilized to ensure that not only newly manufactured papers met the specifications, but that they also retained the required properties over an extended period of time.

The research laboratories involved in the study were separated into the three modes of accelerated aging and included:
The study of accelerated aging by elevated temperature:
- The US Library of Congress Preservation and Research Testing Laboratory, Washington, DC
- The Canadian Conservation Institute (CCI), Ottawa, Canada

The study of accelerated aging by increased light flux:
- KCL (The Finnish Pulp & Paper Research Institute), Espoo, Finland
- The USDA Forest Products Laboratory (FPL), Madison, WI

The study of increased concentration of the most common atmospheric pollutant gases as a means to accelerate paper aging:
- The Image Permanence Institute (IPI) at Rochester Institute of Technology

Although ASTM completed the initial phase of the research, test samples are still being aged, collected and tested, with the Library of Congress taking the lead on coordinating a 100-year paper natural aging research program.

Impact of Federal Regulations

During the 5-year period covered by Public Law 101-423 (1990-1995), a number of relevant events occurred. There was a trend in the paper industry to convert mills from acid to alkaline papermaking, partially attributable to changes in the Environmental Protection Agency (EPA) regulations that govern the amount and kinds of effluent that paper mills can discharge. Once implemented, a reduction in costs of raw materials for alkaline papermaking made the change profitable. Of greater impact was the issuance of Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention." This order addressed recycling in general and placed a number of specific requirements on Government purchasers of paper. Section 504 set a minimum content standard for postconsumer recovered materials in printing and writing papers, with a 20 percent requirement as of December 31, 1994, and 30 percent as of December 31, 1998. "Permanent" paper was defined as a paper that is capable of lasting at least 300 years under normal storage conditions without significant deterioration, where "deterioration" was interpreted to include yellowing and/or the inclination of the paper to become brittle, and hence fragile, leading to a reduction in the ability for ease of handling.

Documentation from the Federal Environmental Executive in a letter to the Director of the New York Public Library (July 19, 1994) stated that all agency environmental executives would be notified that "*the requirements for use of recycled paper are not to conflict in any way with the concurrent requirement for permanent paper use*" (Billington et al. 1995). This opened the way for the incorporation of any amount of postconsumer recycled content into government paper usage, provided that the requirements for permanent paper were addressed and specifications met. This immediately instigated concern regard-

ing the effect of recycling on paper performance and longevity, and the issue was the focus topic of the September 28, 1994, meeting of the National Archives and Records Administration (NARA) Advisory Committee on Preservation. Representatives from a range of Federal agencies were participants in the committee discussions, with representation from standards and testing professional organizations, librarians, paper manufacturers and associations, and other interested organizations. While it was agreed that paper containing a recycled component could be produced to fulfill permanent paper specifications, it was recognized that this would be both an expensive and complex process. Of further concern was the acknowledgement that recycled paper could contain any various quantities of previously recycled paper, and this was immediately expected to result in a potentially reduced quality product, with the prediction that eventually this lower grade paper fiber would fail strength requirements for permanent paper.

Concerns with Recycled Paper: The Impact of the Manufacturing Processes

The issue of the longevity of recycled paper essentially came down to "*how long will my records last when I print them on recycled paper?*" There are three manufacturing practices that contribute to the reduced strength of recycled paper containing various quantities of recycled component. Repulping paper fibers reduces the length of fibers resulting in a decrease in the strength of the recycled paper. Processes that include further drying and rewetting cycles of the pulp – for example with the shipment of recycled pulp from recyclers to recycled paper manufacturers leads to a reduction in the bonding strength of fibers in the recycled paper composite, while the removal of groundwood and lignin further intensifies the reduction of fiber and fiber bonding strength. Research on recycled paper has focused on how changes and modifications of recycled manufacturing procedures can assist the manufacture and production of more durable paper made from pulp that contains a high proportion of recycled fiber content. Changes in brightness and yellowing on aging are a further characteristic of recycled paper composites, as compared to virgin non-recycled pulp papers.

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Paper recovery in Europe has a long history and has grown into a mature organization. European papermakers and converters work together to meet the requirements of the European Commission and national governments. In 2004, the paper recycling rate in Europe was 54.6% and rose to 64.5% in 2007. The voluntary target for the industry is 66% by 2010. The volume of paper consumed in the U.S. continues to increase and in 2008 the percent recovered for recycling rose to 57.4%.

Historical and Recent Recycled Paper Research

Investigations into the effects of recycling began in the late 1960s (Howard 1990). This area of research focused on establishing the cause and effect relationships from some of the negative impacts of recycling papers, illustrating that the major cause of the change in properties of the recycled paper was the reduced bonding ability of the fibers in the paper composite. While loss of intrinsic fiber strength had been observed by some it appeared that this was a lesser effect with a range of results indicating loss, no change or even an increase in fiber strength. The loss of flexibility in recycled papers was linked to the reduced swelling capacity of the fiber in the paper assembly, where McKee (1971) measured this trend using the Water Retention Value (WRV) and noted that first two cycles showed the most rapid decrease in fiber swelling. However other researchers suggest that the loss of bonding ability could be the result of two effects – changes occurring to the surface of the fibers and changes mainly occurring in the bulk of the fiber. These effects may relate to the accessibility of the fiber surface to enzyme attack and the rate of degradation of the bulk of the fiber.

Factors that control the recycle potential of pulp depend on the manufacturing history. There seems to be general agreement that a greater initial degree of beating of virgin pulp led to a greater loss of pulp quality in the corresponding recycled paper manufactured, and that this was probably due to a loss of internal swelling in the fibers. The effect of drying has an impact, where both high temperature and restrained drying can reduce the swelling potential of recycled papers. Multiple recycling tends to lead to an increase in cellulose crystallinity and decreased flexibility, while reducing swelling and interfiber bonding. Yamagishi et al. (1981) observed a small increase in cellulose crystallinity with recycling of commercial hardwood and softwood pulps.

The effect of chemical additives has a large impact on recycling since virtually all commercial papermaking utilize and incorporate a variety of additives to improve properties. One of these additives, the presence of rosin/alum sizing in the original paper, causes a large increase in the loss of quality of recycled paper, possibly due to inhibited bonding. Deinking of paper generally requires a range of processes, and research into the impact of these and other additives on recycled paper needs further investigation. Sodium hydroxide has been used in recycling since 1800 for ink removal or to aid the breakdown of heavily sized papers. More recently sodium hydroxide has been investigated as an additive to recycled pulp since the inclusion of less than 1% led to improvements in strain to break. Blending with virgin pulp has been shown to improve recycled paper properties, particularly if the added pulp was beaten. However further research is needed in this area.

Nazhad (1994) demonstrated that the degradative effects of recycling result in the loss of potential bonding of recycled fibers, a loss that translates into hornification – a series of irreversible changes that cellulose fibers undergo when exposed to cycles of wetting and drying, and loss of fiber wet flexibility. The research also showed that the overall result of drying and rewetting is a reduced swelling ability of the fibers, with most of the change taking place in the first cycle. Repeated cycling then further reduces the plasticity and therefore flexibility of the fibers.

Wu et al. (1999) assessed the permanence of paper in regards to folding endurance and color (brightness) and found that the content of recycled fiber had a significant influence on paper permanence since a recycled content of 25% reduced fold endurance by 50%. The initial fold endurance of 25% recycled paper was only 30% of the value of virgin fiber (12 versus 42 folds respectively). After 28 days accelerated aging (TAPPI test method T453: heating at 105°C for increasing periods of time), both virgin and recycled papers showed a reduction in fold endurance of one-third from their original. The fold endurance decreased with increasing recycled fiber content but with a similar percent loss to that of virgin fiber. Brightness measurements indicated a minimal reduction after 28 days accelerated (heat) aging. For increasing recycled fiber content from 0% to 100% the crystallinity of the papers after 28 days in heating remained relatively constant while that of virgin fiber increased about 1.5%. The mechanisms of paper strength loss that occurred in recycled paper made from chemical pulps were investigated (Zhang 2003). Both tensile strength and compression strength of paper decreased with recycling. Drying reduced water retention values, flexibility and accessible fiber surface resulting in lower strength and lower density. This effect was significantly increased for recycled papers made from virgin fibers that had been dried in temperatures higher than 150°C. An assessment of the efficacy of adding certain chemicals to virgin fibers before drying showed that some strength loss of the corresponding recycled papers could be prevented.

Recycling was established in Southern Africa in 1826 (Sutjipto 2007). Research in this country indicated increases in strength properties after the first and or second cycles followed by a sharp decrease in mechanical performance. It was suggested that the reduction was due to the increase in deformation of fibers in the paper assembly with these degraded fibers having reduced surface accessibility for bonding. They found that the rate of tensile strength loss from chemical (beaten) pulp was twice as high as that of unbeaten pulp with the recycled process indicating a similar trend between bending stiffness and tear strength.

Brancato (2008) employed atomic force microscopy to assess the effects of hornification – the irreversible changes in cellulose fibers exposed to cycles of wetting and drying. These changes of cellulose fiber surfaces indicated two separate effects: a decrease in the water absorption and retention capacity of recycled pulp, and a change in surface roughness of the recycled paper resulting in a smoother surface. It was proposed that the free microfibrils of the fiber surface formed intrafiber hydrogen bonds, essentially laminating and presenting a more homogeneous surface on the recycled paper.

Recycled Paper Research at the Library of Congress

Following the mandate for inclusion of 30% recycled component in government paper, in the 1990s the Library of Congress Preservation Research and Testing Division began investigating the impact and long-term effects of the resultant product, and the implications for long-term storage, access and longevity of records produced on permanent paper incorporating various levels of postconsumer recycled content. The research followed prior investigations by McComb and Williams (1981) into the value of alkaline papers for research. Their data suggested that recycled fiber from alkaline paper was more akin to the properties of virgin fiber, and would produce recycled paper with better long-term properties. Initial research into the chemical analysis of degradation products of paper resulted in the development of a new proposed accelerated aging test (Shahani et al. 2000).

The current direction of research into recycled paper is focused on assessing the impact of recycled content on permanence of papers and how this influences and changes the mechanical properties and chemical stability of the papers. This will address the issue of whether papers containing post-consumer recycled fibers are less durable than similar papers produced from virgin fiber pulp. In addition, if a permanent paper contains recycled content (of varying amounts, but a minimum of 30%), will this have an adverse effect on the longevity of records and collection items printed on this paper? While there are both environmental and economic advantages to recycled paper, the commensurate changes in optimum permanence properties raise concerns. As noted by Dianne van der Reyden (Bell et al. 2007) "*A new problem that is looming with paper-based materials is recycled paper. While we have papers that are more alkaline, they may have a larger percentage of shorter fibers. This could be a problem in the future because of green technology. There's a move to use greater and greater amounts of weaker fibers, which is good for ecology, but it might not be good for document history*."

The papers selected for inclusion in this research include but are not limited to four different 8 ½" x 11" multi-purpose office papers from a selected manufacturer. One paper was made without the addition of post-consumer recycled content while the other three respectively consisted of 30%, 50%, and 100% recycled fibers. Although the paper composition varied in terms of fiber content, they were otherwise advertised as identical in physical characteristics such as basis weight (20 lb.) and brightness value (92). One carton of each type of paper, consisting of 10 reams of 500 sheets per ream will be randomly sampled per ASTM standard D585. The sampled papers will

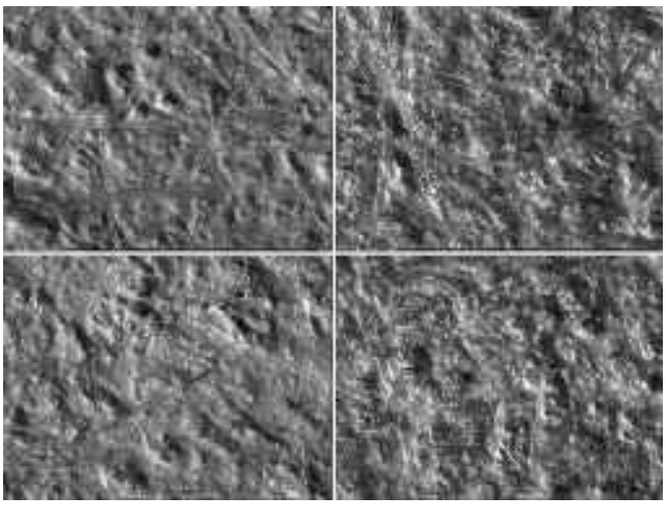

Figure 1. Surface Morphology of Papers - Clockwise from Upper Left: Perma-Dur (0%), 30%, 50% and 100% Recycled Papers.

then be prepared for testing and aging. All papers sampled for the research will be subjected to identical measures of chemical, physical, and optical characterization - before and after accelerated aging. This will allow analysis of the characteristics of U.S. papers containing varying percentages of post-consumer recycled materials while comparing their relative strength and chemical stabilities. A critical component of this research is the comparison of the performance and properties of these papers with known stable papers that meet specifications for permanence.

To assess longevity and stability of papers with recycled content, accelerated aging is required to predict the long-term effects of natural aging. Current standard test methods utilize a controlled temperature aging method with accelerated conditions of 90ºC and 50% relative humidity. Careful mapping of research ovens has been undertaken to ensure consistency of conditions throughout the test samples, with samples being selected to create a statistically significant population. The test samples will be assessed from control conditions (unaged) through a range of time periods with various methods of aging apparatus being assessed for consistency, reproducibility and accuracy. Tests of the paper performance will include the assessment of physical properties; fold endurance as a measure of strength loss, and tensile testing for load at break and changes in extensibility. This will give relevant information about changes in the fiber structure within the fiber assembly as an indicator of its long-term stability. Changes in visual appearance will be measured through optical testing with both the evaluation of brightness to assess darkening or loss of brightness in the papers, and color space measurement to determine changes in hue, value and chroma. Chemical testing to assess changes in the fiber structure and paper assembly will include the determination of pH, alkaline reserve, and the degree of polymerization and viscosity changes. Test methods will be non-destructive when possible, since this is the focus of all research in the Preservation Research and Testing Division. Other technical analyses to assess changes in chemical, mechanical and surface morphology will include Environmental Electron Scanning Microscopy, high resolution image analysis, Fourier transform infrared spectroscopy and other instrumentation in PRTD. Results will be disseminated through the Library of Congress website and other publications as completed, and a larger comparative study will be implemented based upon this pilot study.

Conclusions

The implications of the inclusion of postconsumer recycled content in permanent papers for the preservation of cultural heritage and archival records require serious consideration in regards to ensuring the longevity of these items. While current environmental and economic conditions demand good fiscal and responsible management of resources, the requirements of libraries and archives to maintain permanent records demand research to ensure the performance requirements of papers deemed permanent, especially given government mandates for the inclusion of specific quantities of recycled material. Since the 1970s recycled paper research has begun to develop a framework for understanding the effects of paper manufacture with recycled materials; assessing the inclusion of various additives, lack of uniformity in recycled composites, the impact of the number of previous recycling cycles the fiber had experienced, and the influence of processing variables including beating, pulp formation, drying and heat. The commensurate changes in mechanical and chemical stability need to meet the specifications for permanent papers, with the Library of Congress Preservation Research and Testing Division continuing almost two decades of research into standards, test methods and materials science of stable library materials for permanent records. Further research is required to more accurately assess the long-term impact of loss of strength and changes in chemical stability from the inclusion of recycled paper content in permanent records and this ongoing research at the Library will examine these issues to ensure preservation of current and future library and archive materials.

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"There's a move to use greater and greater amounts of weaker fibers, which is good for ecology, but it might not be good for document history."

Dianne van der Reyden

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Recherches sur le papier recyclé à la Bibliothèque du Congrès

L'actuelle prise de conscience des problèmes liés à l'environnement pousse de nombreux pays à mettre en place des programmes gouvernementaux de recyclage des matériaux. Aux Etats-Unis, l'utilisation du papier recyclé fait partie de ces programmes. Dans le cas des bibliothèques et des archives, l'utilisation et la conservation à long terme de supports et de documents écrits sont une préoccupation majeure. La qualité du papier fabriqué à partir d'un composant recyclé pose donc la question de sa durée de vie. A la Bibliothèque du Congrès (Division de la Recherche en Conservation), la recherche se concentre sur l'évaluation des qualités d'archivage du papier recyclé en étudiant les répercussions d'un certain nombre de facteurs sur la durabilité.
Depuis les années 1970, la recherche s'est appliquée à comprendre les effets induits par la fabrication de papier provenant de matériaux recyclés en évaluant :
- l'adjonction de différents additifs
- le manque d'uniformité dans les composites recyclés
- l'impact du nombre de cycles de recyclage que la fibre a subi antérieurement
- l'influence des variables de traitement (raffinage, structure de la pâte à papier, séchage et chaleur).

Des changements comparables dans la stabilité mécanique et chimique doivent être conformes aux spécifications du papier permanent.

Les recherches doivent se poursuivre afin d'évaluer plus précisément les conséquences à long terme de la perte de résistance mécanique et des changements dans la stabilité chimique lorsque papier recyclé et documents permanents sont mis en présence. Le programme de recherche en cours à la Bibliothèque du Congrès examinera ces questions afin d'assurer la conservation des matériaux de bibliothèque et d'archive, actuels et futurs, en ayant recours à des tests de vieillissement accéléré qui permettront d'évaluer les performances du papier, les modifications de l'aspect visuel et l'évolution de la structure de la fibre. Les résultats seront communiqués sur le site de la Bibliothèque du Congrès et dans d'autres publications une fois les recherches achevées. Une étude comparative plus large sera menée à partir de ce programme pilote.

Investigación sobre el papel reciclado en la Biblioteca del Congreso

La conciencia actual acerca de los problemas ambientales ha llevado a muchos países a implantar los mandatos gubernamentales sobre el reciclaje de materiales. Una exigencia específica en los Estados Unidos es el uso del papel reciclado. Para las bibliotecas y archivos donde el almacenamiento a largo plazo y el uso de materiales y registros escritos es vital, la calidad del papel que se está fabricando con un componente reciclado puede afectar la longevidad de estos materiales. La evaluación de la calidad de archivo del papel reciclado es un aspecto focal de investigación actual para la División de Investigación y Pruebas de Preservación de la Biblioteca del Congreso (Library of Congress Preservation Research and Testing Division), donde se está investigando el impacto de una variedad de factores en el papel reciclado.

Desde los años 1970 la investigación del papel reciclado comenzó a desarrollar un marco para entender los efectos de la fabricación del papel con materiales reciclados: evaluación de la inclusión de diversos aditivos, falta de uniformidad de los compuestos reciclados, impacto del número de ciclos de reciclaje previos que haya experimentado la fibra e influencia de las variables de procesamiento que incluyen la batida, la formación de pulpa, el secado y el calor. Los cambios conmensurables en la estabilidad mecánica y química deben satisfacer las especificaciones para los papeles permanentes. Se requiere investigar más a fin de determinar con mayor precisión el impacto a largo plazo de la pérdida de resistencia y los cambios en la estabilidad química producto de la inclusión de contenido de papel reciclado en los registros permanentes. La investigación en curso en la Biblioteca del Congreso examinará estos aspectos para asegurar la preservación de los materiales bibliotecarios y de archivo presentes y futuros gracias a que el envejecimiento acelerado permite evaluar el comportamiento del papel, los cambios en la apariencia visual y los cambios en la estructura de la fibra. Los resultados se difundirán a través del sitio web de la Biblioteca del Congreso y otras publicaciones cuando se hayan terminado y se llevará a cabo un estudio comparativo más amplio con base en este estudio piloto.

Electronic Paper

by Jali Heilmann
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Abstract

Following the publication of the first electronic books at the end of 1998, VTT has carried out several studies to evaluate the technical and commercial potential of electronic book technology. Our studies reveal that electronic publishing and electronic books offer several advantages to publishers, consumers, and authors and may result in radical changes in the publishing industry. This will require that publishers adopt a new way to distribute their publications and that the technology develops as expected. All in all, it is very difficult to predict a time when the electronic and the printed book will truly compete with each other, but it seems quite inevitable that successful electronic books will emerge in the course of time. A crucial part of this unavoidable process of digitalisation is the development of paper-like displays, which are also often called electronic papers.

Introduction

Digitalisation, networking and wireless communications enable the production of new types of electronic publications. For example, most of the daily newspapers in the United States have electronic versions, which are very popular in some cases. The most famous example of such a publication is *The Wall Street Journal Interactive Edition*. Many special magazines, like trade journals, are delivered only by the Internet. Also the archives of libraries are rapidly becoming digitised. These are some of the reasons why electronic publishing is expected to be the most profitable publishing sector in the future. At the moment, most of the electronic publications are read on the liquid crystal screen (LCD) of a PC, but the developing display and computer technologies enable the manufacture of light, portable information carriers. The electronic books which are already on the market are examples of this development. However, brand new technical solutions are needed, so that these electronic reading devices could compete with the traditional publication products, like printed books, newspapers and magazines. The toughest requirements are set to the displays of these electronic devices.

Electronic papers

According to Drzaic [1], there are several benefits in traditional paper, which have made it display technology of choice for over a thousand years. For example, optical properties of paper have been optimised for human visual system, so that printed text on paper has a good contrast, sharpness and wide viewing angle - paper is comfortable for extended reading. Also colour images can be printed easily. A sheet of paper is also very light, durable and flexible. It can also be said that a pile of paper, for example a magazine, is an independent data base with total freedom of transportation and, at the same time, it also provides a permanent storage of information. It is also a cheap media and it doesn't require energy for reading. And moreover - people are used to work with paper.

But there are also some weak points in paper. Foremost of all, paper can't be updated. It is also very heavy, if lots of information is needed, it consumes high amounts of money to print and distribute, it can't be connected to networks and it is also hard to search for information. Electronic paper is an attempt to take the good properties of paper and combine them with many benefits of electronic communication.

New technologies are being developed for the production of flexible, thin displays for electronic books and newspapers. The most attractive aspect of these new displays is that they can be manufactured cheaply from low-priced materials. Some of them are called electronic paper, because they aim to have the same convenience, lightness, readability (angle-independent readability), whiteness and contrast as conventional paper, and even a similar touch and look. The other advantage of electronic paper is that it is also a memory display, which means that the display uses power only when the display view is updated. The greatest benefits of this can be realised with the reading devices like electronic books, because when reading, page is updated on slow pace – and the whole device uses so little electricity that small batteries would suffice in a portable device for a months. These projects have considerable credibility, as we can see by the active involvement of electronics and communication giant companies.

The ultimate goal is to develop books or newspapers which look like traditional publications, but can be erased and re-written. An electronic newspaper could be re-written at night, for example, and you could take it with you in the morning. Similarly, all the books you have ever read could be loaded onto your electronic book and re-read whenever you like. The industry believes that products like these could be commercially viable within few years.

Electronic papers can be manufactured utilising many different display technologies. For example, there are technologies in traditional liquid crystal display (LCD) area, which can be utilised in memory display production. Also electrochromic materials, which can be changed between two colours, can be

used in electronic papers. However, at the moment, the most successful commercial memory display technology is so called electric ink, which is based on electrophoretic technology. The electric ink display consists of very small micro capsules, which contain black and white particles suspended in oil. By applying an electrical charge, the black and white particles can be moved from one side of the capsule to the other. This way the display can form black fonts on white background – or vice versa. These particles stay in the position without consumption of additional electric power, until they have been moved again. Electric ink displays are used in most electronic books at the moment. The size of the displays has so far been only six inches, but also an electronic book with ten inch display has now on sale. All of these displays are black and white.

1. The first models of electronic books were heavy and easy-to-break devices, which were inconvenient to read and use.

Electronic books as an application area of electronic paper technology

In this article, the electronic book is defined as a simple and easy-to-use hand-held computer which is specially designed for the reading of text. The success of hand computers has paved the way for electronic books, but also technical advances such as the development of electronics, batteries and displays have enabled devices. Nevertheless, the most important element is the Internet which allows a fast, cheap and easy distribution of book files which can be bought from the virtual bookstores of the Internet. Also many magazines have produced an electronic book version of their publications.

Electronic publishing and electronic books offer many advantages to publishers, consumers and authors. Delivery, printing and marketing expenses make up almost 50% of the price of a printed book. Although marketing is also needed with electronic books, book printing and delivery expenses could be saved. Without printing expenses very small editions could be published profitably. In addition 40% of all printed books are returned to the publishers because of no demand in the States, while some editions run out of print. Moreover, 60% of newsstand magazines are wasted and 98% of catalogs do not generate response in the United States. These are some of the reasons why publishers could sell cheaper books and/or make greater profits by electronic publishing. Other benefits are the user-specific databases of the sold books which enable profiled direct marketing. It is also very cheap to store a large number of electronic book files and the data is much easier to update and distribute.

Electronic books and magazines are cheaper for consumers and it is easy and fast to purchase the books. It is also possible to have a large number of book files which do not use up and require space on the bookshelf. The data processing functions, such as search, improve usability and the backlight allows reading in the dark.

Electronic publishing may also benefit authors quite remarkably. The most famous example is Stephen King who published his short novel *Riding the Bullet* in March 2000 only as an electronic version. The price of the book was USD 2.5 and it could be downloaded from electronic bookstores on the Internet. 400,000 copies of the book were sold on the first day which is much more than the usual number of bestsellers at bookstores. King is said to have earned some half a million dollars within a few days. Because the unexpectedly massive demand for the book swamped the billing system, the book was eventually given away for free - but King still got his royalties.

Studies have revealed that the first likely professional applications for electronic books will be in the study environment. There are several reasons for this. First of all, professional literature is expensive and one can spend thousands of dollars for printed books during studies. Because electronic book files are cheaper than printed books students can save considerable amounts of money. Books are also heavy, but nowadays a large electronic archive can easily be carried. The electronic distribution of books and other documents is timely and cost effective, and makes interactive studying possible. Reading appliances can also be connected via wireless networks. In addition different kinds of search functions are possible when the content is in electronic form and for example finding a glossary definition for a term by simply clicking it, is a handy function. Students are also more willing to use new technology.

Because of the success of Amazon's electronic book called Kindle, many big publishers in the States and around the world have started electronic book projects to establish their own e-bookstores and electronic book devices. It is quite evident that all new books will also be in electronic form in the near future. The most popular books for these reading devices have been best sellers and business books.

Comparison of paper, LCD and electronic paper as a reading media

Readability and usability tests were arranged to evaluate how well the LC display of a mobile reading device manage to gain the acceptance and confidence of computer-orientated information technology professionals of VTT [2]. Ten research scientists took part in the tests in which reading an electronic book with LC display was compared with reading a paper. Two magazine articles were given to the test group, one in electronic

book form and the other printed on paper. These articles were selected so that their lengths matched an A4 sheet, and the order of the articles was varied between the persons. The average reading times were measured. The test persons were also given the possibility to make a closer examination of the electronic book. After that, questions were asked about the usability and the readability of the device. Image technical measurements were also carried out. The font quality of an LCD, a conventionally printed book and electronic paper were compared.

Two one-page long articles were read by the test persons, one being in LC display and the other printed on paper. Although the articles were short, the results are clear. It took 116 seconds to read text A on paper, while in the LCD the reading time was 121 seconds. Text B was read in 143 seconds on paper and in 175 seconds in the LCD. From this test we concluded that it is faster to read a text on paper than on a low resolution display.

2. Comparison of e-fonts in an LCD display (left), on paper (middle) and in an electronic paper diplay (right).

Image technical measurements of the e-fonts in LCD, on paper and in electronic paper were made. The contrast between the font and the background is small in the LCD. The darkness of the font is also smaller in the LCD and the standard deviation of the intensity is greater. This is because of the grey, uneven background and the strong surface reflection of the display. There is a lot of raggedness in the diagonal and circular shapes because of the limited resolution.

The low resolution and the low contrast of the display decrease the readability of an LCD, because it is difficult for the reader to distinguish the fonts and to perceive their shapes. People strain their eyes and it is very hard to read long texts. This is the reason why the reading speed of the text was slower and the test group preferred the printed book in our readability tests. The shape and the contrast of the fonts, and therefore readability, are the best in a white non-glossy printed product. The user interface is not at the same level as the printed book. Our tests revealed that the printed book is a superior reading medium when compared to a low resolution liquid crystal display.

When an electronic paper display is examined, it can be noticed that the contrast between the font and the background is much bigger than in the LC display. Also evenness of the font and the background is much better with the electronic paper. The font is still quite ragged when compared to paper and contrast is lower, but all in all readability of electronic paper is much better than with LC display. For a reader, the optical properties of electronic paper give a newspaper-like reading experience at the present level of technology. But electronic paper technology is constantly evolving, so an updatable A4 sheet will be reality in the future.

Effect of ICT on paper market

According to Hetemäki [3], the paper markets in industrial countries are currently undergoing a historical structural change, due to the development of information and communication technologies (ICT). For example, consumption of newsprint has decreased in North America since the end of 1980s. Similar development has also happened in other industrial counties for example in Western Europe. This change has been caused by the development of communication technologies, which provide access to computers, the Internet and broadband connections for an increasingly larger number of people. Especially young people don't read printed newspapers anymore. The structural changes in the consumption of newsprint and office paper, have not yet be seen in the consumption of magazine paper, so there are differences between different publication products It can be said that ICT developments has both positive and negative implications to paper consumption. One technology, which will most certainly affect the consumption of printing paper in the long run, is electronic book devices and their paper-like displays.

Conclusions

New technical solutions are needed for electronic books to produce the same reading enjoyment as traditional books do, but it seems quite obvious that technically more advanced and economically more attractive devices will be introduced in the near future. The many financial benefits for publishers, consumers and writers will promote the development of electronic book technology. This will require that publishers adopt the new way of distributing their publications and that the technology develops as expected. All in all, it is very difficult to predict a time when the electronic and printed book will truly compete with each other, but it seems quite inevitable that very successful electronic books will emerge in the course of time. The crucial part of this development is the development of electronic paper technology.

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Demand Drivers for Printing Paper

by David Pineault, John Shane, Barb Pellows, Jim Hamilton, and Steve Adoniou

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Rapid technological change in the printing and graphic arts industries means paper manufacturers need to explore new ways to create value for their print customers.

The graphic arts industry in the mature markets of North America and Europe are in the midst of a radical transformation. Due to a variety of "trigger" events, the print industry has been able to significantly alter the way its does business in a several key ways. Chief amongst these has been the development of digital technologies, including the Internet. The digitization of print has radically changed manufacturing and customer expectations through shorter run-lengths, leaner supply chains, personalized print, shorter turn-around, higher levels of complexity, more use of color, and, higher levels of transparency.

"The rising complexity of the print job including the increased use of color, variable data, and, print-on-demand will require a change in strategy."

The print industry of the future will be characterized by a migration of the document back to the enterprise and will feature highly personalized, color content. Print service providers will continue to consolidate and offer a broader range of services in more diverse geographical markets.

In emerging markets such as the so-called BRIC countries (Brazil, Russia, India and China), the future of print will be driven by population growth (and, urban population growth in particular), rising household incomes, the development of a consumer class and the further deregulation of print media delivery vehicles.

One off-shoot to these macro-trends will be rapid growth in advertising expenditure as retailers attempt to lure consumers to their brands, products and services. Paper consumption will also receive a boost from the general rise in business activity and the accompanying expansion of transactional and business communications documents. Paper usage is forecast to rise slightly faster than overall GDP growth in these economies over the next 5 – 10 years due to a proliferation of transactional, direct mail, magazines, catalogs, and various business communications documents.

Product innovation is key

The global paper industry is undergoing a rapid transformation. The North American and, now, the European industries are witnessing an unprecedented wave of consolidation and capacity rationalization. Companies that were once diversified all along the industry value chain have divested non-core assets, sold timberlands and reorganized bloated corporate structures. Globalization is also accelerating and the activity is going both ways. Producers in mature markets are investing in geographical diversification in emerging markets not only as a way to reduce operating costs, but also to take advantage of rapid demand growth and to be closer to their customers. Meanwhile, manufacturers in emerging markets are reviewing distressed assets in North America in their never-ending search for sustainable fiber resources.

Product innovation, in response to technological change in the printing and graphic arts industries, is expected to be a distinct feature of the paper industry's continuing transformation. As manufacturers learn to cope with declining demand for their products they will have to create new ways to provide value to their print customers. This will involve more partnering all along the value chain from document solution, manufacturing, distribution to final consumption.

The rising complexity of the print job including the increased use of color, variable data, and, print-on-demand will require a change in strategy. The past few years has seen the introduction of technology-specific paper brands such as laser and inkjet product lines. More recently, manufacturers have introduced product lines that are compatible in both offset and digital environments, thereby simplifying the supply chain for their print customers. Either way, innovation, automation, and, digitization will be unifying themes across developed and developing markets.

Read the complete article at:
www.paperage.com/issues/march_april2008/03_2008issue.html

Modern Ink-jet Prints: Structure and Permanence

by Rita Hofmann
ILFORD Imaging (Switzerland) GmbH

Introduction

During the last 15-20 years, digital printing and the new imaging materials that were developed have brought the printing of photo quality images into the hands of everybody. While previously professionals and advanced amateurs only would endeavour to make black and white and colour prints in the dark room, current owners of modern IJ printers can print good quality images without much understanding about colour and materials properties. The development from spot-colour office documents to full colour pictorial photo prints took less than 20 years, compared to more than 100 years it took photography to develop its full potential.

This fast development is a disadvantage for those who have to deal with archiving and preserving digital colour photos from the last 20 years. There are a great variety of print systems, media and colorants. The life cycle of a typical printer is only 6 months to a year before it is substituted by a new model. Typically, media formulation and ink formulation are changed in 1-2 year cycles, colorants in 3-5 year cycles. In general, those changes are not openly published and are often invisible to the user. But while the image quality may be very similar, the permanence properties can be dramatically different.

"This fast development is a disadvantage for those who have to deal with archiving and preserving digital colour photos from the last 20 years."

It is therefore very difficult to make general statements about IJ print permanence. This report tries to shed some light on the photographic IJ materials used in digital printing and their permanence.

IJ print methods

There are several IJ print processes each with a different demand on material properties. For example, IJ printers for outdoor display on cars, on buildings and in other demanding applications which for have to last several years are generally printed on plastic substrates like vinyl (PVC), or metal or other very stable substrates. Pigmented solvent or UV-cured IJ inks allow the display for up to 5 years outdoor without visible change. The solvent ink wets the substrate and the pigment partially dissolves in the substrate. An UV cured IJ print is the digital relative of an analogue UV-cured screen print. The UV cured resin protects the pigmented colorants inside a film. It also allows printing on any non-absorbing surface, from metal to glass and plastic. Both types of printers are made for large width of up to 5 meters and can only be handled by professionals owning the necessary venting equipment and colour know-how. The print quality is good enough for viewing at a distance, not for close view.

Materials intended for indoor and smaller formats are generally water based, media as well as inks. They need additional protection such as laminates when displayed outdoors. Print width range from 1.8 m to 10 cm. The larger widths are generally roll-fed and targeted at displays, posters, pop-up displays, printing proofs and sometimes fine art. Smaller printers are for professional photographers, portraits, fine art and designers. Most printers targeted at professionals use pigment-based inks today. The small desk-top printers for home use mainly have dye-based inks. These prints have the highest colour brilliance, but generally lower permanence.

The variety of media for those printers is very large. Plain papers, coated papers, photographic surfaces, fine art papers, films, textiles, labels and other specialities are available for each class of printer.

IJ colorants and media for photographic applications

As the variety of print media and colorants available in IJ is vast, this report will only concentrate on those used for indoor applications, printed with aqueous based inks on paper media and intended for photo-quality and fine art output.

The inks used in aqueous IJ printing fall in two categories, those based on pigments and those based on dyes. Dyes and pigments may have very similar chemical structures. While dyes are water soluble and used in inks as true solutions, pigments are larger agglomerates and insoluble in water. They are used as a dispersion in the ink. Dyes penetrate easily into substrates, pigments tend to stay close to the surface, particularly if the pores are small as it is the case for glossy papers. Dyes tend to diffuse and are less stable against air pollutants, humidity and often light if not protected. Pigment prints may smudge on the surface and may be very scratch sensitive. Most A4 sheets size and desk-top photo quality IJ printers are dye-ink based, most wide format roll (36 to 60 inches) printers have pigment ink.

Often the base material of the print media is very similar to traditional substrates. Photographic RC bases used for IJ are similar to those used in colour negative paper and are expected to have similar ageing properties. PET films and fine art substrates are similar to traditional films and fine art papers as well. Print media thickness ranges from 150 gram/m2 to 300 g/m2, which is the higher limit of papers that can be fed on desk-top printers. Some

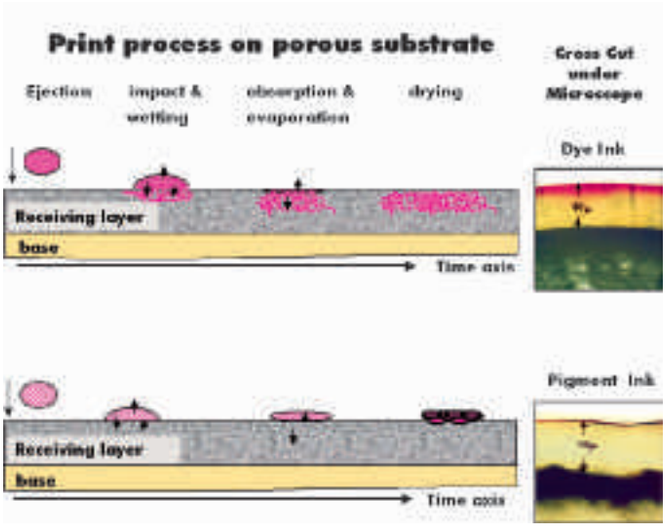

Fig 1. Print process and cross cut of media, dye and inks.

wide format printers can feed stiff boards, but more often roll-fed papers are mounted on boards if rigid display is required.
Porous papers can be un-sized plain or fine art papers. However, high quality ink-jet printing needs a special receiving layer that absorbs the ink vehicle and keeps the colorants close to the surface. The receiving layers have to absorb the water contained in ink needed to print black, which is typically 30-35 ml/m2. The thickness of those layers is around 20-40 microns. The receiving layers are either porous and absorb by capillary forces or they are a polymer film like gelatine films and absorb water in a swelling process. Polymer receiving layers cannot be printed with pigment inks, as they stay on the surface and do not adhere well to the layer. Dyes penetrate into the layer and are protected inside against abrasion and air pollutants.
Matt papers have an opaque white layer made form mineral oxides with rather large particles and pores. Glossy porous papers are made of mineral-oxide particles and pores of nanometer scale. These glossy nanoporous layers are nearly as transparent as polymer films leading to very brilliant and saturated colours.

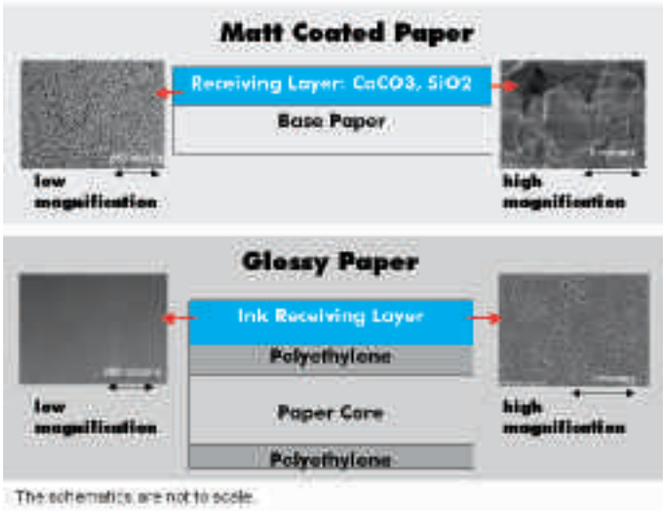

Fig 2. Matt coated and nanoporous microscopic cross section, schematics.

Many photo-quality IJ layers are coated on RC papers in which a base paper is laminated on both sides by a thin PE layer. RC papers were originally developed for silver halide prints. They form a barrier between the paper pulp and the layer, thus avoiding penetration of the developing solution into the paper pulp and allowing faster processing speeds. In addition they have high dimensional stability, suppress the cockle of the paper pulp and lead to very glossy surfaces. These last three properties are also required in IJ papers and have lead to RC papers wide spread use in IJ photo prints. Photographic IJ media come in two surface finishes, glossy and semi-gloss, whereby the latter bears numerous names such as semi-matt, pearl, luster, satin. The semi-gloss surface can be achieved by adding matting agents to a glossy layer or coating a glossy layer on a RC base that has been imprinted with a fine wafer pattern.
All polymer papers and some nanoporous papers have a backing layer including slipping agents to improve feeding. Slipping agents are sometimes added to the front as well to help handling, avoid sticking and reduce the sensitivity to finger prints.
The whiteness and opaqueness of the photo papers are achieved with either titania or baryta, titania being the more widespread. Often titania is imbedded in the PE-layer of the RC paper. Many IJ papers contain optical brightener which may be added to the base paper, to the receiving and the backing layer. Optical brighteners tend to migrate under the influence of pressure and temperatures and can transfer to other sheets upon contact.
The type of layer is an important factor for the image quality, the permanence and the handling requirements of IJ prints.
Ink layer surfaces are generally more fragile compared to hardened photographic gelatine layers. The IJ polymer layers have to be very swellable to absorb the large ink volume fast. They easily dissolve in water and can become tacky at very high humidity.
Nanoporous papers are resistant to water, however the very porous layer easily takes sup coloured liquids and stains. Due to the very high surface area of nanoporous layers, they tend to adsorb pollutant from air and are easily contaminate by emissions form wood products or paper components, which can lead to yellowing of the layer. Archival quality enclosures are needed for long-term storage of such prints.

Factors in Print Ageing

For print stability one should distinguish between the stability of the image and colour and the mechanical or physical stability of the print. The usual four factors contribute to IJ print degradation, light, humidity, temperature and air pollutants. The mechanical stress depends very much on the application and if it leads to bending or folding. But even if kept flat, the mechanical resistance and brittleness of prints will slowly change over time. The most important degradation factor for a printed IJ image depends on type of print material used. Dye-based nanoporous prints are very sensitive to air pollutants, particularly ozone, while dye-based polymer prints are rather

insensitive to ozone but sensitive to high humidity. Pigment based prints on nanoporous layers are rather insensitive to humidity and light, but sensitive to surface abrasion. It is helpful to understand the basic materials used and adapt the handling and storage to the critical weakness of the print. The main questions to answer are if the print ink was dye or pigments based and the receiving layer is polymer or mineral-oxide. Compared to traditional silver halide photos, most modern IJ prints are less sensitive to temperature and may benefit less from cold storage. On the other hand, they are often more sensitive to surface damage, air pollutant and humidity. It is therefore not easy to compare the permanence of modern IJ prints with traditional photographic prints. Depending on the use, application and environmental conditions, one or the other technology may turn out to be more durable.

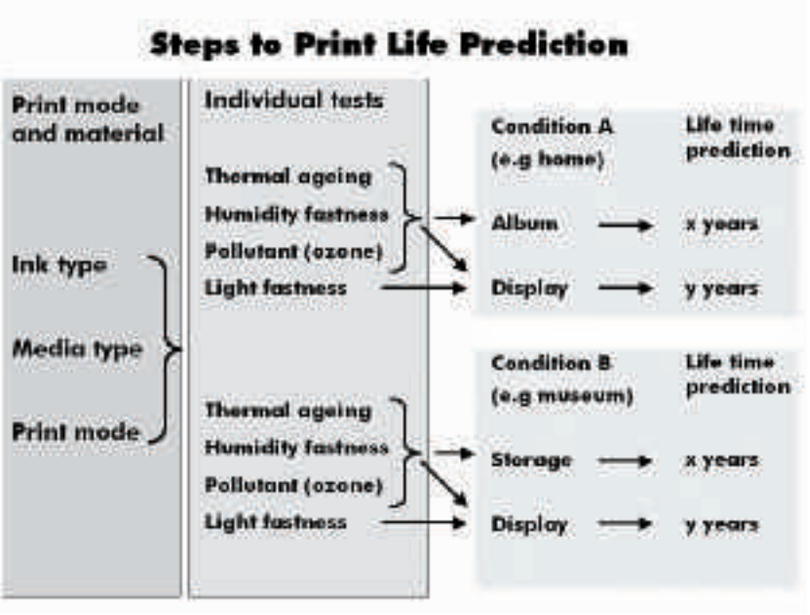

Fig 3. Process to predict print life.

The overall life expectancy of a print will be determined by the environmental factor that is most destructive under the storage conditions and this factor depends on the type of paper layer and ink used. It is therefore quite important to at least characterise the paper and ink type. This means understanding if it has a layer at all, a matt pigment coated layer, a glossy nanoporous mineral-oxide layer, or a polymer layer and if the substrate underneath the layer is RC paper, baryta paper or another type of paper. It is important to know if the print was made with a pigment ink or a dye-based ink.

Test methods for Permanence

As many of the IJ print materials have only been around for several years, permanence ratings for IJ prints are generally based on accelerated testing and extrapolated predictions. This bears two uncertainties. One is to assume that, the test method is representative of natural ageing. The other uncertainty is to know which will be the environment in which the print will be kept. Manufacturers and independent labs have spent considerable time and effort to characterise the aging of modern print materials, mainly for the stability of the colour image, not so much on the physical and mechanical stability changes due to ageing. Most life time predictions are limited to the colour image degradation. For the physical stability, the general assumption is to rely on the stability of the substrate without receiving layer.

In the natural environment, many factors will act on the print at the same time, for example humidity and light. All test methods are designed to isolate the exposure factors and do not test for a possible accelerating interaction. It is very difficult to compare the results of the tests with natural ageing of prints. For the best print systems, life expectancy predictions can reach 100-200 years and are beyond the time span of one generation. There is no common agreement about the end point of print degradation either, which in some case is set to the first visible point of change, in others to a very visible point and still others to the level of acceptability. The end point used and the environmental conditions for the prediction need to be known before life time predictions can be compared. Often predictions are meant for the typical home, whereby the typical home is by itself will change over the seasons and the regions. Museum storage and display are easier to specify and often better controlled. The control of humidity and temperature is well documented, but air quality monitoring is not always done.

Stability

Image stability claims can only be made for one printer/ink/media combination. A great number of those combinations exists. It is difficult to make general statements about the permanence of IJ paper prints. The thermal or dark stability of IJ photo prints, which is relevant for storage in an album, has been good for most products since early on. Modern media printed with dye-based inks are designed to withstand 70% RH without migration of the dye. Pigment prints are not sensitive to colorant migration under humidity. The light stability of dye-base prints on modern media is at least as good as traditional silver halide prints. Pigment ink prints are considerably more stable, up to 50 years compared to 20 for 250 lux light display conditions. Stability vs. air pollutants, mainly ozone, for unprotected prints on display is 5-10 years. In areas of high ozone concentrations this can reduce to 1-3 years. It is recommended to display images protected behind glass, if possible not in contact with glass.

"It is helpful to understand the basic materials used and adapt the handling and storage to the critical weakness of the print."

Useful sources for information about stability, print methods and storage

1. Wilhelm, Henry, "A 15-year History of digital Print Technology and Print Permanence in the Evolution of Digital Fine Art Photography - From 1991-2006", *Proc. IS&T's International Conference on Non-impact Printing*, NIP 22, p. 308 (2006).

2. IS&T: The Society for Imaging Science and Technology - 7003 Kilworth Lane – Springfield, VA 22151 USA – URL: www.imaging.org

3. WIR: Wilhelm Imaging Research, Inc. - 723 State Street - Box 775 - Grinnell, Iowa 50112-0775 URL: http://www.wilhelm-research.com/index.htm

4. IPI: Image Permanence Institute - Rochester Institute of Technology - 70 Lomb Memorial Drive - Rochester, NY 14623-5604 USA - URL: http://www.imagepermanenceinstitute.org

5. Martin Juergens: Identification of digital prints - URL: http://www.martinjuergens.net

Nouvelles technologies d'impression jet d'encre: structures et permanence

Pendant les 15-20 dernières années, l'impression numérique et les nouveaux matériels développés ont mis le tirage d'images de qualité photographique à la portée de tous. Tandis qu'auparavant seuls les professionnels et les amateurs avertis s'essayaient à tirer des photographies en noir et blanc et en couleur dans leur chambre noire, les actuels propriétaires d'imprimantes à jet d'encre modernes peuvent imprimer des images de bonne qualité sans rien connaître des propriétés des matériaux et de la couleur.

Ce développement rapide présente un inconvénient pour ceux qui sont en charge de l'archivage et de la préservation des photos numériques couleur des 20 dernières années, compte tenu de la variété des systèmes d'impression, des supports et des colorants. Le cycle de vie d'une imprimante type est seulement de 6 mois à une année avant qu'elle ne soit remplacée par un nouveau modèle. La formulation des supports et celle des encres changent dans un laps de temps d'un ou deux ans, trois et cinq ans pour les colorants. En général, ces changements ne sont pas affichés et sont souvent invisibles pour l'utilisateur. Pourtant, si la qualité d'image peut être très semblable, les propriétés de permanence peuvent être radicalement différentes.

Vu la variété des supports et des colorants disponibles dans le champ de l'impression numérique, l'article se limitera aux impressions avec des encres à base d'eau sur des supports papier et destinées à un usage intérieur, à la photographie de qualité et d'art. Les encres utilisées dans l'impression à jet d'encre aqueuse se divisent en deux catégories, les encres à base de pigments et les encres à base de colorants.

Facteurs de vieillissement des impressions

En ce qui concerne la stabilité de l'impression, il faut distinguer stabilité de l'image et de la couleur et stabilité mécanique ou physique. Les quatre facteurs habituels contribuant à la dégradation des impressions à jet d'encre sont : la lumière, l'humidité, la température et la pollution atmosphérique. Le facteur de détérioration le plus important pour une image imprimée par jet d'encre dépend du type de support et d'encre utilisé. Les impressions obtenues avec une encre à colorant sur du papier à couche nanoporeuse sont très sensibles à la pollution atmosphérique, particulièrement l'ozone, tandis que des impressions alliant encre à colorant et papier à couche polymère sont plutôt sensibles au taux élevé d'humidité. Les impressions obtenues avec une encre à pigment sur du papier à couche nanoporeuse ne sont pas affectées par l'humidité et la lumière, mais par l'abrasion de surface. Il est donc essentiel de comprendre les matériaux de base utilisés (c'est-à-dire caractériser le type de papier et d'encre) pour adapter la manipulation et le stockage aux points faibles des tirages.

Il s'agit principalement de déterminer si l'encre est à base de colorant ou de pigment et si la couche réceptrice est composée de polymère ou d'oxyde minéral. Comparées à l'argentique, les impressions par jet d'encre les plus modernes sont moins sensibles à la température et bénéficieront donc moins d'un stockage en chambre froide. D'autre part, elles sont souvent plus sensibles aux dégâts en surface, à la pollution atmosphérique et à l'humidité. Il n'est donc pas évident de comparer la permanence des impressions par jet d'encre et des impressions photographiques traditionnelles. Selon l'utilisation, l'application et les conditions environnementales, l'une ou l'autre des technologies pourra s'avérer plus durable.

Tests

Comme la plupart des matériels d'impression à jet d'encre ne sont sur le marché que depuis quelques années, l'évaluation de la permanence de ce type d'impression est généralement basée sur des tests accélérés et des prédictions extrapolées, ce qui soulève deux incertitudes. D'une part, cela suppose que la méthode de test soit représentative du vieillissement naturel, et d'autre part que l'on connaisse l'environnement dans lequel le tirage sera conservé.

Les fabricants et les laboratoires indépendants ont consacré beaucoup de temps et d'effort à caractériser le vieillissement des matériaux d'impression modernes, principalement au niveau de la stabilité de la couleur, et non pas tellement de la stabilité physique et mécanique. Il est toujours très difficile de comparer les résultats de ces tests avec le vieillissement naturel des impressions, sachant qu'ils dépendent du critère de dégradation choisi et des conditions environnementales de conservation.

Impresoras modernas de inyección de tinta: estructura y permanencia

Durante los últimos 15-20 años, la impresión digital y los nuevos materiales para la reproducción de imágenes que se han desarrollado han puesto la impresión de imágenes con calidad fotográfica al alcance de todo el mundo. Mientras antes los profesionales y aficionados solo se dedicaban a hacer impresiones en blanco y negro y a color en un cuarto oscuro, los actuales dueños de impresoras modernas de inyección de tinta pueden imprimir imágenes de buena calidad sin tener mucho conocimiento acerca del color ni de las propiedades de los materiales.

Este rápido avance es una desventaja para quienes han tenido que lidiar con el archivo y la preservación de fotos digitales a color de los últimos 20 años. Existe una gran variedad de sistemas, medios y colorantes de impresión. El ciclo de vida de una impresora común es de apenas seis meses a un año antes tener que sustituirse por un nuevo modelo. Comúnmente, la formulación de los medios y de los tintes ha cambiado en ciclos de 1-2 años, y los colorantes en ciclos de 3-5 años. En general, esos cambios no se publican abiertamente y con frecuencia no son visibles para el usuario. Sin embargo, aunque la calidad de la imagen puede ser muy similar, las propiedades de permanencia pueden ser dramáticamente distintas.

Debido a que la variedad de medios impresos y colorantes disponibles en inyección de tinta es vasta, este informe se concentrará solamente en los que se utilizan para aplicaciones internas, impresos con tintas de base acuosa sobre papel para productos con calidad fotográfica y artes. Las tintas usadas en la impresión de inyección acuosa se dividen en dos categorías, una basada en los pigmentos y la otra en los tintes.

Factores determinantes del envejecimiento de las impresiones

En cuanto a la estabilidad de las impresiones se debe hacer una distinción entre la estabilidad de la imagen y el color y estabilidad mecánica o física de la impresión. Los cuatro factores que contribuyen usualmente con la degradación de la impresión con inyección de tinta son: luz, humedad, temperatura y contaminantes. El factor de degradación más importante para la impresión con inyección depende del tipo de material de impresión utilizado. Las impresiones nanoporo a base de tintes son muy sensibles a los contaminantes del aire, particularmente el ozono, mientras que las impresiones en polímeros a base de tintes son insensibles al ozono pero sensibles a la humedad elevada. Las impresiones a base de pigmentos sobre capas de nanoporos son bastante insensibles a la humedad y la luz, pero sensibles a la abrasión de la superficie. Es muy importante conocer los materiales básicos empleados (es decir, determinar el tipo de papel y tinta) y adaptar la manipulación y el almacenamiento a la debilidad crítica de la impresión.

Las principales preguntas que se deben responder son si la tinta es a base de pigmentos o de tintes y si la capa es un polímero o un óxido mineral. En comparación con las fotos de haluro de plata, las impresiones en los equipos de inyección de tinta modernos son menos sensibles a la temperatura y pueden beneficiarse menos del almacenamiento en frío. Por otra parte, generalmente son más sensibles a los daños de la superficie, los contaminantes del aire y la humedad. Por consiguiente, no es fácil comparar la permanencia de las impresoras de inyección de tinta modernas con las impresiones fotográficas tradicionales. Dependiendo del uso, las condiciones ambientales y de aplicación, puede resultar más duradera una u otra tecnología.

Métodos para determinar la permanencia

Ya que muchos de los materiales impresos con inyección de tinta han existido desde hace pocos años, los índices de permanencia para este tipo de impresiones generalmente se basan en las pruebas aceleradas y predicciones extrapoladas. Ello implica dos dudas. Una es suponer que el método de prueba representa el envejecimiento natural. La otra es saber cuál será el ambiente en el que se guardará la impresión. Los fabricantes y los laboratorios independientes han invertido tiempo y esfuerzo considerables para caracterizar el envejecimiento de los materiales impresos modernos, principalmente para determinar la estabilidad de la imagen a color, pero no tanto en los cambios de la estabilidad física y mecánica producto del envejecimiento. Todavía resulta muy difícil comparar los resultados de estas pruebas con el envejecimiento natural de las impresiones, debido a que dependen del punto de degradación de la impresión utilizado y de las condiciones ambientales que se deben conocer para hacer las predicciones del tiempo de vida.

Why and How the Art Market Converts to Archival Pigment Prints?

by Philippe Serenon
CEO, WINCH

IPN: Philippe, could you please introduce yourself rapidly?
PS: I spent 15 years at Kodak, in particular in the Professional products division for films, papers and equipments for pro labs where I created the Museums and Heritage market segment in Europe in 1995. I proposed a business model by which Kodak would invest in digitization and have return on the downstream revenue created (i.e. Getty and Corbis today) but it was not accepted. I then left, intending to come back to photography in a digital company. I was offered this opportunity by HP 6 years ago and created my consulting company, WINCH. Today I collaborate essentially with their Graphics Solutions Business Division, including Large Format Printing for Fine Art, managing relationships with world famous artists, photographers, designers and digital artists.

IPN: Do these artists adopt digital prints?
PS: Definitely. Renowned photographers such as Martin Parr and Thomas Hoepker from Magnum, Albert Watson or Joel Meyerowitz are now selling such prints to public or private collections. To avoid any confusion, the words "digital prints" cover different technologies and inks: what they concentrate on are Archival Pigment Prints based on Inkjet technology.

Exhibition of Thomas Hoepker from Magnum, Cologne, 2008, Archival Pigment Prints.

IPN: Tell us why, please.
PS: There are a number of good reasons, both artistic and technical.

- Inkjet printing is a very young technology: but it took less than 20 years to reach a level of image quality (resolution, color gamut, neutral black & whites, dynamic range…) capable of transmitting the emotional dimensions and intents of the artist, as well if not better than conventional photography. Therefore, there are no more artistic barriers.
- Producing high quality digital prints has improved and simplified overtime: time for early adopters and computer freaks is behind and most artists can easily control the various steps required.
- In conventional photography, color printing had to be done by a professional lab. In digital, it is easy to do it in your own studio which offers great flexibility, direct quality control and reduced cost.
- Process is much more stable, providing better longevity.

IPN: Could you detail on this?
There are some intrinsic technology factors to be understood: photography is basically a chemical process based on oxidation of silver particles placed in different sensitive layers in the paper, process being stopped by fixation. By definition stability is relative to fixing. Also, resin coated photo papers over time can see yellow stains move up to the surface, damaging the image dramatically.
Inkjet printing is about writing an image with millions of pens (nozzles), using pigment inks with several colors, actually 12 for the best printers which is more stable than a chemical process. In fact, pigments placed on paper are as stable as when they are on a painting. As a result, longevity tests done by Wilhelm Institute of Research, independent lab, give to artwork printed on HP using their inks and papers more than 200 years lifetime. It is fundamental for artwork owners. M. Parr stated publicly that he switched to selling these prints as he had too many returns from owners dissatisfied by damaged C Prints[1] which he had to replace.

IPN: Can you comment more on papers?
PS: To me, choice of paper is definitely artistic. The variety of "digital "papers available on the market is far larger than photo papers as cotton or fiber paper and canvas can be used as well. Each has a different lifecycle but it is documented.

IPN: What about preservation conditions?
PS: This is well documented by WIR[2] on their website. Of course, longevity improves with care taken as any other artwork such as light, humidity, air, etc.

IPN: How do galleries react?
An increasing number has converted and sells these new prints. We have testimonials from US and European galleries collected at Paris Photo in 2008 which prove that they are very confident in these prints both for artistic and conservation reasons. But it is fair to say that North American artists are less shy than European ones, both for natural immersion in technology as well as for cultural and historical dimensions.

IPN: How about institutions?
Anne Biroleau-Lemagny from BnF herself was convinced initially by John Batho who achieved results he had never been able to reach before[3]. 30% of recent acquisitions are archival digital pigment prints. Bill Ewing from the Musée de l'Elysée of Lausanne, reference in photography, states that the artist decision prevails and that he welcomes new technologies as any other. In October 2008, Joel Meyerowitz had a speech planned at MOMA for 30 minutes about this in front of 40 world famous curators. It lasted 2 hours!

IPN: Will these new prints kill any other solutions?
PS: Art started by painting on caves' wall and several technical breakthrough changed the expression tool and support along the centuries. But cultural dimension of Artwork prevails and all techniques are represented in Museums and libraries collections. This one will have its own lifecycle and who knows what will appear in the future. But before this happens, in the meantime, it will take an increasing share due to all its benefits: image quality and color richness, large choice of supports, longevity of work, ease of use and cost.

Contact:
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1. C Print: Chromogenic print.
2. http://wilhelm-research.com/
3. Source: *Images Magazine* n° 26, December 2007-January 2008.

Ongoing Study on the Conservation of Paper and Books: Evaluating Paper Deterioration and Strengthening of Deteriorated Paper

by Naoko Sonoda, Masazumi Seki, Takayuki Okayama and Hajime Ohtani[1]

A slightly modified version of the paper prepared for "Advances in Paper Conservation Research", held at The British Library Conference Centre, March 2009.

1. Introduction

1.1. Background

Many libraries and archives are faced with the problem of acid paper, and a large percentage of their collections of books published around the beginning of the 20th century are at risk. The National Museum of Ethnology, Osaka (Japan), received, in March 1998, a donation of approximately 13,000 volumes of the British Parliamentary Papers dating from 1801 to 1986, from Kyocera Co. Ltd, on condition that they were made available to a wide range of researchers[1]. With less than 1% of these Papers missing, they are the most complete original version of the British Parliamentary Papers that can be perused in the world. Nevertheless, due to the increased fragility of paper, perusal of a part of these papers was either very difficult or impossible. Supported by the researchers willing to see these papers in their original form and by the donor willing to assist in realizing such desires, the National Museum of Ethnology, in collaboration with other institutions, has been conducting a study on strengthening degraded papers and evaluating paper deterioration.

Members of the present research team are very diverse[2]. Some of us are archivists, librarians, paper conservators or conservation scientists, while others are paper chemists and analytical chemists.

1.2. Preliminary study on the condition of the British Parliamentary Papers[3]

A preliminary investigation was conducted on samples from 47 of the British Parliamentary Papers selected from different periods to evaluate their present condition. The double fold test and the zero-span tensile strength test, which measure the strength of one fiber, were carried out on each sample. The results of the double fold test and the zero-span tensile strength test suggest that, on the whole, samples of paper from the first half of the 1800s are comparatively stronger than those from the last half of the 1800s to the first half of the 1900s.

The fiber composition of papers was then examined using small pieces of paper, detached during the double fold test. The fiber composition shows that most of the samples from the first half of the 1800s were composed of linen and samples from the last half of 1800s showed an increased ratio of esparto as well as the addition of cotton rag, Manila hemp and groundwood pulp (GP). Softwood chemical pulp (NBSP) began to appear from around the 1880s and became main stream by the 1900s. Samples from the period of World War II showed a great portion of non-wood fibers. After World War II, softwood chemical pulp and hardwood chemical pulp (NBKP and LBKP) were used.

In summary, the present condition of the British Parliamentary Papers is as follows:

(1) Papers from the first half of the 1800s are comparatively strong.
(2) Papers from the last half of the 1800s are comparatively weak.
(3) The use of groundwood pulp may be one cause of fragility of papers from the last half of the 1800s.

1. The British Parliamentary Papers have been transferred to the Center for Integrated Area Studies, Kyoto University (CIAS) in April 2006. The collection is open to the public at Kyoto University Library.

2. Naoko SONODA and Shingo HIDAKA (National Museum of Ethnology, Osaka), Takayuki OKAYAMA (Tokyo University of Agriculture and Technology), Hajime OHTANI (Nagoya Institute of Technology), Masazumi SEKI (Kochi Prefectural Paper Technology Centre), Katsuhiko MASUDA (Showa Women's University), Mutsumi AOKI (National Institute of Japanese Literature), Masako KANAYAMA (Gangoji Institute for Cultural Properties), Satoko MURAMOTO (National Diet Library), Tsuneyuki MORITA (National Museum of Ethnology, Osaka, professor emeritus) and Raysabro OYE (Tokyo University of Agriculture and Technology, professor emeritus).

3. Sonoda, N., Hidaka, S., Morita, T., Okayama, T., Ohtani, H., Seki, M., Masuda, K., Kanayama, M. and Muramoto, S., "New evaluation methods of paper deterioration: Study of British Parliamentary Papers in the collection of National Museum of Ethnology, JAPAN", *Durability of Paper and Writing*, Proceedings of the International Conference held in November 16-19, 2004, Ljubljana, Slovenia, 92-94, 2004.

2. Strengthening of Book Papers through Use of Cellulose Derivatives[4]

2.1. Preparation of the deacidification/strengthening dispersion

The study of the present condition of the British Parliamentary Papers led us to undertake research on a paper strengthening method applicable not only to sheet papers but also to bound books. This is the reason why an easy and efficient spray method was used as the application method. Cellulose derivatives were selected as a strengthening agent because of their chemical similarity to cellulose. Special attention was paid to use only a minimum amount of water for fear that use of water might cause deformation of paper.

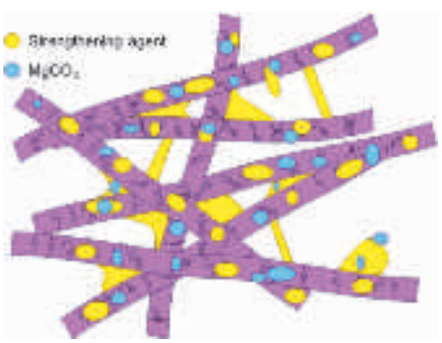
-Cellulose derivatives soluble in water but NOT soluble in organic solvents: Methyl cellulose MC, Carboxymethyl cellulose CMC.

Cellulose derivative (MC or CMC) was gradually added to distilled water of 80°C, and the distilled water was gently stirred. The solution was stored in a refrigerator overnight. MC or CMC gel was then heated in a water vessel at approximately 60°C. Deacidification agent (magnesium carbonate) dispersed in alcohol was added to the MC (or CMC) solution. The mixture of MC (or CMC) solution in water and alcohol was briskly stirred using a homogenizer. We finally obtained a dispersion with water content of 23.8w% and a cellulose derivative (MC or CMC) level of 1.25w%. The dispersions of MC and CMC are both smooth, white liquids, but the CMC dispersion needed continuous, gentle stirring, as it undergoes rapid separation if left standing.

- Cellulose derivatives soluble in an organic solvent: Ethyl cellulose EC, Hydoxypropyl cellulose HPC.

Cellulose derivative (EC or HPC) was gradually added into the alcohol. After complete dissolution, a dispersion of magnesium carbonate in a minimum amount of water was added into the alcohol. When the mixture became homogenous, alcohol was added again. At this point, the mixture was a dispersion with water content of 10.0w% and a cellulose derivative (EC or HPC) level of 1.25%. As the dispersion is highly vaporous, it was put into a sealed plastic container for immediate application.

4. Seki, M., Sonoda, N., Morita, T. and Okayama, T., "A New Technique of Book Papers Strengthening Using Cellulose Derivatives", *Restaurator* (26), 239-259, 2005.



1. Diagram showing the distribution of the strengthening agent and deacidification agent ($MgCO_3$) on the fibers.

A deacidification agent was added to ensure a simultaneous deacidification and strengthening of paper. Microscopic observation showed that, after application of the deacidification/strengthening dispersion by spray method, the fine particles of deacidification agent and strengthening agent were distributed homogenously on the fibers.

2.2 Effect of the deacidification/strengthening treatment

The physical measurements (grammage, ISO brightness, tearing strength, folding endurance, zero-span tensile strength, tensile strength) of samples before and after deacidification/strengthening treatment were conducted in compliance with ISO 536, ISO 2470, ISO 1974, ISO 5626, ISO 153561 and ISO 1924-2, respectively, to compare the effectiveness of different cellulose derivatives as a strengthening agent. The physical measurements were also performed during artificial aging in order to evaluate the permanence of the strengthening effect. Accelerated ageing was performed in an air-circulated oven at 120°C, in compliance with ISO 5630-4. The periods of artificial ageing were 0, 1, 5, 10 and 20 days. After each period, the humidity of the paper sample was controlled, in compliance with ISO 187.

It became clear from the series of experiments that the amount of cellulose derivative necessary for an effective strengthening was 0.3g/m^2. The addition of a deacidification agent such as magnesium carbonate to the strengthening dispersion resulted in simultaneous strengthening and deacidification. In summary, CMC, MC and HPC presented a good strengthening effect when used in combination with a deacidification agent. Of these three cellulose derivatives, MC exhibited the highest strengthening effect on paper and was the most compatible with magnesium carbonate.

If the paper is not too heavily degraded, its tensile strength, tearing resistance, folding strength and zero-span tensile strength can be improved after treatment. Except for zero-span tensile strength test, which did not show an apparent amelioration, the results of tests for tensile strength, tearing resistance, and folding strength showed the effectiveness of the treatment on artificially aged samples. However, if deterioration has progressed so far that it is even difficult to turn a page, strengthening with cellulose derivatives is not appropriate since it will have the adverse effect of making the paper stiffer. In such a case, a more radical method such as paper splitting may be considered.

3. New techniques for evaluation of paper deterioration

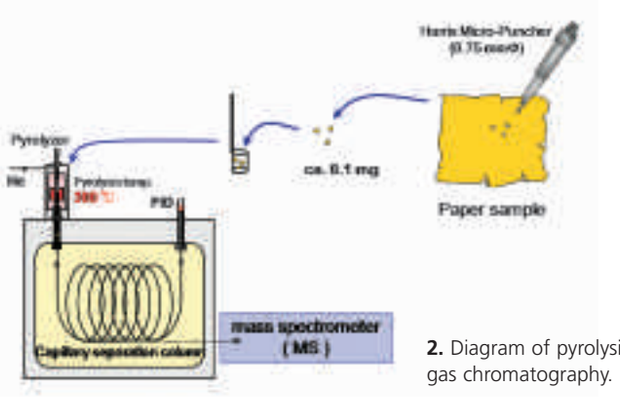
3.1. Acoustic emission[5, 6]

Acoustic emission (AE) monitoring, which is almost non-destructive and listens to high frequency sounds emitted by a material when it is under stress, has been proven to determine the onset and progression of small-scale damage. To evaluate paper deterioration with this technique, an AE sensor of 3mm diameter was used. The AE sensor was mounted on the upper platen of a ring crush tester. The paper sample was compressed slowly at constant rate of speed, and the number of times the sensor signal exceeded a counter threshold were counted.

Zero-Span tensile strength test and AE monitoring carried out on a series of samples from different periods resulted in very similar results. The time taken to reach the maximum AE ring-down count in the papers in poor condition was considerably shorter than that taken in the better preserved papers. These findings will permit the use of AE signals to monitor the preservation level of old and valuable paper materials. AE signals such as ring-down count could be useful in assessing the deterioration of aged paper materials.

3.2. Pyrolysis-gas chromatography[3, 7]

Pyrolysis-gas chromatography (Py-GC) was applied to the evaluation of paper deterioration. A tiny piece (ca. 0.1mg) of paper was subjected to Py-GC.



2. Diagram of pyrolysis - gas chromatography.

At 300°C, normal paper decomposes only slightly, and the main decomposition product is levoglucosan (1,6-Anhydro-β-D-glucose). On the other hand, with a sample of paper from a highly deteriorated book, thermal decomposition progressed sufficiently even at this temperature. In addition to levoglucosan, its dehydrated product levoglucosenone was clearly observed. It suggested that the long-term deterioration of acid paper was caused by dehydration from glucose units accompanied by chain scission. Comparing the results of the analysis of samples taken from the middle of a paper with those of samples from the edges of the same page, it was found that the peak of levoglucosenone was relatively much higher at the edges. The deterioration of paper had progressed more at the edges than in the middle.

By using the relative amount of levoglucosenone to levoglucosan as an index, it seems possible to rapidly evaluate the degree of deterioration of paper from a very tiny piece or sample, and accordingly, without greatly damaging valuable archival or library materials.

5. Okayama, T. and Sato, K., "A new method for the assessment of deteriorated paper documents", in *Edinburgh Conference Papers* 2006, The Institute of Conservation, London, 219-226, 2007.

6. Okayama, T., Fukai, K., Sonoda, N. and Morita, T., "Evaluation of Paper Deterioration – Application of Acoustic Emission Measurement Using Small Test Pieces", *Summaries of the IADA XI Congress*, Vienna, 17-21 September 2007, 71, 2007.

7. Ohtani, H., Komura, T., Sonoda, N., and Taguchi, Y., "Evaluation of acidic paper deterioration in library materials by pyrolysis-gas chromatography", *Journal of Analytical and Applied Pyrolysis* (85), 460-464, 2009.

3.3. Rolling test[3]

We devised a new sensory evaluation method called the "rolling test," using acrylic cylinders of different calibrations (60mm to 5mm in diameter, with intervals of 5mm). In this method, a paper is first rolled around a cylinder with a 45mm diameter (or 60mm in the case of heavily deteriorated paper) from a corner, forming a 45° angle to the page. If the page is rolled safely, without wrinkles, tears or any kind of resistance, the same test is performed using a narrower cylinder. As soon as any sign of resistance appears, rolling is stopped.

A series of preliminary tests conducted on a number of paper samples seem to suggest that the rolling test permits the evaluation of paper samples that are too "weak" to be properly measured by ordinary physical measurements. When evaluating whether or not a book requires conservation treatment, the degradation state of the entire page should be taken into consideration. We believe that the rolling test is an effective method for sensory evaluation and deserves further examination, as it can be carried out on a larger surface of the page than the double fold test, and it is almost non-destructive.

4. Future Issues

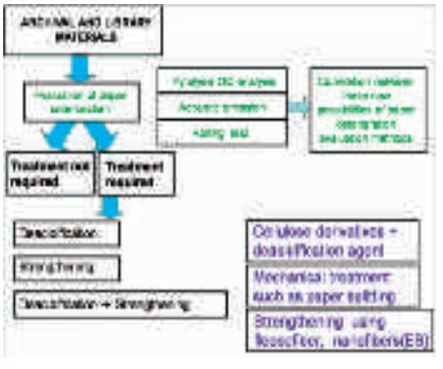
When speaking about the strengthening of paper, many questions need to be considered. At what stage of damage do we need to start treatment? What is the minimum necessary limit of the paper strength to make it available to use? To what extent can we carry out the treatment? Only when these standards are established, can we effectively select the appropriate strengthening method.

Presently, we are conducting further research to see how these different approaches of evaluation of paper deterioration are related:

- Acoustic emission and other physical measurements
- Pyrolysis-gas chromatography
- Rolling test
- Sensory judgment based on the experience of restorers and/or librarians.

The results of this investigation will be published later.

We are also aware of the fact that an appropriate method of strengthening must be selected in accordance with the degree of deterioration of paper. Strengthening through use of cellulose derivatives is applicable to papers that are not in an advanced stage of deterioration. For more deteriorated papers, a more radical mechanical treatment such as paper splitting may deserve further investigation. Also a new possibility, such as strengthening using fleecefiber or nanofiber may be worth examining in future.



3. Overall diagram of our research.

The Survey of pH Value in National Library of China and the Project of Conservation for Ancient Books

by Tian Zhouling and Zhou Chongrun
China National Preservation Center for Ancient Books, National Library of China

The pH value is an important factor for books preservation and prolonging books life. The conservators in National Library of China made a survey of pH value for Chinese ancient books. And in order to improve the books condition, the project of conservation for ancient books of China has been carried out.

China is one of the most ancient civilizations in the world. And it has centuries-old history and brilliant culture. Paper was invented in China in 100 BC. Methods of printing came into use by the 7th century which promoted the development of Chinese brilliant culture. Chinese is good at recording its history by books. The books produced in Qing Dynasty and before Qing Dynasty are called ancient books. The number of Chinese ancient books is enormous. The ancient books record the civilization harvest. And the ancient books are history & culture witness of China and are precious for researching, inheriting and developing the Chinese traditional culture. They are more precious because they are not regenerated.

However, the Chinese ancient books have traveled down the past dynasties, and encountered man-made ruin and natural corroding. Over half of the ancient books have been damaged. According to records, there are only about 100 thousand kinds of Chinese ancient books, about 20 million volumes. Among them, there are 20 million volumes of rare books. The Chinese ancient books have become precious history & culture inheritance for China, even for the whole world. They not only have important literature value, but also a very rare cultural relic value. Therefore, protecting the precious ancient books and making them travel down the ages is our holy duty.

I. The survey of pH value in the National Library of China

In the recent years, the conservators in the National Library of China found that the ancient books faced many problems. Among them, an important problem is acidification, and acidification has become the main factor affecting paper preservation longevity. Acidification is the biggest reason damaging the ancient book in peaceful society. If this condition develops without being dealt with, there will be no ancient books after one hundred years.

Acidification is a phenomenon that the pH value of the paper gradually enhanced. Our investigation finds that as far as there is acid in the paper, the paper will deteriorate even though the book is not used. The stronger the acid in the paper, the quicker the paper deteriorates. The stronger the acid in the paper, the shorter the longevity is.

1. Material and process change in papermaking has vital effect on the acidity in the paper

The material of the ancient literature is mainly paper. Paper is a long-lasting and very resistant material. The paper of the ancient book before 19th century is handcraft paper. The raw material of the paper is old linen, hemp or cotton rags. These materials have more cellulose, little hemicelluloses and little lignin. For example, the rags contained pure cellulose. The degree of polymerization of cellulose is bigger than hemicelluloses and lignin, varying from a few hundred to several thousand. The degree of polymerization of celluloses of cotton which have been no more than slightly degraded is in the range of 700-1400, which corresponds to molecular weights of between 120,000 and 260,000. The celluloses are not far more accessible to chemical reagents than the hemicelluloses and lignin. Moreover, in the ancient process of papermaking, calcium oxide was used, which is alkaline. So the paper made before mid-19th century is not easily acidifying or ageing.

But after mid-19th century, in response to the increasing demand for paper, wood pulp as the main raw material and rosin sizing came into use for papermaking. The wood pulp has less cellulose and more hemicelluloses and lignin. The rosin sizing usually is alum which is same as aluminum sulphate in chemical. As a result, most of the papers produced after the middle of the nineteenth century have generated problems of "acidic paper". The machine papermaking and chemical papermaking are one important reasons which make the paper acid.

2. The effect of environmental pollution on the acidity in the paper

The other reason which caused the acidification is environmental pollution. There is more and more acidic gas, including SO_2, NO_X and ozone. The acidic gas in the atmosphere accelerates the acidification of the paper. The SO_2 and NO_X are acid gas. They can react with water to form H_2SO_4 and HNO_3. The H_2SO_4 and HNO_3 are strong acid and they can destroy the cellulose structure. The ozone is strong oxide agent. Ozone can make the cellulose oxide.

3. The results of the survey of pH value

In order to protect the ancient book and to know the current state of the ancient books preservation, the conservators in National Library of China made a survey, named "The survey of pH value in National Library of China" which notices that the paper of the ancient books has begun to acidify. The paper of Chinese ancient books is made from much material including

bast, hemp, straw, and bamboo. The material was processed into paper through over ten procedures. At the initial stages, the paper was neutral or basic slightly and the pH value was in the range from 7.0 to 8.0. But the pH value changed with the time. In the 1960s, certain branch checked the pH value of the 60 kinds of ancient books. And they found the average of the pH value was 7.6. The pH value of the bast paper was 8.3, and bamboo paper 6.9. All was neutral or basic slightly. The results are below in the table.

Number	Dynasty	PH value	number	Dynasty	PH value	number	dynasty	PH value
1	Ming	7.39	9	Ming	7.10	17	Qing	6.07
2	Ming	6.59	10	Ming	6.79	18	Qing	6.22
3	Ming	7.42	11	Ming	7.02	19	Qing	6.00
4	Ming	6.85	12	Song	6.05	20	Ming	6.26
5	Ming	6.67	13	Song	5.85	21	Ming	6.90
6	Ming	7.16	14	Yuan	6.30	22	Ming	5.54
7	Qing	6.22	15	Song	5.65	23	Qing	6.98
8	Ming	7.16	16	Ming	6.84	24	Qing	7.07

Table 1. The pH survey result from ancient books and special collection.

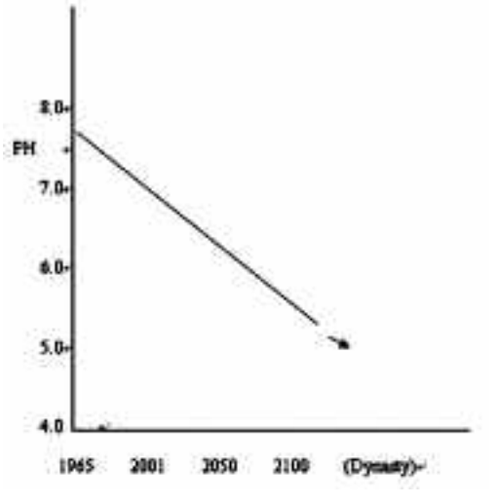


Fig. 1. The forecast of the pH value development of Chinese ancient books.

In the beginning of the 20th century, western country reported an emergency concerning the acidification of the books in the library. The conservators in our country made an inspection of 60 kinds of ancient books. The average of the pH value was 7.6. Among them, bast paper was 8.3 and bamboo was 6.9. They were neutral or alkaline. We were pride of our ancestral and gratified for non-acidification of Chinese ancient books.

But after only 40 years, the conservators in the National Library of China found that the ancient books have been acidifying: the average of the pH value is 6.6. Among them, the pH value of the bast paper is 6.7, and the pH value of the bamboo paper is 6.4. Comparing with the data we check in the middle of the 20th century the data slow down. These phenomena began to accelerate Chinese ancient books deterioration. If no measure is carried out, the books will acidify at the same speed. And after 50 years, the pH value of the ancient books will drop to about 5.5. After one hundred years, the value will drop to below 5.0. The ancient books will be brittle and the result will not be imaginable.

Fortunately, there has come a new opportunity in the last two decades. With the development of the economy and more investment in culture, the idea of cultural heritage preservation is deeply rooted among the people. *Outline of the Programme of Chinese Cultural Development during the 11th Five -Year Plan* was issued on September 13th 2006. The paper puts emphasis on "education in Chinese traditional culture, the inheritance of classic books and techniques". And as an important measure and a phase target, the "Chinese Ancient Books Preservation Project" should be launched, in order to make greater efforts towards the preservation of rare books and other relics.

II. Chinese Ancient Books Preservation Project

The preservation project is the center of the preservation work in the 11th Five-year Plan. The aim of the project is to establish scientific and effective regulations, to promote actual work, and to arouse public attention (form a proper attitude to preservation). The preservation work will abide by the following principles: preservation should be the primary aim; conservation should be carried out urgently; conservation shouldn't limit public access to the books; and the management of ancient book collections should be strengthened. The work should follow the idea of: preserving by laws and using scientific methods; making a balance between the preservation and use of the ancient books; concentrating on crucial points and carrying them out step by step. In this project, special funds will be devoted to rescue the damaged books and to make conservation archives. Basic research and testing will be carried out, including the combination of traditional and modern techniques (the most important is deacidification), and new standards for preservation and conservation.

The preservation project will promote conservation work. It is an important point in the plan to establish a national preservation laboratory. It can provide scientific evidence from experiments and tests for the conservation work. Also research on standards of book stacks and conservation techniques will provide a base for the conservation of ancient books. Professional staff is also required.

In order to ensure the project is carried out successfully, in 2005 the NLC spent nearly one year cooperating with the nine main libraries on drawing up six basic standards. The standards included Standards for Ranking Ancient Books, Standard for Ranking of Damage, Basic Requirements for Ancient Book Stacks, Techniques and Quality Standards of Conservation, the Standards for Surveying Ancient Books, and the Professional Requirements for Conservators. The last one is issued as a recommended standard for the preservation project, and the other five are appointed to be the standards for the library profession by the Ministry of Culture. All of these standards are set out by the experiences arising from long-term working experience. The detailed explanations for these standards can be found in the *Journal of National Library of China*. These standards are very useful in preparing the preservation project, and will influence the work of ancient book care in all the libraries in China.

Half a century of the Centre for Conservation and Restoration at the National Archives of Slovenia

by Marija Grabnar
Division of records preservation, National Archives of Slovenia

Introduction

The Centre for Conservation and Restoration of the written cultural heritage at the Archives of the Republic of Slovenia celebrated in 2006 the 50th anniversary of its continuous activity. The review of the past work done, at a half a century jubilee is therefore expected, at the same time it also portrays the characteristics of the experts – conservators-restorators of the documents on paper and parchment - that are worth emphasizing. Their activities go beyond the main organisation, because of the services they provide to all the Slovenian archives, to numerous museums, galleries, and also to private persons. They are closely linked to the tradition of preservation of the written cultural heritage on paper and parchment in Slovenia. Until the establishment of a similar centre at the National Library in the beginning of the 1990s, they were also its only creator.
An average of 10 conservators has worked since 1980s and for decades now their work has followed a constant path in two working groups. The larger group restores two-dimensional objects (documents on parchment, drawings, paintings, architectural plans on transparent paper); the smaller one is restoring mostly book bindings.
Their distinctive characteristic, evident from the beginning, is permanent and practical training at home as well as abroad, while in all this time we still lack universities and undergraduate programmes that would train conservators-restorators of written cultural heritage on paper and parchment in Slovenia.
Their continuous fifty-year long activity places them among important creators of tradition in preservation of written cultural heritage not only in Slovenia but also in wide Mid-European area. Their development is divided into three important periods. The beginnings of the workshop and its development at the Museum of the National Liberation PRS under the leadership of Ljudmila Krese in the years from 1956 to 1974; the preparative arrangements and the actual incorporation within the Archives of the Republic of Slovenia under the leadership of Nada Čučnik Majcen in the years from 1975 to 1983, to a period of intense development that set in under the leadership of Jedert Vodopivec in 1990.

The beginnings of the restoration workshop under the leadership of Ljudmila Krese (1956-1974)

It is understandable that the beginnings of the restoration of the written cultural heritage in Slovenia were largely influenced by the European restoration tradition, which has formed relatively late, at the end of the 19th century[1], but has existed on a distinct way since the great catastrophic in 1966, when the river Arno in Florence burst its banks and flooded the famous galleries, libraries and archives and destroyed, by the expert estimation, from 3 to 4 million books.
The rescue workers were forced to use all their knowledge and thereby introduced many new methods. Otherwise the restoration workshops around Europe, except Italy[2], were established in the 1940s and 1950s of the past century.

The first workshop or better put laboratory in the former Yugoslavia was established in 1949 at the Institute for Preservation of Cultural Monuments in Serbia.
Ljudmila Krese, chemistry graduate at Technical undergraduate school, boldly began the conservation work at the Museum of national liberation PRS (today Museum of Modern History of Slovenia). In all those years there were never more than four restorers restoring the written heritage, the other restorers were restoring mostly museum pieces.
The work was compromised by damp and dark workplace situated on the ground floor of the Museum, as well as expensive and difficult of access imported durable materials.
The problem also concerned the museums, libraries and archives, the ones who ordered the restoration work, who also very often could not afford to cover the costs of materials, much less the restoration work itself.
In spite all of that they tackled the difficult task of restoration of older archival and library materials. And in the late 1960s they were already restoring older materials for most Slovenian archives, museums and libraries.

The preparative arrangements for the incorporation within the Archives of the Republic of Slovenia under the leadership of Nada Čučnik Majcen (1975-1983)

Long lasting and steadfast endeavours of Nada Čučnik Majcen, the new leader also a graduated chemist, were repaid after the

1. Dr. Franz Ehrl, Prefect of the Vatican Library, gathered librarians of the European Libraries in 1898 in St. Gallen in Switzerland due to problems concerning preservation of the written materials; the same problem was also discussed by German archival workers in Dresden in 1899.
2. A renowned Central Institute for the Pathology of the Book in Rome was established in 1938 and is still active.

workshops incorporation within the National Archives. On January 1st in 1980 the workshop at last joined the Archives and began to function as its working unit.
On the model of similar workshops found in Munich, Rome, London and Vienna, they modernized their laboratory equipment. They were given a renovated ground floor of the Gruber palace with approximately 170 square metres of working space and 25 square metres space for a repository.
In a relatively short period while being a leader of the workshop, Nada Majcen laid firm foundations and guidelines for further development. As the head of the Committee for Conservation and Restoration of Archival Material at the Yugoslavian Archivists Association, she re-established relations with Yugoslavian conservatories, and as a member of the International Archival Council[3] she also promoted an active affiliation of Slovenian conservators of written heritage to international expert public. Under her leadership the successful cooperation with the Pulp and Paper Institute in Ljubljana began.

Development of the central Slovenian restoration workshop under the leadership of Jedert Vodopivec from 1990 onwards

Improved working conditions contributed to a fresh professional impetus to achieve considerable working results. From here a lot of effort was dedicated to education: by entering undergraduate University programmes the restorators acquired higher professional qualifications, and were the organizers of their own courses and practical workshops. Since 1993 the workshop has been the main teaching base for Slovenian conservators-restorators of the written heritage where they could acquire demanding specific practical and theoretical expert knowledge.
Deservedly Jedert Vodopivec, also of chemical profession, and two of internationally renowned experts passed their expert knowledge and experiences on to them. A Slovenian conservator-restorator of paper objects working at the Gallery of Modern Art in Rome, Karmen Čorak Rinesi introduced restoration techniques for artworks on paper to them, while an Oxford professor, Christopher Clarkson, an internationally renowned expert on medieval books, gave them useful knowledge on medieval codices. He is also known as one of the most cited author on medieval book bindings.

In the past decade they have proved themselves as excellent organizers of three symposia, two of them with an international attendance and as organizers of several professional education courses. In 1996, while celebrating their 40th anniversary of activity, they exhibited documents to warn about the causes of decaying and to present the methods of restoration. This occasion coincided with the international symposium entitled "Book and Paper Conservations" where experts in the fields of humanities and natural science dealt with the same problems in detail. In 2003, at the annual Board of Preservation meeting that works within the International Council on Archives (ICA/CPTE) renowned international experts discussed the problem of handling the written documents being exhibited too often nowadays at the symposium entitled "Exhibiting Archival and Library Material and Works of Art on Paper".

At the celebration of the 50th anniversary of activity, in 2006, acknowledged Slovenian experts presented the perils of the effect of light on cultural heritage at an interdisciplinary conference ("Light and Cultural Heritage"). Proceedings of all the above mentioned symposia (international editions were published in English and Slovene languages) have brought the scientific results nearer to a wide circle of readers (general public) and they also serve as textbooks for Slovenian conservators-restorators. It is the same for a pioneer work on medieval manuscript book bindings written by Jedert Vodopivec, which was published in 2000 at the Archives of the Republic of Slovenia, contributing to an absorbing knowledge on the history of book binding and to the establishment of the terminology, concerning the conservation of medieval and modern books.
With scientific research methods, carried out in cooperation with various university and scientific institutions, they also investigate the mechanisms of paper ageing, perform indestructible, spectroscopic process analyses on the object surface, and later on apply their research results in practical work.

Conservators-restorators of the written cultural heritage at the Centre for Conservation and Restoration at the Archives of the Republic of Slovenia consider the official standpoint of the international organizations in their work and also of national professional associations. They conserve the documents, meaning, they are trying to slow down the process of ageing and further disintegration or with minimal conservation interventions give them back their form and functionality. They document exactly every intervention made. Curators and guardians of the documents are informed of the procedures in advance; they also receive recommendations on safe storing, exhibiting and transportation.

Conclusion

The fifty years of activity of the Centre for Conservation and Restoration, summarized, could be described in this few words. From its relatively humble beginnings it has evolved into a central Slovenian restoration workshop. The main motive of success for conservators-restorators are their professional ambitions, throughout so characteristic. Professional problems are resolved interdisciplinary; they compare their know-how with the practical work and experiences abroad; their research results are introduced by publishing in professional national and foreign publications.
Their half a century long working tradition is not just a confirmation of a quality work done, but an invaluable asset for their further development.

3. She was a member of the Committee in years 1976 - 1983.

Book Conservation Training with Prof. Christopher Clarkson

by Dr. Jedert Vodopivec
Head of Conservation Department, Archives of the Republic of Slovenia

In January 1995 Prof. Clarkson was the first to confirm his participation at the "Book and Paper Conservation" international conference that was held in 1996, in Ljubljana, the capital of Slovenia (ex northern part of Yugoslavia). He did it without asking a single question about security issues that due to the ongoing war in Bosnia at the time might have been a source of concern to many other people. The conference was organized to celebrate the 40th anniversary of the Book and Paper Conservation Centre at the Archives of the Republic of Slovenia and C. Clarkson contributed with the paper "The safe Handling and Display of Medieval Manuscripts and Early Printed Books".

Although my initial intention was to improve the field of written heritage conservation by organizing practical workshops on book and paper conservation, it soon turned out that it would be easier to raise funds for hosting an international conference than to organize practical training sessions. But the wide acceptance and national and international response convinced Vladimir Žumer, at the time director of the Archives of the Republic of Slovenia (ARS), to support my secret project – a practical workshop for my staff – the following year. Prof. Clarkson responded favourably to the invitation to lecture and lead these practical workshops that were much needed among book conservators. From this beginning a sequence of seven two-week practical and theoretical workshops, at the Archives of the Republic of Slovenia, was developed under the guidance of Prof. Clarkson. The first five workshops were organized together with the National and University Library and the last two with the Conservation Department of the Academy of Fine Art and Design of the University of Ljubljana. Between these two groups of workshops there was also the second conference "Exhibiting archival, library and works of art on paper and parchment" in July 2003 where Mr. Clarkson participated with the paper "The Permanent Display of the Single Parchment Membrane in Fluctuating Environmental Conditions: from Small Charter to the Mappa Mundi".

1. 1997, October 20-30, workshop "Conservation principles and practices based upon late medieval stiff-board bookbinding construction"
2. 1998, November 30 – December 11, workshop "Limp vellum bindings"
3. 1999, November 8 – 19, workshop "Minimum conservation interventions in treatment of parchment and books"
4. 2000, October 16-27, workshop "Housing and Mounting of single parchment membranes and design and construction of protection for library and archive objects"
5. 2002, November 18-29, workshop "The preservation and conservation of albums, scrapbooks, specimen-books and guard-books"
6. 2005, November 10-25 "Conservation of medieval manuscript and incunabula"
7. 2008, November, 3-14, "Limp and semi-limp vellum and paper bindings"

All seven workshops and two symposia have improved the theoretical and practical knowledge among our conservators-restorers, with the workshops being particularly useful. The participants were conservators-restorers permanently employed in the Archives of the Republic of Slovenia and the National and University Library and all those who were at the time temporarily or by contract employed by conservation departments of both institutions. Apart from practical demonstration, Prof. Clarkson always incorporated in his workshops relevant historical background on materials and tools as well as modern innovations. At each visit he also gave a public lecture to the students of the University of Ljubljana.

The last workshop focused again on limp and semi-limp vellum bindings. The main reason was that this type of binding is not, at present, an accepted conservation subject. As limp bindings are often present in 16th and 17th century archival and library collections, we decided to consolidate the knowledge as well as to extend it to paper bindings.
This last workshop with 23 participants was the largest ever held at the Archives RS and had international attendance from the Czech Republic, Croatia, Lithuania, Italy, Hungary, Serbia and Slovenia. Participants were introduced to the variety of structural types of limp vellum and paper bindings used in the 16th and 17th centuries and studied and practiced a few. The first week ended with a demonstration of the parchment making process by Mr. Marjan Petač at his Goričane workshop near Ljubljana. As the topic of this seminar was also limp paper bindings, we had the opportunity to host Mr. Jacques Brejoux, from Moulin Du Verger in Puymoyen near Angouleme in the Cognac region of France, for two days. Over the past 30 years he has been making hand-made paper based on techniques that were used in paper making before the 18th century and at present with Mr. Clarkson he is developing a cover paper based on those superb papers produced around 1500 for the Venetian and Florentine republics.

After hosting all seven workshops, which were extremely intensive for all the participants as well as for the organizers and for Mr. Clarkson himself, we may definitely say that all participants over the years started to understand (and some even to fully adopt) the philosophy of book conservation which is based upon understanding materials and structures, and not upon

the last two centuries of European bookbinding craft and rebinding "fashion".

The term "conservation" started to be applied to books during all the activities in the Biblioteca Nazionale Centrale, after the Florence flood (1966) mainly by C. Clarkson. His intention was to show a distinct philosophical and practical break with the hand binding and tradecraft tradition of the past three centuries. In fact the word "conservation" was limited to the world of art and museum objects, it is only in the past few decades that it has been used in connection with library and archive heritage.

Christopher Clarkson (graduated in 1964 from the Royal College of Art and Design) began his conservation career by being in the first team of conservators that went to Florence in 1966 in order to save the flood damaged written heritage. During this period Mr. Clarkson started his basic research, studying medieval bookbinding structures, and also became fascinated by the limp vellum and paper binding structures that had survived the initial damage and urgent treatments and handling directly after the Florence flood.

After studying period bindings for many years, Christopher Clarkson still admires the early 16th century limp vellum bindings. Coming as they do at the very end of a long period of creative book construction, it is a positive statement that embeds good structural and conservation principles. This binding type can contribute greatly to a sound training, for as he states in his book (*Limp vellum binding and its potential as a conservation type structure for the rebinding of early printed books*): "… the limp vellum binding is the only type of all the historical and new ways of binding, which will, to the sensitive observer, show up faults in material choice and technique most readily…" In studying binding collections it is clearly evident that materials and structure started to decline in quality from the mid 16th century, such traits are emphasized by the seemingly simpler limp and semi-limp vellum binding structures, thus they have good training potential, particularly those before c. 1530.

Prof. Clarkson's research and practical work, with numerous written papers, has enormous significance for book conservation worldwide. Today Christopher Clarkson is a world renowned expert on conservation of archival and library material and encompasses incredibly detailed theoretical and practical knowledge of the subject. In his distinguished career, with his remarkable knowledge, extensive experience and his own engineering approach he has managed to develop and make practical application in almost all major areas of theoretical and practical education in the field of conservation, exhibition and handling of books. Many revolutionary approaches that younger generations of book conservators take for granted are actually the result of his research and application into good conservation practice.

In his more than 40 year career, Prof. Clarkson devoted himself to the study of book conservation. Due to his efforts in conservation and his teaching skills he has been, and still is, regularly invited by many renowned institutions and centres to help increase their knowledge and strengthen their skills. His teaching, innovation and numerous articles have had a profound effect on understanding book structures. However, his main contribution is undoubtedly that of abandoning the rebinding practices based on bookbinding tradition of the 19th and 20th centuries and application of expert and scientifically grounded principles of conservation to the area of the book. He has influenced conservators' worldwide including Slovenia.

This November Mr. Clarkson concluded his seventh workshop and ninth working visit to Ljubljana and the Archives of the Republic of Slovenia. I'm sure that anyone who has had a chance to participate in even one workshop with Prof. Clarkson has been infected with a different and most of all wider conception, of what is still today, a rather unfamiliar (unknown) area of book conservation.

Fig 1. Participants of the Ljubljana 2008 workshop "Limp Parchment and Paper Bindings" with Christopher Clarkson and the organizer Jedert Vodopivec in front the National Archives of Slovenia.

News

New Pac Regional Centre in South Korea

The PAC Core Activity has just created a new regional centre for Korea, based at the National Library of Korea in Seoul.
The Director of PAC Centre for Korea is: Gui-Won LEE, director of KRILI (Korea Research Institute for Library and Information).

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Publications

The Digital Print, Identification and Preservation, by Martin C. Jürgens, Getty Conservation Institute, August 2009

This invaluable resource demystifies the complex, rapidly changing, and sometimes confusing world of digital print technologies. It describes the major digital printing processes used by photographers and artists over the past forty years, explaining and illustrating materials and their deterioration, methods of identification, and options for acquiring and preserving digital prints. A removable poster provides a ready reference for identifying specific processes and materials.
Anyone involved in identifying and preserving digital prints – from conservators, curators, archivists, and registrars to photographers, artists, and printing studios – will welcome this comprehensive, one-of-a-kind volume.
Martin C. Jürgens, a conservator of photographs in private practice in Hamburg, Germany, specializes in the conservation of historical and contemporary photographic materials and digital prints.

The Digital Print, Identification and Preservation
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$60.00
Available August 2009
http://www.getty.edu/bookstore/titles/digital.html

Events and Training

Announcements

iPRES 2009: the 6th International Conference on Preservation of Digital Objects, 5-6 October 2009, San Francisco, USA

The California Digital Library (CDL) is pleased to host this year's International Conference on Preservation of Digital Objects (iPRES 2009) at Mission Bay Conference Center in San Francisco on October 5th and 6th, 2009.
iPRES 2009 will be the sixth in the series of annual international conferences that bring together researchers and practitioners from around the world to explore the latest trends, innovations, and practices in preserving our scientific and cultural digital heritage.
The promise of digital preservation will be realized when it is truly integrated into the mainstream of digital scholarship, culture, and commerce. iPRES 2009 will continue the discussion of creating our digital future.

The theme of the iPRES 2009 conference is "Moving into the mainstream, enabling our digital future", which is intended to spark discussion of:
- Re-positioning preservation awareness and services further upstream in the digital lifecycle so that "born-archival" replaces "born-digital" as the norm;
- Re-emphasizing that digital preservation problems and solutions encompass legal, economic, and social as well as technological dimensions;
- Re-asserting the need for comprehensive integration of preservation analysis and activities into the organizational planning and operations of institutions that produce, manage, or exploit digital resources;
- Bringing preservation issues to the attention of the broader public in order to change minds, policies, and expectations;
- Stressing the importance of seeing digital preservation as an outcome resulting in usability.

Information about registration will be posted soon at:
http://www.cdlib.org/iPres/index.html

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http://www.cdlib.org/iPres/index.html

DISH2009, 8-10 December 2009, Rotterdam, the Netherlands

Digital Strategies for Heritage (DISH) is a new bi-annual international conference on digital heritage and the opportunities it offers to cultural organisations. Triggered by changes in society, heritage organisations face many challenges and need to make strategic decisions about their services.
DISH2009 aims at sharing knowledge about and experiences with digital strategies. What roles do cultural heritage institutions have in a networked society? What is the impact of digitisation on these organisations? Why are certain digital services more successful than others? Which business models are suited to the cultural heritage sector? Why would archives, museums and libraries co-operate? These are some of the questions that will be addressed in keynotes, presentations, debates and workshops.

The conference will be for all staff of cultural heritage institutions that are responsible for policy issues and/or management of digital collections and services. The conference will enable participants to learn more about strategic decisions on all aspects of digital heritage services.

DISH2009 builds on a series of successful national conferences in the Netherlands (2004-2008). The main organisers of the conference are the Netherlands Institute for Heritage and the DEN foundation. The Programme Committee consists of representatives from Europeana, the Association of European Research Libraries LIBER, Flemish interface centre for cultural heritage FARO, Virtueel Platform (Netherlands Sector Institute for e-culture) and the EU-project PrestoPrime.

You can find all the information regarding the call for paper, programme and registration at: http://www.dish2009.nl/

"Cultural heritage online. Empowering users: an active role for user communities", 15-16 December 2009, Florence, Italy

Following the success of the previous conference in 2006, Fondazione Rinascimento Digitale, Ministero per i Beni e le Attività Culturali and the Library of Congress are delighted to announce that the 2nd "Cultural heritage online" conference will be hosted by Teatro della Pergola in Florence in December 2009. This conference aims to explore, analyze, and evaluate the state of the art and future trends in user communities and cultural contents on the web from an international perspective.

Internet continues to have an impressive impact on cultural heritage and humanist communities by affecting the way they work, use, exchange and produce knowledge. New architectures and radically different paradigms arise continuously engendering a deep rethinking of traditional roles and tasks. Though a continuous increase in ICT use has spread in the cultural heritage community, cultural institutions have been slower to adopt new technologies for cultural, economic and organizational reasons. Today it seems that users not only are able to adapt to technological changes faster than cultural institutions, but they are also driving innovation, by proposing new ideas and building up new paradigms of knowledge production.
Nowadays innovation is coming from the users, whereas in the past they were the recipient. In order to keep abreast of the rapidly growing technology trends, archives, libraries and museums must be more involved in the dialogue between ICT developers and final users, starting from the way cultural institutions create and share digital resources.
The conference will start on the 15th of December with keynote lectures that investigate user needs and expectations, analysing how to better involve users and the cultural heritage community in creating and sharing digital resources. Special attention will be devoted to the viability of a sustainable approach for the long term preservation of digital contents from the user perspective. The focus will not be on specific detailed technology aspects but rather on real benefits and practical opportunities, evaluating limits and risks, for both users (e.g. researchers, students, tourists and citizens), and cultural institutions.
The plenary session on the 16th will start with the presentation of national and international scenarios, followed by two thematic sessions with scientific speeches selected through a Call for Papers, that will ascertain the advancement of the research on the relationship user-institution towards the development of cooperative Web 2.0 tools and on sustainable digital preservation policies.

Main Topics
- Cultural heritage and interactive Web
- Digital libraries
- Digital humanities
- Cooperation among museums, archives, libraries
- Digital preservation

Who should attend
- Cultural heritage institutions administrators and curators
- Digital humanities researchers and students
- Cultural tourism operators
- Professional associations in the fields of museums, archives, libraries
- Funding agencies
- Technology providers and developers

Programme at: http://www.rinascimento-digitale.it/conference2009-programme.phtml

More information at: www.rinascimento-digitale.it/conference2009

Contact: info@rinascimento-digitale.it

Reports

Report from "Advances in Paper Conservation Research" conference, 23-24 March 2009, British Library, London, UK

In 2005 the Andrew W. Mellon Foundation awarded the British Library the largest grant ever for library and archive conservation research in the UK. The $695,000 grant has been used to establish the Identical Books Project, a study into the deterioration of paper and books in the six UK legal deposit libraries and two UK national archives.
The Advances in Paper Conservation Research Conference marked the end of this three year project. The conference brought together the project collaborators including expert researchers from around the world, 16 speakers and over 100 attendees. The break times had a vibrant buzz, with many contacts and new ideas emerging.
The first day reviewed the context of research in libraries, archives and the wider scientific movements. Helen Shenton, Stephen Bury and Dr Barry Knight outlined the status of cultural heritage research in the UK and the British Library. Dr Jana Kolar and Dr Henk Porck gave similar insights into the European research environment. Dr Fenella France initiated discussion on environmental standards for the care of books and other cultural materials, which led onto contributions by Velson Horie, Dr Jana Kolar and Dr Matjia Strli on the data collected on the condition of the Identical Books and their storage environments.
The second day looked primarily at the development of methods for evaluating paper, books and their environments. Dr Lorraine Gibson, Dr James Lewicki and Dr Steve Hobaica explored the measurement of volatile organic compounds emitted from books and paper and their potential for non-destructive monitoring of condition. Dr Robbie Goodhue examined many different ways of monitoring the storage environment and what this means to collections. Dr Dirk Lichtblau and Dr Matjia Strli described a newly developed tool, SurveNIR, which uses near infra-red spectra to estimate important paper properties non-destructively. Giordana Santoro described how the staff in the legal deposit libraries came together to gather the Identical Books data while Velson Horie outlined results and conclusions drawn from the data. Dr Masazumi Seki described the properties of matching copies of Identical Books and methods of strengthening paper.

The conference concluded with a round table evaluation of the achievements and ways forward for conservation research. Three lessons of the project stood out:
- Collaboration between collections institutions, researchers, and innovative companies had created synergies and new opportunities. A number of significant players represented in the audience supported a call for a new wave of joint work.
- Volatile organic compounds will be further investigated for non-destructive characterisation of books, including development of the "nose". This will build on the tested partnerships to develop research proposals and attract funds.
- Collections that have been well characterised will be used for investigation of long term studies of change and the response to their environment. There is already commitment from holding institutions in the UK and North America to share in the data gathering tool being provided by the Library of Congress.

The proceedings are published on the web at: http://www.bl.uk/aboutus/stratpolprog/ccare/events/index.html#Advances
and printed:
C. V. Horie (ed), *Advances in Paper Conservation Research*, British Library (2009)
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It is available from:
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Report from the International Newspaper Conference on "Legal Deposit of Newspapers for Libraries: Challenges of the Digital Environments", 13-16 April 2009, Red Palace Moscow and Mozhaisk, organised by the Russian Book Chamber Moscow, IFLA Newspapers Section and IFLA-PAC

By Else Delaunay

Invited by the Russian Book Chamber (RBC) the Conference took place near Mozhaisk (100 km southwest of Moscow) where RBC's vast collections, especially the

The Red Palace, head office of the Russian Book Chamber, Moscow.

newspaper collection, are preserved in two new buildings with fine preservation conditions. A detailed visit to the site was planned on 16th April. The RBC was founded in 1917. Most items are received by legal deposit of which the RBC is responsible within the Russian Federation. The Chamber's Bibliographic Centre is an independent State institution responsible for the National Russian Bibliography.
The Conference was hosted in a centre outside Mozhaisk where all the necessary equipment was available. Around 40 delegates from Russia, Moldavia, Ukraine, Belarus, attended the Conference as well as 10 from Western Europe and the United States. 13 papers were given during the 2 days conference as the colleagues from Kyrgyzstan and Kazakhstan were not able to attend. Discussions following each presentation were facilitated very much thanks to the excellent IFLA interpreter, Eric Azgaldov.
After a general presentation of legal deposit of newspapers and the collection building, Hartmut Walravens, chair of the IFLA Newspapers Section, turned over to the future. There are several options: digitising and availability of a long term archival system of the enormous amount of electronic files; microfilming for long term preservation; contact with great providers (as Google) being then very careful when preparing specifications and conditions.
Edmund King, secretary of the IFLA Newspapers Section and head of the British Library Newspaper Library, underlined how important it is to preserve the digital data of newspapers. He also introduced the British Library digital library which should include all kinds of electronic items as well as the web archiving.
Alexander Dzhigo, deputy director of the RBC and Konstantin Sukhorov, director of the Department for the National Bibliography, gave a presentation of all the activities dependent on the Newspaper Collection kept by the RBC. Since 1980, the Russian National Bibliography includes some 4.5 million bibliographic records. Thanks to the Legal Deposit (in Russia before publication) the RBC receives daily electronic data of 300 bibliographic records of books, 500 of periodical articles and 120 of newspaper articles.
Several papers dealt with book chambers in Ukraine, Moldavia and Belarus and their newspaper collections as well as the bibliographic work on these items.
Miranda Remnek, professor at the University of Illinois insisted on the archiving of digital newspapers which should be available in the long term considering their importance for researchers.
Else Delaunay talked about legal deposit in France of electronic files of regional newspapers prior to printing. Some experiments have been going on but failed finally. Actually a single title is concerned: *Ouest France* according to an agreement in 2006 between Ouest France and the Bibliothèque nationale de France.
Fredrick Zarndt, head of the Planman Consulting Inc., Coronado, USA, gave 2 papers: one about access policy and strengthened copyright, a technical presentation. The second one was a paper in cooperation with 4 specialists among whom Henry Snyder, professor at the University of California Riverside and member of the IFLA Newspapers Section. This paper introduced an architecture for born-digital newspapers in PDF format ready for printing. This format is compatible with most of the already existing formats, widely used for digitisation of historical newspapers (not born digitally). The architecture is developed according to newspaper models METS/ALTO used by libraries worldwide, thus facilitating the use of already existing delivery software to which you add some minor modifications. Each format, each addition, each digitisation programme mean a challenge of which the issue is important. There is an urgent question: which future for our digital past? It was indeed a very good paper providing some clear and rather easy solutions.
At the end of the second day it was decided to set up the Resolution of the Conference. The papers should be published soon in the IFLA Publications Series.

See also: www.ifla.org/en/newspapers

Russia PAC Regional Centre in the limelight

by Christiane Baryla, IFLA-PAC Director

Taking the opportunity of the annual International Newspaper Conference organised by the very active IFLA Newspapers Section and cosponsored by IFLA-PAC, I had the great pleasure to visit IFLA-PAC Regional Centre in Moscow, hosted by the beautiful and efficient **Library for Foreign Literature**.
I was welcomed by our colleague and PAC regional Director **Rosa Salnikova** and met the well-known Library Director, **Ekaterina Genieva**.

Rosa Salnikova, Irina Shilova and Christiane Baryla.

PAC Russia, one of the first PAC centres created, is in charge of a very large area from European Union eastern boundaries to Asia borders.
Managed by Library Head of Preservation, Rosa Salnikova, it is supported by the Preservation and Restoration Department. Furthermore, I would like to thank a lot Ekaterina Genieva, the Library Director, for her unfailing support since the beginning.
My visit had several purposes. It was my first visit in Moscow and even if I met Rosa before on the occasion of several IFLA events, it was quite important for me to discover PAC offices as I did it before in Japan, China, Chile, South Africa and Benin. The department of Preservation is well equipped and has an important know-how in restoration. What interested me a lot was the links with other structures in Russia particularly in terms of training. I visited Suzdal School in Restoration where Rosa Salnikova is consultant. The School works not only in the field of books but also paintings and arts. It is a good example of convergence in preservation and restoration for museums, archives and libraries.

Besides the visits, we met to discuss PAC Russia activities. PAC Russia disseminates IPN and our publications and translates in Russian summaries and articles on request. I often insisted on the role of translation for the centres as it is the only way to spread information to all our colleagues. English is not understood everywhere and I still insist a lot on the importance of languages if we want to communicate genuinely.
Rosa Salnikova also attended conferences on Preservation, generally on traditional restoration in or out Russia. It was the case for the International conference "History of the Book Collection of Princes Esterhazi", at the National Library of Hungary in Budapest.
Training is another key word in our network: Rosa managed a master-class on book repair during the IV Moscow International Open Books Festival. She also trained staff from Museums (Moscow, Tula, Suzdal) in the restoration of collections from the end of the 19th century.
Obviously she is called for as expert for preservation issues by different Russian institutions and she regularly organizes special visits in the field of restoration.
The last part of my visit was dedicated to a more general meeting with Director Ekaterina Genieva and her colleagues in order to discuss the possibility of organizing events next year in the PAC area. We are thinking about a conference project in Kazan. My comment is that it is really important to propose events, locally, when it is possible. And I was happy to share with Dr Genieva the same points of view about what would be PAC activities at an international level.
I congratulate the PAC Russia, knowing how difficult it is to work internationally in a context of crisis.

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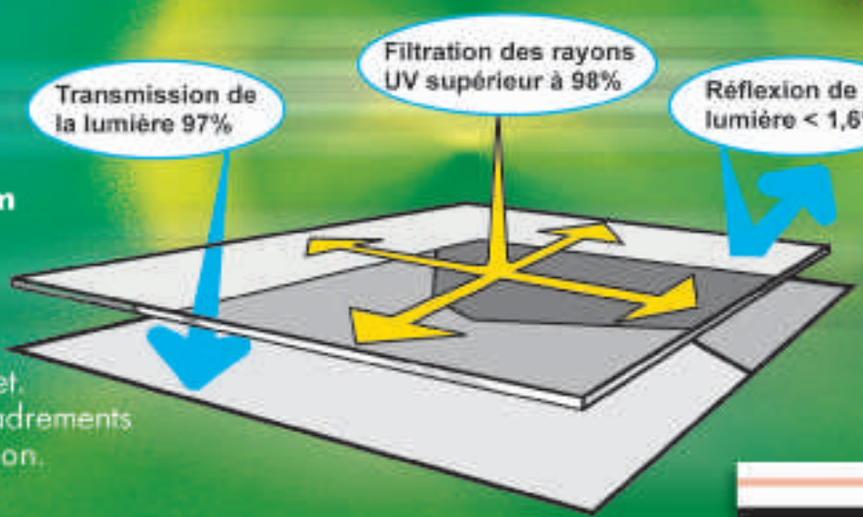

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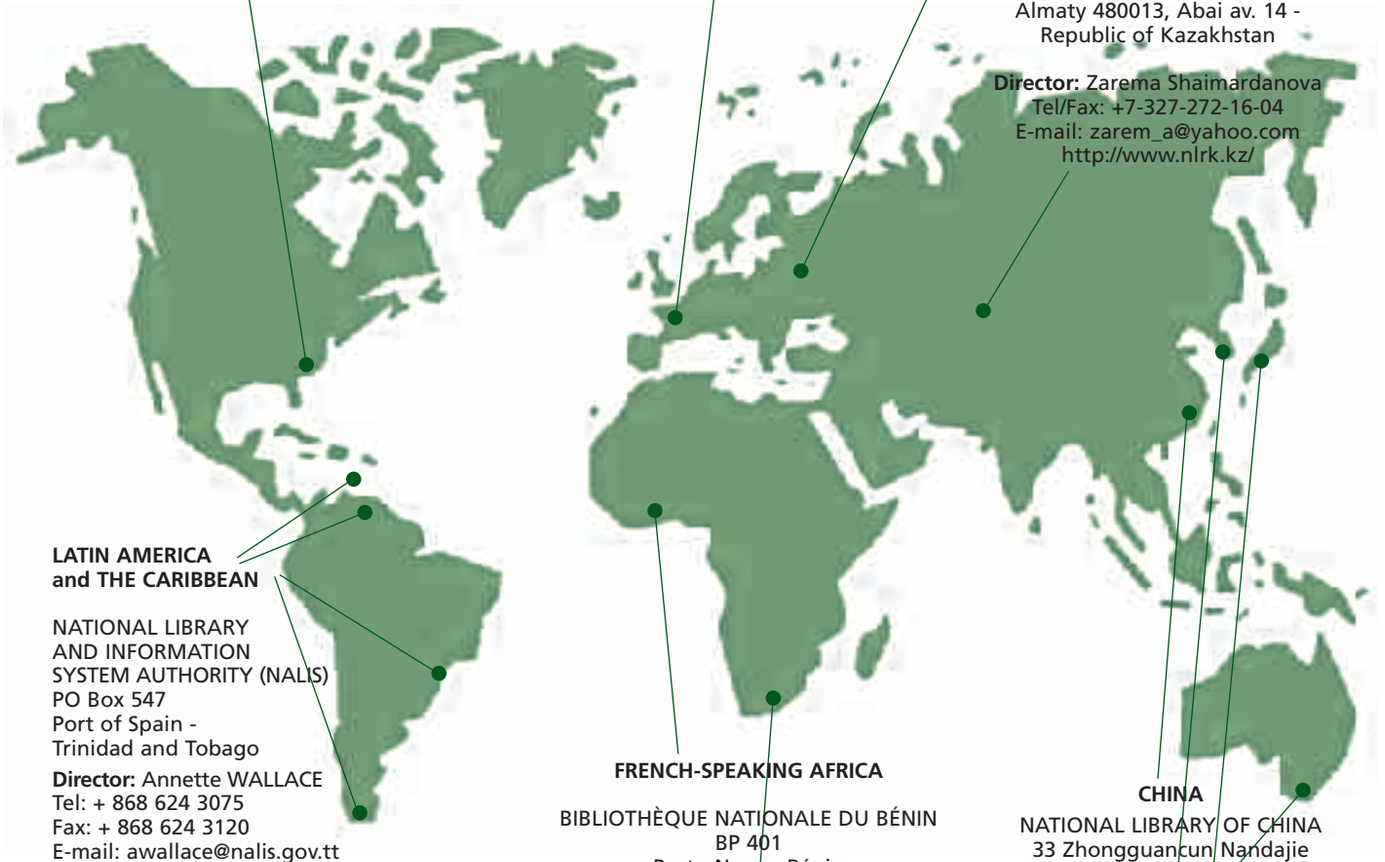

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