

## Operating systems and procedural standards to ensure the integrity of documentary manuscript holdings

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### Abstract

The integrity of the manuscript documentary heritage depends on the extent of adherence to rigorous protocols that integrate technical management with environmental control. The implementation of modern operational systems in global libraries and archives provides a safety net against human and operational risks. Meanwhile, technical requirements specifically those pertaining to temperature, humidity, and lighting form the first line of defense against the organic degradation of paper fibers.

As the manuscript documentary heritage constitutes a nation's living memory and the intellectual bridge connecting its past to its present, this wealth of knowledge faces formidable challenges imposed by time and surrounding environmental conditions. Consequently, preservation is no longer a mere traditional storage process; it has evolved into a comprehensive science built upon two inseparable pillars: operational systems that govern the administrative and security pathways of the manuscript, and technical specifications that regulate the physical and chemical variables of the preservation environment.

This paper aims to shed light on this preventive system, which ensures the sustainability of the manuscript and protects it from damage before it occurs. Furthermore, it reviews the International Standards required to create an ideal preservation environment that guarantees the survival of the manuscript at the highest possible quality for the longest period of time."

**Keywords:** Operating Systems, Procedural Standards, Documentary Manuscripts, Integrity, Preservation, Manuscript Holdings.

### Introduction

The heritage of any nation is the sum of its deep-rooted history, ancient civilization, monuments, and cultural acquisitions. These may manifest as a book, a manuscript, a sculpted statue, or an inscription on a wall. Thus, heritage holds immense significance and provides profound benefits to ambitious nations seeking to understand life through its facts, manifestations, and imaginations—a knowledge achieved by linking the present to the past and launching from the present toward the future.

Despite this importance, what has been written about this cultural heritage remains insufficient to unveil many of its features. This is due to the nature of these artifacts regarding their locations, discovery conditions, and the difficulty of handling them. The Arabic manuscript represents a vital,

illuminating aspect of this valuable heritage. Undoubtedly, the millions of Islamic and Arabic manuscripts that have reached us are very few in number, a tragedy resulting from several factors. Perhaps the most significant were the catastrophes these manuscripts endured during wars and repeated turmoil in the Islamic world, notably at the hands of the Mongols led by Hulagu in 1258. Millions of manuscripts were destroyed in libraries, including the Library of Baghdad an event known as the "Baghdad Catastrophe" where books were either burned or thrown into the Tigris River, turning its waters black from ink and red from the blood of the slain. Additionally, the fall of Granada led to the complete burning of the most significant Arabic manuscripts in that region.

The absence of public awareness regarding the civilizational and scientific value of manuscripts has left many of them neglected in public and private libraries, exposed to damaging factors that led to their deterioration and the loss of their features. Nevertheless, manuscripts have known various methods of preservation, maintenance, and restoration since the Islamic Caliphate and the era of flourishing Islamic civilization. Rare and precious manuscripts once filled the treasuries of various Arabic-Islamic libraries, most notably the House of Wisdom (Bayt al-Hikma) during the Abbasid Caliphate. Over time, methods for restoring and preserving historical documents evolved in the modern era starting from the mid-19th century. Interest grew further in the late 20th century, leading to the establishment of specialized restoration departments in libraries and institutes dedicated to "book diseases" and their treatment worldwide to maintain their quality and elegance. Programs for manuscript treatment were developed, and the global concept of preservation evolved into a set of rules that practitioners must adhere to, including:

- The necessity of retaining archaeological features while eliminating all factors of damage and distortions that have afflicted the Arabic manuscript.
- The imperative that materials used in treatment and restoration in Arab libraries and institutions do not cause further harm to this national wealth.
- Accordingly, this research aims to achieve the following objectives:
  - Defining manuscripts and the craft of Arabic manuscript production.
  - Identifying measures and methods for manuscript preservation and the role of information technology and modern mechanisms in this field.
  - Raising awareness about the civilizational, intellectual, and cultural role of manuscripts as the nation's memory and the link between ancestors and future generations.
  - Promoting the collection of manuscripts in specialized centers to protect them from environmental decay.

The conditions for the proper preservation of manuscripts and documents can be reviewed through the following:

### **1. Definition of the Manuscript**

"The term 'manuscript' (Al-Makhtut), as it is currently used today, was entirely unknown in ancient times in its modern technical sense. Instead, other terms were employed, such as 'Kitab' (Book), 'Sifr' (Scroll/Tome), 'Juz' (Section), 'Risala' (Treatise), or 'Mujallad' (Volume)<sup>1</sup>, among other

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1- Mustafa El-Sayed Youssef, *Preservation of Manuscripts: Science and Practice*, Imam Mohammad bin Saud Islamic University, Riyadh: Alam al-Kutub, 2002, p. 15.

nomenclatures. These expressions were applied to any composed work discussing a specific subject or multiple topics, recorded on hand-written papers<sup>1</sup>.

The word 'manuscript' emerged in the modern era as a counterpart to the word 'printed' (Matbu') after the world became acquainted with printing. It began to refer to the copy of a book written by the author's own hand or by other scribes. It also refers to the copy that the author submits to the printing house for publication."<sup>2</sup>

## **2- Detailed Definition of Codicology (The Science of Manuscripts)**

**Codicology** is often described as the "**Archaeology of the Book.**" It is the scholarly discipline that studies manuscripts as physical, three-dimensional objects, rather than just focusing on the literary or historical texts they contain<sup>3</sup>.

### **2.1. Etymological Origin**

The term is derived from the Latin word *Codex* (meaning a book formed of bound leaves) and the Greek suffix *Logia* (meaning study or science). While the text is the "soul" of the manuscript, Codicology examines its "body."<sup>4</sup>

### **2.2. The Scope of the Science**

A detailed definition of Codicology covers several analytical layers:

- **Material Analysis:** Examining the support materials used for writing, such as papyrus, parchment, and paper. This includes studying the chemical composition of inks and the origin of the paper (using watermarks).
- **Structural Composition:** Analyzing how the manuscript was put together, including the gathering of folios (quires), the sewing methods, and the binding techniques.
- **Layout and Design (Mise-en-page):** Studying the geometry of the page, including ruling (the lines made to guide the scribe), margins, and the arrangement of text and illustrations.
- **Paleography Integration:** While Paleography focuses on the *handwriting* itself, Codicology looks at the scribe's tools, the inkwell, and the physical environment in which the writing occurred.

### **2.3. The Codicological Approach to History**

Codicology provides "silent evidence" that the text alone cannot offer. By studying a manuscript's physical features, scientists can determine<sup>5</sup>:

- **Provenance:** Where the manuscript was created and who owned it over centuries (through ownership seals and marginal notes).
- **Dating:** Estimating the age of the manuscript through carbon dating of materials or the analysis of watermarks.
- **Socio-Economic Context:** The quality of the leather, gold leaf, and pigments used can reveal the wealth of the patron or the importance of the scriptorium where it was produced.

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1- Abdulaziz bin Mohammed al-Musfar, *The Arabic Manuscript and Some of Its Issues*, King Saud University, Riyadh, 1999, p. 9.

2- Abdel-Moiz Shaheen, *Methods of Maintenance and Restoration of Antiquities and Artistic Acquisitions*, Cairo: Egyptian General Book Authority, 1993, p. 127.

3- Déroche, François, *Islamic Codicology: An Introduction to the Study of Manuscripts in Arabic Script*. London: Al-Furqan Islamic Heritage Foundation. (2006). P.19.

4- Gacek, Adam. *Arabic Manuscripts: A Vademecum for Readers*. Leiden: Brill(2009). P.p.338.340

5- Gacek, Adam *The Arabic Manuscript Tradition: A Glossary of Technical Terms and Bibliography*. Leiden: Brill. . (2001). p.300

## 2.4. Relation to Other Sciences<sup>1</sup>

Codicology does not work in isolation; it is a multi-disciplinary field:

- **Philology:** To understand the text's evolution.
- **Paleography:** To study the evolution of scripts.
- **Conservation Science:** To develop methods for preserving and restoring these physical objects.

## 3. The Status of Manuscripts in Arabic-Islamic Heritage

Since the dawn of the early Islamic era, Muslims have prioritized knowledge. Evidence of this lies in the historical competition among Caliphs and Princes to acquire books and establish libraries, which were variously known as Bayt al-Hikmah (House of Wisdom), Dar al-Ilm (House of Knowledge), Dar al-Kutub (House of Books), or al-Khizanah (The Treasury/Library).

Al-Jahiz once presented a copy of Sibawayh's book to Muhammad ibn Abd al-Malik al-Zayyat during his ministry under Al-Mu'tasim. Ibn al-Zayyat remarked: "Did you think our treasuries were devoid of this book?" Al-Jahiz replied: "I did not think so; however, this copy is in the handwriting of al-Farra, cross-referenced by al-Kisa'i, and refined by Amr ibn Bahr al-Jahiz." Ibn al-Zayyat responded: "This is the most magnificent copy in existence," expressing his great joy and admiration for it<sup>2</sup>. Furthermore, Caliph Al-Ma'mun enriched the Arabic library with treasures of manuscripts translated from Greek; he would occasionally receive the most extensive works and send expeditions to the lands of the Byzantines (Rum) to acquire them<sup>3</sup>.

The relative political stability during that period of the Islamic Caliphate, combined with the encouragement of scholars, was a primary factor in the scientific renaissance. However, this era did not last. Political conflicts over power grew within the Islamic state and abroad. The strife among the "Taifa" kings in Andalusia led to their sequential fall, while the malice of the Frankish kings led them to burn hundreds of thousands of manuscripts in the squares of Cordoba<sup>4</sup>.

Religious crusader fanaticism also led to the burning of Dar al-Ilm in Tripoli (Levant), which contained three million books in 522 AH, less than thirty years after its establishment. Sectarian disputes among Muslims further led to attacks by North African soldiers and supporters of Fatimid rule on the seat of the Caliphate in Cairo in 461 AH, resulting in the burning of thousands of manuscripts to assert the Ismaili school of thought<sup>5</sup>.

Similarly, the library of Aleppo, endowed by Sayf al-Dawla al-Hamdani, was burned in 460 AH, and the Nizamiyyah school was burned in 410 AH. As for Genghis Khan, he used books to build horse stables, and the Tigris River changed color due to the sheer volume of books thrown into it<sup>6</sup>. The Mustansiriyyah Library in Baghdad and other houses of books were not spared from the tyrant Hulagu when he entered Baghdad in 656 AH<sup>7</sup>.

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1- Muzerelle, Denis. *Vocabulaire codicologique: répertoire méthodique des termes français relatifs aux manuscrits*. (Paris, 1985). P.123.

2- Yaqut al-Hamawi, *Mu'jam al-Udaba* (Dictionary of Writers), Vol. 16, p. 123

3- Muhammad al-Tunji, *Al-Manahij fi Ta'lif wa Tahqiq al-Makhtutat* (Methodologies in Authoring and Editing Manuscripts), Damascus: Dar al-Mallah, 1986 Edition, p. 263.

4- Kurd Ali, Muhammad, *Al-Islam wa al-Hadara al-Arabiyya* (Islam and Arabic Civilization), Vol. 01, p. 267.

5- Muhammad al-Tunji, *Al-Manahij fi Ta'lif al-Buhuth wa Tahqiq al-Makhtutat* (Methodologies in Research Writing and Manuscript Editing), p. 263.

6- Kurd Ali, Muhammad, *Al-Islam wa al-Hadara al-Arabiyya* (Islam and Arabic Civilization), Vol. 01, p. 267.

7- *Ibid.*, p. 264. (Note: "Ibid." is the standard Latin abbreviation for "the same reference").

Successive wars and tribulations continued to ravage the nation's heritage until most of it was destroyed. This decline only slowed with the entry of Muhammad the Conqueror in 857 AH and the consolidation of Ottoman control over the Islamic Caliphate. During this century, the Crusades took a different form; European rulers ordered the establishment of missionary institutions to study Islam. Early Arabic manuscripts began to appear in printed form in Rome at the start of the 16th century, and printing activity flourished in several European cities during the 17th century. As Arabic printing spread there, precious manuscripts were transferred to Europe. During this period, European colonial ambitions began. This is evident in what occurred in Algeria during the colonial era, where both private and public libraries were decimated. The colonizers seized mosques and Zawiyas (religious schools), confiscating their contents, such as those of the Great Mosque in the capital and the mosques of Tlemcen, Constantine, Mazouna, Bejaia, and Annaba... <sup>1</sup>.

This included endowed collections (Waqf), such as those dedicated by Salah Bey to his school in Constantine and Muhammad al-Kabir to his school in Mascara. It also included the library of the Qaitna Zawiya, which accompanied Emir Abdelkader when he lost his capitals and operated from the "Smala" (tent city). The colonizers seized the Smala, and the Duke of Aumale gifted some of these manuscripts to the Chantilly Library in France. This occurred in 1835, and in Tlemcen in 1836. Bide-Roger, who accompanied Clauzel's campaign against Mascara and Tlemcen, narrates how he seized manuscripts and transported them to Algiers on animal backs. On the road from Mascara to Mostaganem, a camel fell into a deep abyss carrying forty manuscripts, all of which were lost. He admitted that what he collected along that route amounted to about a thousand manuscripts<sup>2</sup>.

Added to this was the migration of some Algerians with their precious manuscripts, such as "Ibn al-Annabi," who was exiled by Marshal Clauzel in 1830; Hamdan Khodja, who fled from the role of Vigo in 1836; and Mustafa al-Kabbati, who was exiled by Marshal Bugeaud in 1843<sup>3</sup>.

### **3.1. Historical Wealth and Intellectual Volume**

The Arabic-Islamic manuscript tradition represents one of the most prolific periods of human intellectual history. Between the 8th and 19th centuries, the Islamic world produced millions of handwritten codices covering diverse fields such as astronomy, medicine, theology, and philosophy.<sup>4</sup> The early adoption of paper technology in the 8th century triggered a "knowledge explosion," making books more accessible and allowing for the creation of massive public and private libraries in cities like Baghdad, Cordoba, and Cairo.

### **3.2. Geographical Distribution and Repositories**

Today, it is estimated that between three to four million Arabic-Islamic manuscripts survive globally. These are not concentrated in one region but are scattered across the world. Significant collections are held in the Süleymaniye<sup>5</sup> Library in Turkey, Dar al-Kutub in Egypt, and various national libraries in Saudi Arabia, Morocco, and Iran. Furthermore, major European institutions, such as the British

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1- Abou el-Kacem Saadallah, *Tarikh al-Jaza'ir al-Thaqafi* (The Cultural History of Algeria) 1830-1954, Beirut: Dar al-Gharb al-Islami, First Edition, p. 327.

2- Berbrugger, Adrien, *Description de la campagne de Mascara* (Description of the Mascara Campaign), Paris: French Archives, 1837, pp. 76, 77, 87.

3- *Ibid.*, entry for October 30, 1830.

4- Bloom, Jonathan M. *Paper Before Print: The History and Impact of Paper in the Islamic World*. New Haven: Yale University Press, 2001. p. 43.

5- Roper, Geoffrey (Ed.). *World Survey of Islamic Manuscripts*. 4 Volumes. London: Al-Furqan Islamic Heritage Foundation, 1992-1994. p. 120.

Library and the Vatican Library, house thousands of rare manuscripts acquired through trade, diplomacy, or colonial history<sup>1</sup>.

### **3.3. The Physical Condition and Conservation Challenges**

The physical status of these manuscripts varies greatly. While many are preserved in state-of-the-art, climate-controlled environments, a vast number remain in perilous conditions. In conflict zones or economically disadvantaged regions, manuscripts face threats from high humidity, insect infestations, and acidic ink corrosion. Furthermore, political instability in countries like Yemen, Iraq, and Mali has put private "family libraries" at risk of physical destruction or illicit trafficking.

### **3.4. The Digital Revolution and Accessibility**

In the 21st century, the status of Arabic-Islamic heritage is being transformed by digitization. Large-scale projects led by organizations such as the King Faisal Center and the Qatar National Library are racing to scan and upload high-resolution images of these codices. This "Digital Codicology"<sup>2</sup> not only protects the original copies from excessive handling but also democratizes knowledge, allowing researchers worldwide to study rare texts that were previously inaccessible behind closed doors<sup>3</sup>.

### **3.5. The Role of Modern Codicology**

Scholars today are moving beyond just reading the text; they are applying Codicology (the archaeology of the book) to understand the manuscript as a physical object. By analyzing paper watermarks, binding techniques, and marginal notes (marginalia)<sup>4</sup>, researchers can reconstruct the social and economic history of the Islamic world. This scientific approach helps in dating undated works and identifying the "itinerary" of a book as it traveled across continents through different owners and scholars<sup>5</sup>.

## **4. Conditions for the Proper Preservation of Manuscripts and Documents<sup>6</sup>**

Preservation and conservation (maintenance) are complementary pillars in protecting manuscripts from the erosion and deterioration they face over time. To clarify this integration, we can define Preservation as the management of the environment surrounding the manuscript whether in storage, on library shelves, or in the hands of researchers and readers to ensure its safety from insect, microbial, or human-induced damage, while simultaneously preventing cross-contamination between holdings.

In contrast, Conservation refers to the active treatment and remediation of damage that has already occurred, such as paper brittleness (desiccation), calcification, acidity, gaseous pollution, or infestations by insects and fungi. Each of these conditions requires specific methodologies to reverse or mitigate its effects on the manuscript.

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1- Vrolijk, Arnoud, and Jan Just Witkam. *Arabic Manuscripts: A Vademecum for Readers*. Leiden: Brill, 2007. p. 69.

2- King, David A. "The Digital Preservation of the Islamic Scientific Heritage." *Journal of Islamic Studies*, 2012. P.30.

3- Davidson, Garrett. "The Digital Future of Arabic Manuscript Studies." *Journal of Open Humanities Data*, 2021. P.93.

4- Déroche, François. *Islamic Codicology: An Introduction to the Study of Manuscripts in Arabic Script*. London: Al-Furqan Islamic Heritage Foundation, 2006 P.120.

5- Gacek, Adam. *The Arabic Manuscript Tradition: A Glossary of Technical Terms and Bibliography*. P.339.

6- ISO 11799:2015 – Information and documentation — Document storage requirements for archive and library materials. > Relevance: This is the definitive source for building resilience, subterranean storage logic, and pollution limits (the  $50 \mu\text{g}/\text{m}^3$  threshold)

The correlation between preservation and conservation is evident in two primary aspects:

**1. Post-treatment Care:** The necessity of providing optimal preservation conditions for manuscripts that have undergone conservation to prevent the recurrence of previous damage<sup>1</sup>.

**2. Preventive Care:** Providing high-quality preservation for uninfected manuscripts to shield them from potential deterioration.

Given the importance of both fields, we will detail each separately to provide a comprehensive overview. Since preservation is the first step in safeguarding any asset by providing conditions that extend its lifespan and maintain its natural state for as long as possible it is appropriate to begin here, following the principle that "prevention is better than cure." To protect manuscripts from destructive factors and the loss of text, we must control the "aging factors" previously discussed. This minimizes adverse outcomes, such as the buildup of acidity or the proliferation of microorganisms, by utilizing the latest scientific and technological advancements, given the high archaeological value and environmental sensitivity of manuscripts<sup>2</sup>.

#### **4.1. Protection from Atmospheric Pollution**

Atmospheric factors include sulfurous and non-sulfurous gases, dust, and various airborne particles that harm manuscripts. Because these pollutants are easily dispersed by wind, they pose a significant threat to these silent witnesses of history. Protection against these factors is achieved through<sup>3</sup>:

- **Periodic Cleaning:** Regular cleaning of storage areas using vacuum extractors to remove dust and harmful particles, particularly from floors.

- **Air Filtration:** Passing air into storage units through carbon filters containing activated charcoal, or water filters containing specific solutions to eliminate sulfur dioxide.

- **Smoking Ban:** A strict prohibition of smoking inside storage areas and reading rooms.

- **Pollution Standards:** In all cases, the concentration of atmospheric pollutants in the environment surrounding the manuscript should not exceed  $50 \mu\text{g}/\text{m}^3$ .

#### **4.2. Sterilization**

In its general sense, sterilization refers to the elimination of all forms of life, whether cells, germs, eggs, or larvae. While methods vary, the goal remains the eradication of biological threats. Because manuscripts are organic environments that provide a "nutrient medium" for specialized organisms that cause decay, we must be meticulous in selecting sterilization methods<sup>4</sup>. The chosen method must eliminate pests without leaving harmful residues on the pages, neither in the short nor the long term. Generally, there are two approaches to sterilization:

#### **4.3. Use of Pesticides (Chemical Methods):**

This is a common method, yet it requires caution with manuscripts due to their age and the sensitivity of their inks and paper. A conservation specialist must test the pesticide's compatibility with the manuscript's components (paper, leather, adhesives, and furniture) simultaneously<sup>5</sup>.

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1- ISO 18911:2010 – Imaging materials — Processed safety photographic films — Storage practices.

Relevance: Useful for the sections regarding air filtration and carbon/charcoal filters.

2- BS 4971:2017 – Conservation and care of archive and library collections. (British Standards Institution).

3 -Ritzenthaler, M. L. Preserving Archives and Manuscripts. Chicago: Society of American Archivists. (2010). P159.

4- Pinniger, D. Integrated Pest Management in Cultural Heritage. London: Archetype Publications. (2015). Pp.36-37.

5- Florian, M. L. Fungi in Heritage Collections: Guidance for Management. Rome: ICCROM. (2002).P130.

- **Targeted vs. Broad-Spectrum:** If an infestation is limited to a specific organism, a targeted pesticide is used. If multiple types are present, broad-spectrum pesticides with combined effects are employed.

- **Insecticides:** Used for insect damage appearing as perforations or holes on margins and text. Examples include "Nocidowa," "Dendrin," and "Malathion." Concentrations should not exceed **5%**, depending on the severity, using a solvent that does not affect the ink.

- **Antimicrobial Agents (Fungicides/Bactericides):** Used for colored stains caused by microbial growth. Unlike acidity, which makes paper brittle, microbial damage weakens the paper structure. As fungi are more prevalent than bacteria, "Benlate" is often the most suitable fungicide. Studies show that fungal activity decreases as the concentration of the fungicide increases<sup>1</sup>.

#### **4.5. Methods of Application:**

- **Light Spraying:** Misting the pages of the infected manuscript.

- **Immersion:** Disassembling the manuscript and soaking pages in a pesticide solution, followed by natural air-drying.

- **Interleaving:** Placing special papers treated with pesticide solutions between the pages and changing them periodically.

- **Fumigation:** Using substances that transform into toxic gases to penetrate the tunnels and holes where eggs and larvae hide.

#### **4.6. Natural Pest Control Methods:**

This is a modern trend aimed at avoiding the toxic risks of chemical pesticides and their potential impact on inks and the physical/chemical properties of paper and leather. These methods include the use of:

- Short-wave radiation (Infrared and Ultraviolet).

- Electromagnetic and electrical waves.

- Hot air and ultrasonic frequencies.

Natural methods are still undergoing extensive research to ensure they offer the safest and most effective results while preserving the original features of the manuscript.

#### **4.7. Occupational Safety and Precautions**

To ensure the safety of both the manuscripts and the personnel working with them, the following safety protocols must be followed during sterilization:

- Use of specialized masks equipped with carbon filters.

- Preparing pesticides immediately before use.

- Avoiding heat sources near pesticides to prevent ignition or loss of efficacy.

- Sealing storage areas for **24 hours** after sterilization is complete.

- Thoroughly washing hands and face with soap and water after handling chemicals.

- Maintaining a rapid communication link with a medical center in case of accidental poisoning or fainting.

### **5. Specifications for Manuscript Buildings and Storage Facilities**

#### **5.1. The Building**

The architectural design of a facility dedicated to manuscript preservation must adhere to several critical conditions:

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1- Zycherman, L. A., & Schrock, J. R. A Guide to Museum Pest Control. Foundation of the American Institute for Conservation of Historic and Artistic Works. (1988).p.93.

- **Structural Resilience:** The building must be resistant to natural disasters such as earthquakes, fires, and floods. Additionally, walls must be constructed with high-quality thermal and moisture insulation.
- **Standard Compliance:** The design must comply with international scientific standards and specifications for library and information center architecture.
- **Subterranean Storage:** It is preferable for the manuscript repository to be located in the lower levels of the building to minimize exposure to natural light.
- **Light Control:** Exhibition halls must be equipped with blackout curtains to block direct sunlight<sup>1</sup>.

## 5.2. The Library and Exhibition Halls

These areas must be equipped with specific systems to maintain the integrity of the holdings:

- **Climate Control:** Air conditioning systems must maintain a temperature range of **16°C to 20°C** and a relative humidity (RH) of **50% to 60%**. These systems require regular periodic maintenance and calibration checks.
- **Light Shielding:** Use of curtains and shutters is mandatory to protect documents from UV radiation and sunlight<sup>2</sup>.
- **Pest Barriers:** All openings and ventilation points must be fitted with fine-mesh screens to prevent the entry of insects without obstructing airflow.
- **Plumbing Restrictions:** No water pipes or fluid conduits should pass through the library or manuscript exhibition halls to prevent leakage risks.
- **Fire Safety:** The facility must be equipped with advanced fire detection systems and appropriate suppression equipment (such as gas-based systems).
- **Sanitation Protocols:** Halls must be cleaned at regular intervals. Dust should be removed using vacuum cleaners equipped with high-efficiency particulate air (HEPA) filtration systems. Floors should be cleaned with a damp mop once a week.
- **Waste Management:** Storage areas must be inspected regularly, and all waste must be disposed of in locations far removed from the primary repositories.
- **Dark Storage:** Manuscripts should be kept in total darkness; lights must be extinguished immediately upon exiting the area.
- **Biological Monitoring:** Periodic inspections by specialists are required to ensure the collection remains free of bacterial or fungal infections.

## 5.3. Furnishings (Equipment)

### A. Shelving Units:

- **Material and Coating:** Shelves must be metallic and coated with three layers of protective finish to prevent oxidation (rust). They must be completely free of sharp edges or protrusions that could tear the manuscripts<sup>3</sup>.
- **Airflow:** Sufficient space must be maintained between shelves to allow for natural air circulation.
- **Elevation:** The bottom shelf must be elevated at least **15 cm** above the floor level to protect manuscripts from floor-level humidity and potential water disasters.

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1- Tétreault, J. Airborne Pollutants in Museums, Galleries and Archives: Risk Assessment, Control Strategies and Preservation Management. Ottawa: Canadian Conservation Institute. (2003).p40.

2- Appelbaum, B. Conservation Treatment Methodology. London: Butterworth-Heinemann. (2007). P.145.

3- Harvey, R., & Mahard, M. R. The Preservation Management Handbook: A 21st-Century Guide for Libraries, Archives, and Museums. Rowman&Littlefield. (2014).p.100.

- **Placement:** A gap of at least **5 cm** must be maintained between the shelves and the walls. The top of the shelving units should be covered with panels to prevent dust from settling on the manuscripts<sup>1</sup>.
- **Accessibility:** Shelves should not exceed a standard height; they must be easily accessible to ensure the safe handling and retrieval of manuscripts.

#### Manuscript Storage Guidelines

**Placement:** It is strictly prohibited to place manuscripts directly on the floor.

**Orientation:** When storing manuscripts, they must not be placed on their foreedge or their spine; doing so exerts excessive pressure on the spines and the binding.

**Shelf Alignment:** Manuscripts should not protrude beyond the edge of the shelves to prevent friction or accidental contact with staff or equipment.

**Special Housing:** Rare manuscripts or those in poor condition must be stored in custom-made boxes (archival boxes). This prevents any metal components or sharp edges from damaging adjacent manuscripts.

**Oversized Items:** Large manuscripts should be stored horizontally (flat), and no more than three volumes should be stacked on top of each other.

**Airflow and Spacing:** A clearance gap of at least 5 cm must be maintained between the books and the back panel of the shelves.

### 6. Environmental Factors (Physico-chemical Agents)

#### 6.1. Climate: Temperature and Relative Humidity

Climate control is the pillar of conservation. Organic materials are **hygroscopic**, meaning they react to variations in moisture.

- **Temperature:** It should be maintained between **16°C and 18°C**. Excessive heat accelerates oxidation reactions and the acidification of paper<sup>2</sup>.

- **Relative Humidity (RH):** The recommended standard is between **45% and 55%**.

Mold Risk: Above 60%, fungal spores begin to develop.

*Mechanical Risk:* Below 40%, fibers become dry and brittle.

- **Stability:** Rapid fluctuations (day/night cycles) cause irreversible mechanical stress on bindings and supports.

#### 6.2. Light (Electromagnetic Radiation)

Ultraviolet (UV) and infrared (IR) rays break down cellulose chains.

- **Effects:** Yellowing of paper, crumbling, and fading of inks (especially vegetable-based inks).

- **Measures:** Storage in total darkness. For exhibition, the threshold of **50 lux** should not be exceeded, with a limited cumulative annual dose.

### 7. Packaging and Storage

The choice of storage materials is critical to preventing **acid migration**.

- **Material Quality:** Boxes, sleeves, and folders must have a **neutral pH** (between 7.5 and 8.5) with an alkaline reserve to neutralize ambient acidity (ISO 16245 Standard).

- **Furniture:** The use of metal shelving with baked epoxy powder coating is preferred over wood, which releases organic acids (acetic acid).

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1- Ritzenthaler, M. L. *ibid.* p.115.

2- Dureau, J. M., & Clements, D. W. G.: *Principes de conservation et de sauvegarde des documents de bibliothèque* (1986). pp 16-20.

- **Orientation:** Large manuscripts should be stored **flat (horizontally)** to prevent the text block from sagging.

## 8. Handling and Usage

Humans are often the primary agents of mechanical degradation.

- **Hygiene:** Washing hands with soap and water is recommended. The use of gloves is generally reserved for photographic or metallic documents, as they reduce manual dexterity when handling fragile paper.

- **Physical Support:** Using book cushions or specialized lecterns allows a manuscript to be opened without straining the sewing or the spine of the binding<sup>1</sup>.

- **Substitution:High-fidelity digitization** is the best preventive conservation method, as it allows the content to be consulted without handling the original.

## 9. Biological Protection (Integrated Pest Management)

Microorganisms and "bibliophagous" insects (such as woodworms and silverfish) can destroy a collection in a short amount of time.

- **Measures:** Regular inspection of the premises, air filtration (**HEPA filters**), and maintaining strict cleanliness (no food or water nearby).

- **Treatment:** In case of infestation, **anoxia** (oxygen deprivation) is the gentlest treatment method for the document.

### Quick Reference Guide: Conservation Standards<sup>2</sup>

Category	Parameter	Ideal Range / Standard	Risk of Non-Compliance
Climate	Temperature	16°C – 18°C	Accelerated acidification & oxidation.
Climate	Relative Humidity	45% – 55%	>60%: Mold growth; <40%: Brittle fibers.
Lighting	UV/IR Exposure	Max 50 Lux	Fading of inks and yellowing of paper.
Storage	Material pH	7.5 – 8.5	Acid migration and structural weakening.
Storage	Shelving	Metal (Epoxycoated)	Wood emits harmful acetic acid.
Disaster	Pest Control	Anoxia	Chemical treatments can damage old paper.

### - Additional Recommendations

To further protect the collection, you might consider these two specialized steps:

- **The "2-Degree Rule":** In many modern archives, it is noted that for every 5°C (approx. 9°F) decrease in temperature, the life of the paper roughly doubles. If your facility can safely reach 16°C without causing humidity spikes, it is highly beneficial.

- **Air Quality:** Using **HEPA (High-Efficiency Particulate Air)** filters is essential not just for mold, but to remove dust, which is abrasive and attracts moisture.

1- Beck, I: La conservation préventive des manuscrits et des archives, Institut National du Patrimoine (France). (2006). p.p. 92-112.

2- Cullière, A : La conservation des livres anciens, Manuel de bibliothéconomie. (2018).p92.

## **10- Definition of Housing (Conditioning):**

**Housing** (or conditioning) is the art of handling works—that is, preparing them before transport to avoid any mechanical or climatic shock; this action is distinct from simple packing. Housing does not only concern transportation but also the storage of collections in the best possible conditions.

This procedure serves as a link between **preventive** and **curative** conservation; it is the simplest means of ensuring the proper preservation of manuscripts. It is recommended to store manuscripts in acid-free containers to protect them from dust and to prevent damage during handling.

Containers must, therefore, be manufactured from **non-acidic materials**. It is worth noting that most papers and cardboards are acidic and are, consequently, harmful to the documents<sup>1</sup>.

The term "**acid-free**" (non-acidic) refers to both **pH-neutral** materials and materials with an **alkaline reserve**<sup>2</sup>.

There are different types of housing/containers:

-**Slipcases** (Les étuis).

-**Boxes** (Les boîtes).

-**Folders** (Les chemises).

Each manuscript must first be examined before choosing the appropriate type of container; for example, a manuscript in poor condition should not be inserted into a **slipcase** (étui), as it is often difficult to extract,<sup>3</sup> which risks damaging it. In such cases, it is preferable to place it in a **box**. Once classified, the manuscripts must be housed (conditioned) in order to be preserved in the best possible conditions<sup>4</sup>.

**10.1. Materials and Tools:** Numerous tools allow for the implementation of the aforementioned corrective measures, facilitating the safe consultation of graphic works. Among these tools, we can mention:

-**Neutral paper and permanent paper**<sup>5</sup>, either in rolls or sheets.

-**A metal ruler.**

- **A sharp knife (scalpel/cutter)** (Figure 2).

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1- Protective Enclosures for Books and Other Paper Artifacts, CCI Notes, No. 11/1, Ottawa, Canadian Conservation Institute, p. 1.

2- pH: In chemistry, it indicates whether a material is acidic or alkaline by measuring the concentration of hydrogen ions in an aqueous solution. Materials with an alkaline reserve, used for the housing of certain museum works, must have a pH between 7 and 9. See: Vade-mecum de la conservation préventive, op. cit., p. 45.

3- Laffont, Caroline, TheFels University Library: Towards New Conditions for the Conservation of Collections, Master 2 in Preventive Heritage Conservation, Paris I-Panthéon Sorbonne, 2007, p. 3.

4- Delamarre, Aurélie, Treatment and Cataloging of Contemporary Manuscripts: Challenges and Stakes. The Case of the Albi Municipal Library, Study Thesis, 2004, p. 34.

5- A paper is considered "permanent" if it meets all the criteria of a recognized standard (ISO in Europe, and ANSI in the USA). It is a paper that resists chemical and physical variations better than other papers; see: Vade-mecum de la conservation préventive, op. cit., p. 45.



**Figure 1: Material and tools for housing construction**

## 10.2. Implementation of Housing (Conditioning):

There are two forms of housing:

**a- Temporary Housing:** This type of housing is useful for the temporary protection of graphic documents or manuscripts awaiting restoration, and for the storage of items awaiting classification<sup>1</sup>. To ensure this housing, we use cushioning elements, sheets of tissue paper, polyethylene foam sheets, and transparent polypropylene sleeves. These materials are used as rigid supports and dividers, as well as for effective protection during storage<sup>2</sup>.

**b- Permanent Housing:** Permanent housing is based on the creation of permanent supports such as folders, boxes, and pockets; it is an exclusively manual process. For this type of housing, it is necessary to provide full details on the nature of the manuscripts being housed:

- **Flat Works:** Drawings, miniatures, watercolors, pastels, prints, engravings, lithographs, postcards, and autographs.

- **Volume Works:** Books and manuscripts.

### Implementation of Housing for Flat Works:

Flat works are, as their name suggests, all two-dimensional documents. They can be on paper, cardboard, or parchment supports and may feature various techniques. These flat works will be housed in paper sleeves or slipcases. Paper sleeves have the advantage of being very economical and can be manufactured manually. However, if the flat work contains several pages, sub-folders are made for each page (**Figure 3**), and then the work is housed within a single folder: this is the "individualization" technique. Works housed in this manner will be stored in conservation boxes or in a flat-file cabinet<sup>3</sup>.

1- Of a different chemical composition than polyester; stable but less resistant and cannot be used as a vapor barrier. It is used in the form of transparent sheets, notably for manufacturing photographic sleeves; see: *Vade-mecum de la conservation préventive*, op. cit., p. 45.

2- Ibid., p. 46.

3- *Protective Enclosures for Books and Other Paper Artifacts*, CCI Notes, No. 11/1, Ottawa, Canadian Conservation Institute, op. cit., p. 2.



**Figure 2: Preparation of a folder (flat work)**

### **10.3.Housing of Volume Works:**

To create housing for a volume, folders must be constructed. Each folder bears indications of its content as well as its physical significance. These indications are also recorded on various inventory records, allowing for the verification of the box's completeness. As for the order of the leaves within the folders, it is also specified, as the list of items contained is noted on each folder. Furthermore, each item or leaf must be stamped to prove its ownership within the museum's collections<sup>1</sup>.

Before making a folder for a manuscript, its actual dimensions must first be taken, adding **3mm** to all its edges and **1/3** of its length. The folder model is then traced onto permanent paper, followed by cutting it with a sharp knife to allow for easier folding.

The corners must be secured and the folds reinforced using gummed tape to obtain a folder that allows for the classification of manuscripts within conservation boxes. These boxes will be buffered with crumpled Japanese paper or foam to prevent any shifting (jostling) during transport.

Once filled, these boxes should not be heavy; they must be securely closed using tear-resistant polypropylene adhesive tape.

Three standard formats are used for housing folders; the choice of format depends on the measurements of the manuscript and the available storage space. These formats are as follows:

- **Large Format:** 120 cm \* 80 cm
- **Medium Format:** 60 cm \* 80 cm
- **Small Format:** 40 cm \* 30 cm

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1- ToumiRafika. Techniques and Operating Procedures for the Housing, Arranging, and Storage of Manuscripts, DépartementProtectionduPatrimoineUniversité de Médéa.p.p.44-48.



**Figure 3: Construction of a protective folder**

### **Conclusion**

To conclude, the integrity of documentary manuscript holdings depends on a sophisticated integration of rigorous operating systems and adherence to international technical standards. As this study has demonstrated, the transition from simple storage to professional conservation requires more than just physical effort; it demands a systematic approach rooted in archival science.

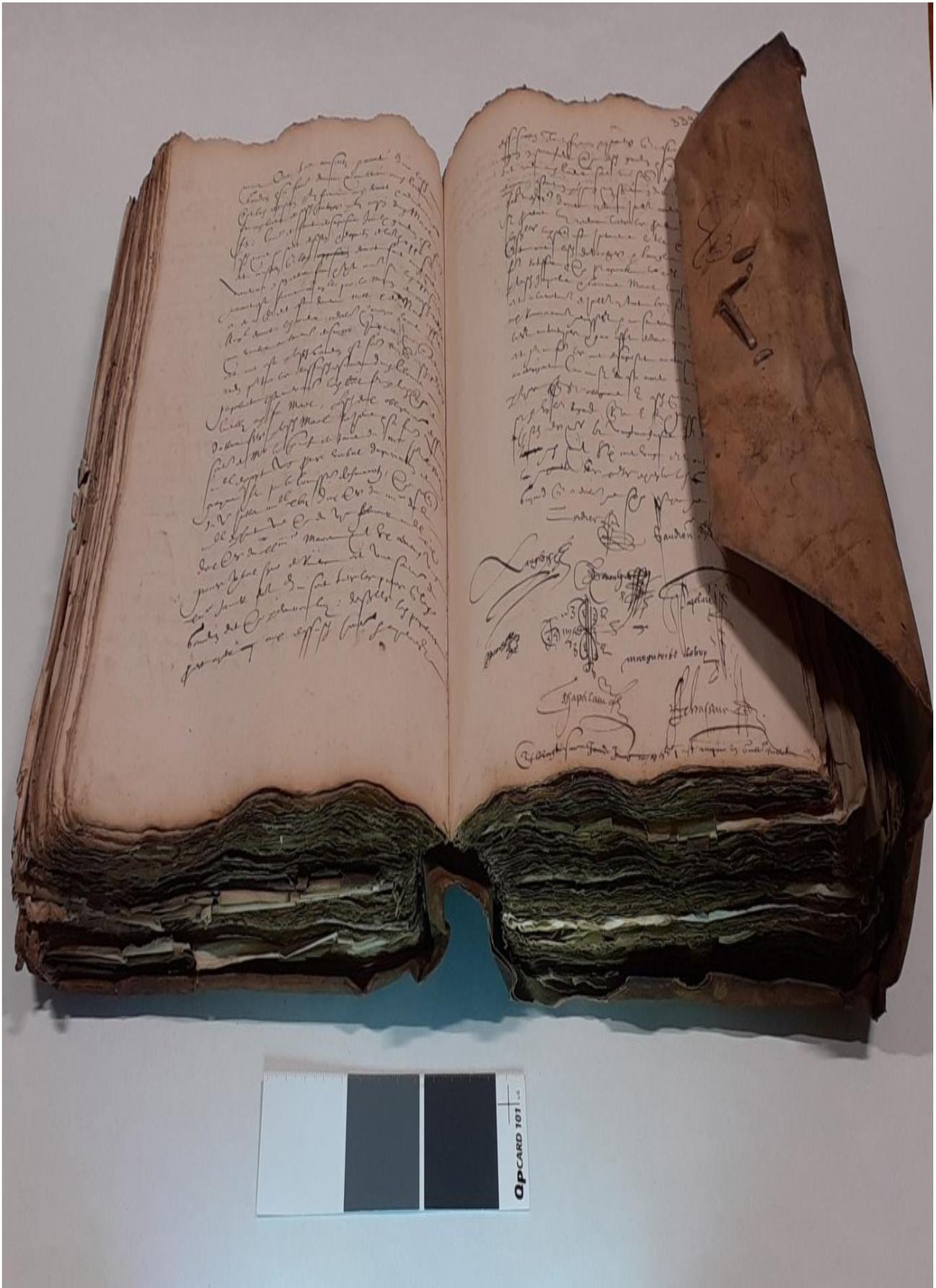
The application of standards such as ISO and ANSI for permanent paper, along with precise manual techniques for creating protective enclosures, forms a crucial barrier against environmental and mechanical degradation. Furthermore, the use of standardized "operating procedures" from initial measurement and cutting to final labeling and inventorying ensures that every manuscript is treated with the individual care it requires while remaining part of a searchable, organized collection.

The implementation of proper housing (conditioning) through the use of acid-free materials, permanent paper, and customized enclosures serves as the first line of defense against physical, chemical, and biological degradation. As demonstrated during the internship at the National Library of El Hamma, the transition from theoretical knowledge to precise manual application (such as crafting folders and boxes) is essential for ensuring that these fragile treasures remain accessible for future generations.

Ultimately, maintaining a rigorous methodology in handling and storage, supported by international standards (ISO/ANSI), is the only way to guarantee the long-term survival of our material heritage.

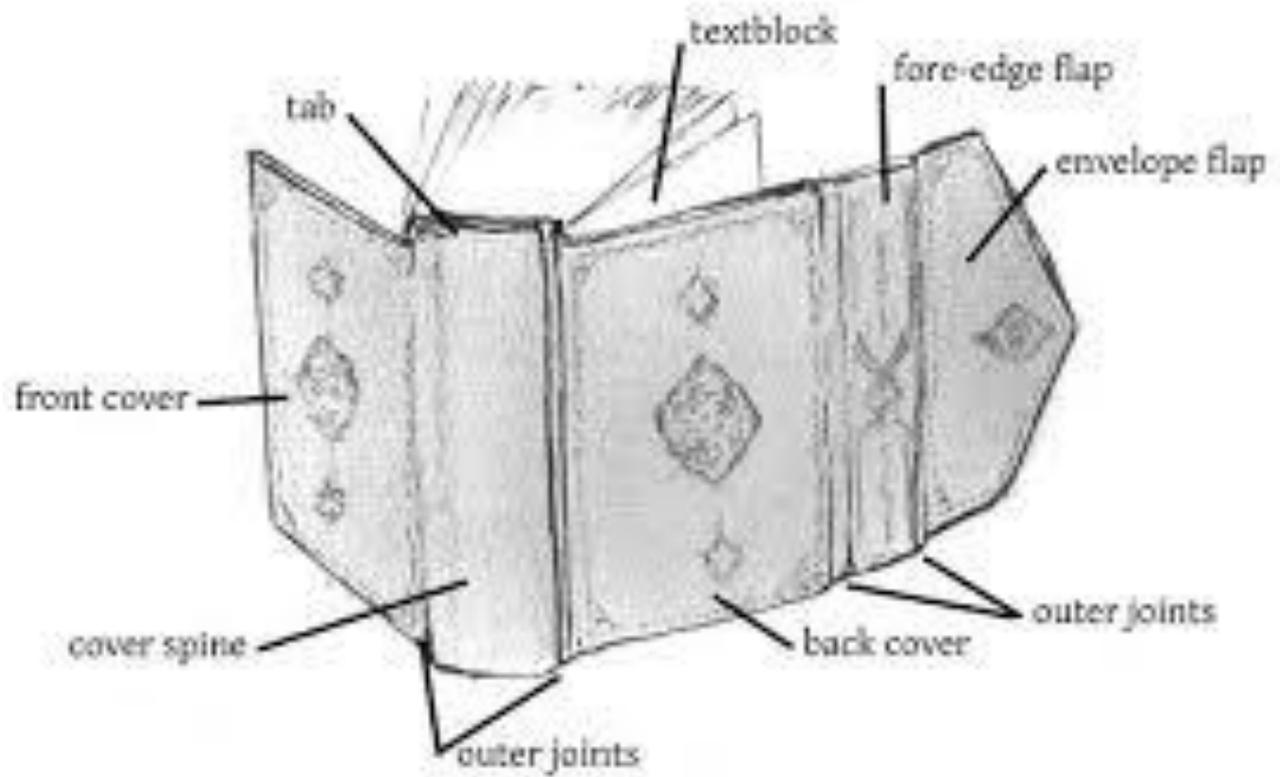
Ultimately, protecting these fragile historical assets is a continuous process. By maintaining the technical standards discussed, institutions can ensure that their documentary holdings are not only preserved physically but also remain accessible and intact for future research, effectively bridging the gap between past wisdom and future discovery.

Appendices











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