

Summary of the Study

The thesis is titled "methods of treatment and maintenance of the paper manuscripts with comparison between the methods of manual and mechanical restoration- applied to selected models for the research".

Thesis research handles the study and evaluation of several thermal lamination of materials used in strengthening the fragile and weak paper as one of the means of modern mechanical restoration means currently used in many restoration centers. The thesis consists of six Chapters contains of theoretical, applied and experimental parts on a number of old manuscripts studies.

Chapter One: History of the beginning of paper industry over times:

The study handles a study on the main materials used from the old historical times like the wood plates, clay fragments, tanned leather, paper, parchment, clothes, papyrus and paper...etc. In addition, the study handled the history of discovery, distribution and industry of paper over time from the east in China since 105 AD, and its transfer to the Arab and Muslim world and Europe through North African, in addition to indication of the concept of monumental paper manuscripts and documents, and the reason for nomination of paper or the so-called Kaged for the Arabs.

Chapter Two: Old and Modern techniques of paper industry:

The chapter included firstly: methods of paper industry in the past in all Arab countries, China, India and Japan. All these phases were primarily performed manually. In addition, the main plant materials used at the time like bamboo, cotton wastes, fishing nets and torn clothes to produce cheap paper, beside the use of other materials like linen and silk that were characterized by quality, and the filling and gumming materials involved in the preparation of the old pulp kneed. In addition, this study examined the methods of modern paper industry and the main materials of preparing the paper pulp, like the fibers of the bark and stem of plants such as flax, hemp, jute, ramie, and leave fibers like the esparto leaves, sisal, manila, and fibers of plant herbs such as straw, corn stems, bamboo, seeds fibers with hair like cotton, wood fibers like soft fibers and hard fibers. Moreover, the study presented the key modern methods of paper industry like the mechanical process, chemo-mechanical process, chemical process of all types like soda pulping process, sulphate (Kraft) process and sulfite process. In addition, the research included: main materials and instruments used in the manuscripts industry. These materials include cotton, linen, chemical composition of paper (cellulose, lignen, hemicellulose), and the old writing tools, inks, colors...etc.

Chapter Three: Factors of damaging of the paper manuscripts:

The chapter discusses the main factors of manuscripts damage. It includes firstly: physiochemical external factors and the harmful and

damaging effect of light and the chemioluminescence damage and distortion that it causes to the paper, and the temperatures, relative humidity and the resulting dryness and fragility of the fibers, in addition to contribution to the biological infection, air pollution gases like sulfite dioxide gas, hydrogen sulfide, nitrogen oxides, ozone gas, ammonia, and the resulting aspects of damage including the weakening and loss of chemical and mechanical properties of the paper fibers, beside the introduced factors of damage including the latent effects in the manuscript itself like the effect of lignin, and the effect of the other additives during the industry like media, fillers, surface strengtheners, and effect of varnish, inks and colors.

In addition, the chapter included secondly: biological factors of damage like the insects, and microbiological factors like parasites and bacteria, and the resulting aspects of damage like the erosion of paper and loss of areas of it, color deformation and surface spots, in addition to the human damage. The chapter also examined the standard methods of controlling the museums and cinemas environment, and the storage areas like the intensive lighting, temperature and humidity rates and air pollution gases.

Chapter four: scientific bases of treatment and restoration

This section included the methods used in the treatment and restoration of the manuscripts like the different cleaning processes to remove the dust, dirt and color spots. The approaches adopted in cleaning include: mechanical cleaning which is one of the safe methods. In this process, several tools of soft brushes, rasps, erasers, special powders, air sucking systems, chemical cleaning by chemical solutions are used, and water solution is particularly used with the insensitive inks. Neutral water removes the alkyd compounds that appear in paper and protect them against future acidity. Soap that transforms the remaining fats to water soluble materials can be added, and methyl alcohol and organic solvents like acetone and toluene can be used in dry cleaning whether by local cataplasms or by immersion and cleaning by enzymes that digest and crack the complicated organic matters to simple water soluble matters, and removal of starch and fungal spots. The chapter also discussed the methods of removing and neutralizing acidity, and the main solutions used in it. In addition, the section handled strengthening by different materials like hydroxypropyl cellulose, methyl cellulose, parlin and starch to enhance the paper resistance to mechanical pressures, and reviewed the major approaches used in manual restoration like the restoration and refilling of holes, edges and corners, and mechanical restoration using suspension of paper pulp that depends on the mechanism of interconnection and interlocking between the cellulose fibers in the paper pulp in the presence of water, and the thermal lamination process by

transparent plastic and fabric laminates to strengthen the fragile and weak paper and to separate it from the environmental factors of damage, and the chapter examined the key standard methods internationally followed in the presentation and storage of manuscripts.

Chapter Five - experimental study, examinations and scientific analyses used in the inspection of manuscripts:

The section included two parts:

Part One: methods of examination and analysis of the paper manuscripts. This included the main scientific examination using light microscope, scanning electronic microscope, and polarized microscope.

Analysis using the infrared spectrum, deviation of X-Rays, chromatographic analysis, and analysis using Raman.

Second: Experimental Study: The experimental study included some laminates used in thermal lamination of paper, such as:

- Material: Texicryl sans Support
- Material: Polyethylene and tissue paper
- Material: Texicryl Archibond Polyacrylic
- Material: Area bonded fiber A.B.F
- Material: Polyethylene
- Material: Polyacrylic

Strengthening of paper is applied by the above mentioned materials using the thermal lamination, at the restoration center in the Egyptian Book House, at temperature that ranged between 117 to 120 C, for a period of 1 minute and pressure of 35 Kg². The newspaper sheets were used as material to which the experimental study shall apply. In addition, lamination was made on one side in half the samples, and on both sides on the other half. In addition, the samples were subjected to temperature and light aging on three different times at temperature of 100 C to reach a similar condition to that of the old paper. The mechanical properties of the samples were measured. The measurement included measurement of the tensile strength and strain. The visual properties were measured, as the color change was measured and the values of brightness, whiteness and yellowness were measured. We noted that the mechanical properties of paper are low, after the thermal and light aging, and it increased in the thermal aging than in the light one, while the visual properties are affected by light aging more. This appears in the low rate of whiteness and high rate of yellowness. In addition, it was found that texicryl sans support is the best material used in treatment, as it increased the tensility and elongation well, followed by Texicryl Polyacrylic Archibond, then the Polyethylene and tissue paper, while polyacrylic was the worst because it was transformed to material to plastic, followed by polyethylene. In addition, the A.B.F material is not recommended for use because of change in the visual properties, followed by polyacrylic, while

we noted low whiteness degrees with increase of yellowness after aging, and brightness is not much affected for all materials.

Chapter Six- "Applied Study":

This registered the aspects of damage before the beginning of treatment and restoration. In addition, a number of different examinations and analyses was made to determine the definition of manuscripts and the relating materials. Examination was made by electronic microscopic examination to identify the type of fibers that compose the monumental paper. In addition, a sample of paper was analyzed to define its components and identify the ink means by the Infrared Spectrum, analysis by X-Ray Diffraction (X.R.D) to identify the components in the paper fibers and their ratios.

First: the applied study included manual treatment and restoration of the following manuscripts:

- 1- Manuscript: Al Fasih-T, No. (7180)
- 2- Manuscript: Summary of Key- T, No. (968)
- 3- Trilogy of Bukhari, No. (7510)
- 4- Sharh by Umayya Al Zakkak, T, No. (6631)

Those are kept in the center of Gomaa Al Majed for Cultural and Heritage. In the beginning, the papers of manuscripts were unfolded after the whole pages were numbered. The manual treatment and restoration processes were made using the mechanical cleaning to remove the suspended dust and dirt using soft brush and eraser cautiously from the middle and from the inside to the outside, and the interlocking holes and missing parts were supplemented using the factory's restoration paper in the center. This paper is similar to the original paper of the manuscripts in type, color and thickness. In addition, carboxy was made, like the C.M.C. cellulose as adhesive material, and paper was compressed well for one day to be stretched and to have homogenous appearance. The paper was collected in folders and arranged according to the original one after tracking the number of pages to bind it.

Second- The method of mechanical restoration was used in the manuscript of "Koran Al Saadin" No. 14, which was kept in the Gomaa Al Maged Center. The unfolding and number of pages was completed, and mechanical cleaning was used to remove dust and dirt. Acidity was removed using 12% of calcium hydroxide solution. The fibers used in the process were prepared, and the restoration was completed using the paper pulp suspension system to fill the strong interlocking holes and fill the gaps, and to complete the missing parts in the area of corners and edges.