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SOME ASPECTS CONCERNING THE DURABILITY OF OLD PAPER SUPPORT DETERIORATED BY SOCIAL FACTORS

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Abstract

Abstract

This paper aims to highlight the damages of books and documents caused by social factors. Taking into account examples from our activity, in this paper are presented different types of damages and a short presentation of possible conservation interventions on such documents affected by social factor. Experimental part includes also a study about the durability of old paper deteriorated by social factors using FTIR spectroscopy.

Keywords: old papers, social factor, durability, empirical restoration, scotch tapes

1. Introduction

The influence of environmental effects on cultural heritage is a main preoccupation of world researches in conservation and restoration domain.

It is known that old book's conservation state is determined both by internal factors, like materials and technologies used for its realization, and external factors such as environment, storage conditions and handling. Old books and documents could be affected by improper air quality and other environmental condition, such as high relative humidity and temperature, excessive light, which often lead to the breakdown of constitutive materials of book collections. Our previous studies have been focused on environmental factors that contribute to deterioration processes of the constitutive materials of old books [1-3]. Other important books' deterioration sources are biological factors (microorganisms, insects and rodents), chemical factors and disasters [4].

However, there are some others factors that accelerate deterioration of library and archival materials, which are usually neglected in the literature, such as various human activities, social and cultural uses, management and institutional factors etc. Human beings are one of the biggest enemies of old

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documents, who damage it inadvertently or deliberately [5]. It has been shown that precisely those cases, seemingly minor, contributed largely to the deterioration of books [6, 7]. Some authors affirm that mechanical damage to books includes the human factors and natural disasters [8].

Old books are usually composed by different materials: cellulosic based materials (paper, wood, linen) and protein based materials (leather, parchment). Each of these materials can be seriously affected by social factors.

Based on the activities of our laboratory, this paper aims to highlight the damages of books and documents caused by social factors, possible restoration conservation interventions on documents affected by social factors and some aspects concerning the durability of old paper deteriorated by social factors using FTIR spectroscopy.

2. Theoretical part

Social factors that contribute to the deterioration of old books are presented in this part. Voluntary or not, often people can cause significant damages to the book collection of libraries and archival documents. A proposal for classifying the social factors was presented in a recent study [9] and can be listed as follows.

2.1. Inadequate handling and storage

Inadequate handling and storage of books, especially old hardcover books, contribute to deterioration. Frequently, books are removed from the shelves by pulling the grad cap (the upper end of the spine). This kind of inadequate handling may cause over time the following effects on the old books: the break of the top, the stitch sheets damages, the partial or total detaching of the spine and even the leaves detaching from block book (Figure 1).

Deformations of the book cover appear at forced insertion of books on the shelves. It is known that inadequate photocopying causes damages to the spine. Opening a book too far can cause fail the glue and the detaching of sewing thread of the bookbinding. Overcrowding of books in warehouses, books extend beyond the edges of shelves, poorly installed or improper sized shelving and shelves made of acid-generating materials are other causes for books deterioration.

2.2. Inadequate actions of library users and library staff

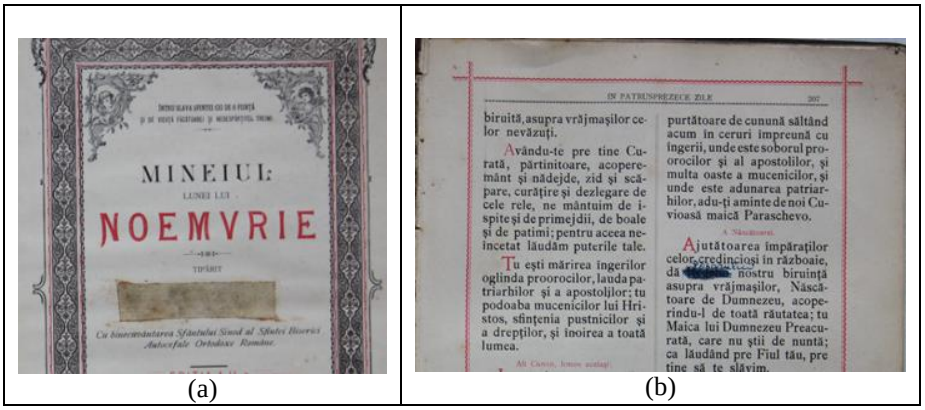
Sometimes, library users badly manipulate the books and make annotations with explanations and translations, underlining and staining with ink the paper support. Over time, marking with inventory data, stamping and using of paper clips and staples for fixing the detached leaves was made by library staff. This category also includes the improper packaging and transporting of library materials for exhibitions [10].

The effects on old books materials of these inadequate actions are diverse. So, ink may be acidic or water-soluble and can cause an increase of paper acidity, respectively the migration of inks under air conditions with high level of relative humidity. Annotations with ball pen or chemical pen and stamps may affect the text readability. Inadequate practice of books left open on the reading table, face downwards, causes weakening of book bindings [4, 10].

Touching block book with bare hands can leave irreversible fingerprint stains on paper. Frequent and careless consultation, reading while drinking or eating, using the dirty hand to manipulate the corners of the leaves, folding the corners or using the metallic corroded paper clips lead to staining and fragmentation of paper support.

(a) (b)

Figure 1. Effects of inadequate handling: (a) the break of the top, (b) the partial detaching of the spine.



(a) (b)

Figure 2. Vandalism acts on old books. The covering of the references to the royal Romanian family with: (a) scotch tape and (b) thick layers of ink.

2.3. Inadequate actions of other books users

Old church books have sometimes wax deposits and stains or oil stains, because, in old time, lighting in church was done by wax candles or oil lamps.

Wax and oil cause changes in the aesthetic aspect of the paper and increase its susceptibility to biologic attack.

2.4. Vandalism

Examples for vandalism acts on old books and documents are the cutting of leaves or colouring of images or texts, deliberately made by unknown persons. The aversion to previous monarchy period in the time of Romania communism leaded to vandalism practices like covering of names or references to the royal family with labels, scotch tapes or thick layers of pencil or ink (Figure 2).

2.5. Empirical restorations and faulty repair

Many years ago, restoration of artworks has been empirical rather than scientific practice. A proposal for classifying the empirical restoration is listed below.

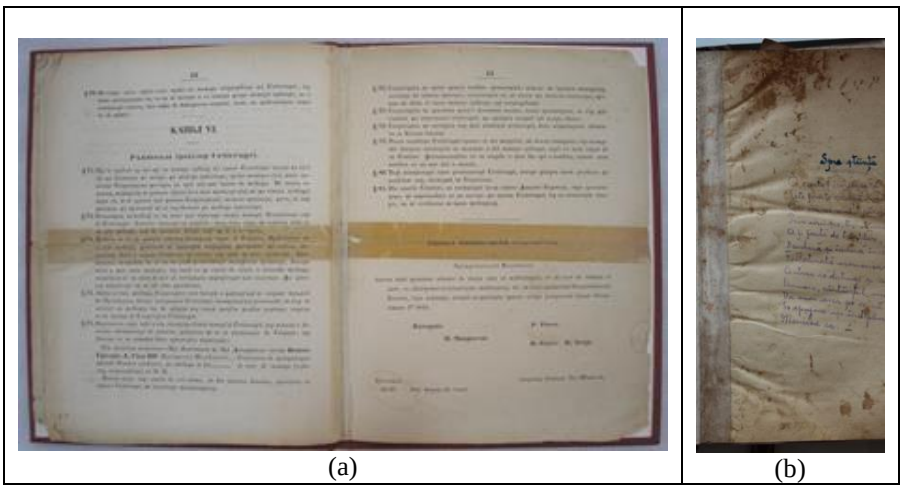
- Restoration and conservation interventions made by people without the necessary studies or without observing the principles of restoration: loss or modification of the original book cover or stitch, loss of the inscriptions documentary value. These may lead to material degradation of the book or document or partial or definitive loss of information.
- Restorations carried out by excessive interventions, without respecting the principle of minimum intervention: restoration of stitching without the need, replacement of original covers, dimensional alterations by shrinking sheets, etc. These interventions have led to irreversible modifications of the document.
- Applying aesthetic treatments only: Excessive paper whitening, application of inadequate adhesives, lacquers or protective coatings on the covers, without checking the effects over time, have triggered particularly severe destruction processes.

In this study reference is made to the faulty repairs, most often performed by unspecialized staff with unsuitable materials. It is the classic case of applications of scotch adhesive tapes, with serious effects on the documents. First adhesive tapes (scotch cellophane tapes) were discovered by an engineer at 3M Company, Richard Drew, in 1930. Scotch tapes differ by carrier material and the chemical composition of the adhesive layer. Usually, transparent tapes have a transparent film backing and an acrylic or synthetic rubber-based adhesive. Often used to repair books or documents which present cracks, these tapes cause, overtime, particularly severe damage to the paper support. They lose their adhesive properties, turn yellow, ultimately harden and consequently brittle the paper fibres [11].

The damages caused by adhesive tapes, on medium and long term are the following:

- Yellowing (and oxidation) of affected paper. Adhesive's oxidation causes pronounced yellowing and browning of paper and oxidation of cellulose inside fibre structure. After the ageing, the adhesive dries out, the carrier of tape and fragment of adhesive is detached easily. A small amount of glue remains adherent to the cellulosic fibre, and can't be removed by classical cleaning methods.
- Yellowing (and oxidation) of nearby works. Sometimes, by pressing, the adhesive traverses (migrate) through the entire thickness of the paper sheet and affects also the pages surrounding the area where it was applied.
- Attracting dust by moving the carrier of plastic from its original position. High temperatures cause the moving of tape from where it was placed, leaving behind a layer of adhesive paper. The surface paper becomes sticky and attracts dust. Moreover, the pages of the book can stick together and the detachment of them could lead to serious damage to writing.
- The deformation of the 'repaired' paper. Scotch tape application can cause the appearance of folds of the paper, because of differences in hygroscopic properties and dimensional stability between paper and plastic.

Some effects of scotch tape on old papers are shown in Figure 3.



(a) (b)

Figure 3. Effects of using scotch tapes on old books: (a) browning area of a book page and the neighbouring page, (b) deformations of the original paper support.

3. Experimental

Taking into account examples from our activity, in this paper a short presentation of possible conservation interventions on such documents, affected by social factors is made. Subsequently, an experimental study on the influence of scotch tapes on the durability of old documents is presented.

Samples of old industrial paper (without patrimonial value) containing acrylic scotch adhesive tape were subjected to conservation interventions (mechanical and solvent cleaning). The purpose of these operations has been the removal of scotch tape (composed of a backing and an acrylic adhesive).

The obtained cleaned samples were submitted to thermal artificial ageing (105^oC for 6 days and 105^oC for 10 days). Thermal artificial ageing was performed in a forced convection oven OF-02G.

The two thermal aged samples of industrial paper were analysed by Fourier Transform Infrared Spectroscopy using Vertex 70 Bruker Spectrometer. The IR acquisition was made by DRIFT method. This instrument was equipped with an EasiDiff diffuse reflectance sampling accessory (Pike Technologies, USA). The spectral measurements have been processed with the Spectra Manager. Normalization of the spectra was based on an internal standard. All spectra were recorded from 4000 cm^{-1} to 400 cm^{-1} with 32 scans and spectral resolution of 4 cm^{-1}. The values obtained are transformed to absorbance spectra (log [1/reflectance]).

4. Results and discussion

4.1. Restoration and conservation interventions on documents affected by social factors

Markings without documentary value, written with pencils are removed by mechanical cleaning (abrasion), by using rubbers. The rubbers recommended for these cleanings must have sufficient abrasion force to remove the markings, but should not affect the support and be made of chemically inert materials. The rubbers recommended by conservators are those based on vinyl polychloride because rubber based and cross-linked oils contain sulphur, which causes deteriorations to documents.

Unmarked notes, written with pen or ink, are removed with solvents, as follows:

- ink stains from stamps are removed with a mixture of acetic acid and ethanol,
- pen ink spots are removed with ethanol, dimethylenglycol or polyethylene glycol,
- aniline-based ink stains are removed with ethanol.

For fragile documents, in the absence of a better product, it can be used rubber powder, applied by light rubbing with a textile pad (gauze). Also, it is necessary to remove all residues after the end of the operation. This procedure is not recommended to be applied on fragile, porous, cracked documents.

Wax deposits are removed mechanically; then the stains are washed with solvent: hexane, petroleum ether, toluene, chloroform.

The empirical restorations made with scotch tapes are removed as soon as they are detected, because in the early stages the adhesives are much easier to remove. As the degree of oxidation of the adhesive increases, the more difficult

the work of the restorer becomes. If a recent strip is removed by light heating and mechanical cleaning, an older strip requires removal through the use of solvents (Figure 4).

Unfortunately, the very old scotch bands cause irreversible damages: the film is sometimes easily removed, but the adhesive penetrates the paper structure among the cellulose fibres and becomes impossible to remove it without destroying the paper support. Frequently, in the restoration process, the removal of the adhesive layer from the paper surface is necessary.

(a) (b)

Figure 4. Removal of the scotch tape by: (a) mechanical cleaning or (b) solvent cleaning.

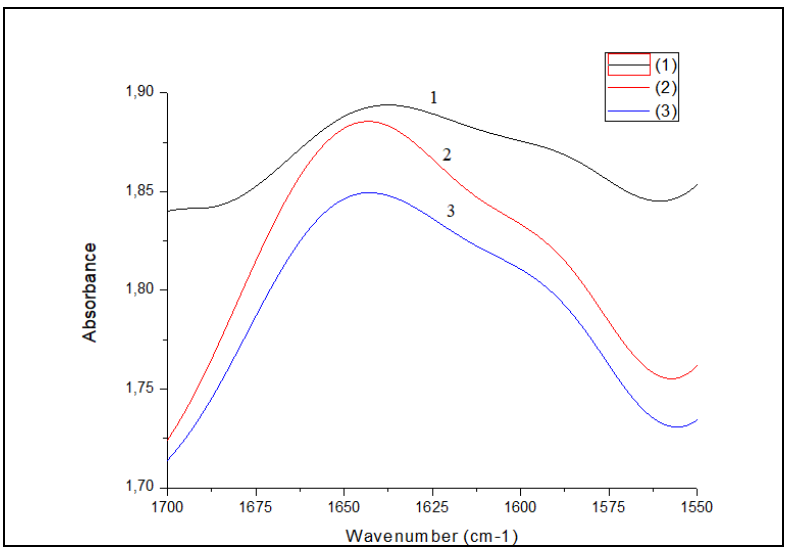


Figure 5. FTIR spectra of the aged industrial paper samples after removing the adhesive: (1) unaged sample; (2) sample submitted to thermal artificial ageing (105^{o}C, 6 days); (3) sample submitted to thermal artificial ageing (105^{o}C, 10 days).

4.2. Study about the durability of old paper deteriorated by social factors

Four main groups of adhesives were differentiated on the basis of the main polymer component – namely adhesives produced on the basis of natural

isoprene rubber, styrene-butadiene rubber, esters and acrylates. With two exceptions, IR spectra of main adhesives allow classification into the mentioned groups [12].

In our previous paper [9] it was shown that all the characteristic groups of acrylic emulsions presented in literature [13] (the frequencies of the C-H stretching bands at 2986 cm^{-1} and 2955 cm^{-1}, the overall profile of the C-H stretching region, C=O stretching at 1732 cm^{-1}, and skeletal vibrations at 1179 cm^{-1}) are still present after removing the acrylic scotch adhesive tape by conservation interventions. In the present study, the FTIR spectra obtained for thermally aged paper are shown in Figure 5.

The study of paper's oxidative degradation involved analysis of the maxima from 1647 cm^{-1}, corresponding to the C=O ($\nu_{C=O}$) [14]. The decrease of the absorption maxima from 1647 cm^{-1}, as a function of the heating time, indicates a reduction of the number of characteristic groups after thermal ageing, which is a consequence of their oxidation. That means the restored cellulosic material with adhesive traces suffers some oxidation processes at thermal aging.

5. Conclusions

It can be concluded that the conservation activities on books and documents are frequently affected by the effects of social factors. Teaching the users is significantly important, so that those damages will not occur again. This will avoid annotations, bending corners books, wetting fingers in order to skim, limiting public access to the works of great value and the provision of digital copies. Exposure will be made respecting the recommendations on conservation rules. Restoration activities of old books will be made by accredited staff, using materials compatible with the original supports.

It is necessary for the restorer specialist to remove the scotch tapes as early as possible. If the paper support oxidation state is reached, more solvents will be needed to remove the adhesive film, as the degradation process advances.

It was shown that all the characteristics groups of acrylic emulsions presented in literature scotch tapes are still in the paper structure after removing the acrylic scotch adhesive tape by conservation interventions.

Over time, the chemical decomposition of the adhesive often coincides with the migration of the degradation compounds into the paper support on which it is applied, causing its deterioration and degradation. After the ageing, the adhesive dries out, the carrier of tape is detached easily, but leaves the document with an adhesive layer that, once entered in the paper structure, cannot be easily removed.

It is demonstrated that the restored cellulosic material with adhesive traces suffers some oxidation processes after thermal ageing treatments. That means the using of scotch tape affects the durability of old documents.

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