Graphic Documents

Graphic Documents

Typology and history

By graphic documents is meant objects as diverse as : books, manuscripts, drawings, engravings, posters and maps. They are composed mainly of organic material of which the origin may be vegetable (paper, bark), animal (leather, parchment), mineral (metals, precious stones) or more recently synthetic (film). They may be flat or three-dimensional. They are also defined by the technique used to transmit their message (manuscript, printed text, drawing, etc.).

The precursors of paper

Since the beginning of the human race, man has drawn signs on all sorts of materials : stone, bone, ivory, clay, metal, wood, bark and leaves, silk.

Stone, used since prehistoric times, is undoubtedly the oldest writing material. Fresh clay was used by the Chaldeans to engrave cuneiform signs. Wood, in the form of tablets covered with wax, chalk or plaster, was known to the Hebrews and the Greeks in the 9th century before our era. Silk was used in China before paper. Tree leaves, dried and rubbed with oil, were used by the Egyptians and the Indians (palm leaves). Tree bark was used almost universally : the Greek and Latin words for "book", respectively *biblos* and *liber*, both signify "bark".

– Papyrus

Throughout Antiquity, papyrus was the most used writing material. Papyrus is an aquatic plant, 2 to 4 metres high, which grows on the banks of the Nile. It seems to have been used in Egypt as long ago as 2 500 years B.C. and its use continued up until the 12th century of our era.

– Parchment

Parchment was used by the Egyptians, the Persians and the Greeks. Parchment was the most common writing material during the Middle Ages in Europe, where it replaced papyrus from the 3rd or 4th century, until the invention of printing in the 15th century gave rise to a strong demand for a lighter and more flexible material. In the beginning, parchment was rolled like papyrus, but it gradually came to be used in the form of a book or codex composed of several gatherings each of a certain number of pages.

Parchment is made from animal skin, generally sheep or calf skin. Vellum, made from the skin of a still-born lamb, is of finer quality. To make parchment, the skin undergoes lengthy processing : the hair and flesh are removed with the aid of lime, the skin is scraped, it is stretched out on a frame to dry, it is polished and finally rubbed with French chalk to make its surface suitable for writing.

Paper

Paper was invented in China. It was made from the bark of the paper mulberry tree. Paper dating from 200 years B.C. has been discovered in a Chinese tomb. Tsai Lun, born in 62 A.D. is thought by some to be the real inventor of paper in China. In any case, it was he who perfected and prescribed the method of papermaking. Subsequently the Chinese made paper from hemp, rhea, rattan, mulberry, bamboo, rice or wheat straw, or even old recycled paper. It was only in the 8th century that the Chinese were forced to pass the secret of papermaking to the Arabs.

Papermaking techniques were slightly changed by the Arabs, who introduced linen into the raw material and the use of paper mills. Paper arrived in Europe by two routes, one via Spain in the 10th century and the other via Italy in the 11th century. The first paper mills were set up in Andalucia, in

Cadiz and Seville. In Italy, paper was introduced via Sicily. In France, papermaking began only toward the middle of the 14th century. The use of paper spread with the invention of printing by Gutenberg.

– Hand-Made Paper

The types of paper produced in the Orient as in the West are made of cellulose (vegetable fibres or material made with these fibres, such as rags) and water by a technique which consists of turning the cellulose into a pulp, dispersing it in water, then letting it drain through a tight mesh mould. Once drained, the layer of pulp remaining in the mould is laid out on a felt, dried and pressed to make a sheet of paper which will undergo different treatment depending on the proposed use.

Until the 19th century, paper was made only from old rags made of linen, hemp or cotton. These rags contained pure cellulose, the other vegetable material in them having been eliminated during previous textile processing.

– Machine-Made Paper

In the 19th century, to cope with the shortage of cotton, experiments were made with other types of raw material : straw, annual plants, and finally wood which became the principal raw material from the second half of the 19th century onward.

Wood is broken down into its component fibres either by mechanical or chemical means. We therefore speak of two main categories of paper pulp : groundwood or mechanical pulp, and chemical pulp.

Groundwood Pulp

Groundwood pulp is obtained by grinding rounds of wood while water is sprayed over them, or by crushing wood chips between the two discs of a defibrator. The heat thereby given out softens the lignin which binds the fibres together. Due to its production process, groundwood contains all the elements of wood : the cellulose, but also the hemicelluloses and the lignin. This process is very efficient (over 90 % of the wood is transformed into pulp), which explains the low cost of groundwood pulp. Mechanical pulp is used mainly for making newsprint and cheap book paper. From the 1870s onward, groundwood pulp was used extensively for papermaking.

Chemical Pulp

Chemical pulp is obtained by dissolving the lignin using appropriate chemical reagents, in order to recover the fibres which are mainly composed of cellulose. The process is carried out at high temperature and high pressure for a variable length of time. This process is relatively inefficient (45-55 % of the wood is transformed into pulp) and the cost of the pulp is thus higher than that of groundwood pulp. Chemical pulp is used to make book paper and writing paper.

Because of the chemical agents used, the two main processes are referred to as 'acid' (using bisulphite) and 'alkaline' (using sulphate).

– The Bisulphite Process

The acid or bisulphite process became widespread after first being used on an industrial scale in 1874. Its active element is sulphurous anhydride which 'sulphonates' the lignin in the presence of heat and transforms it into soluble ligno-sulphonic acids which are then eliminated along with part of the hemicelluloses. These days production by this method is in decline, since new factories are designed for the sulphate process, which pollutes less and offers many advantages in terms of paper quality.

– The Sulphate Process

The alkaline or sulphate process, invented at the same time as the bisulphite process, suffered for a long time from the disadvantage of producing very dark brown pulp which was difficult to whiten using the techniques available at the time. Technical developments in the second half of the 20th century overcame this difficulty and gave the process great new potential, as it can be used successfully with all vegetable material, in contrast to the bisulphite process which can be used only with resinous woods.

The process uses sodium hydroxide (soda) as a descaling agent in the presence of sodium sulphide. It owes its name to the fact that the basic chemical producing these two reagents is sodium sulphate.

Sizing

At the beginning of the 19th century, traditional gelatine sizing was replaced by rosin sizing, which is cheaper and easier to use. Rosin sizing became widely used from 1826 onward.

Sizing is done by introducing into the paper pulp either a resin soap obtained generally by the reaction of rosin on soda, or an actual emulsion of rosin and paraffin. To obtain the gluing effect, aluminium sulphate is added to the resin. The consequent reduction in pH causes the precipitation of resinic acids from resinate ions. These precipitates are held by the fibres, but definite fixing occurs only after drying. This process is falling into disuse with the increasingly wide use of the alkaline sulphate process. In this case pine resin is replaced by synthetic resins

Recycled Paper

Recycled paper is currently the most important raw material for the production of paper and is increasingly frequently used for printing and writing papers. There are several reasons for changes in the paper industry : ecological (elimination of chlorine to avoid the formation of dioxin), chemical and technical (the use of new sizing products in a neutral medium). It is inadvisable to use recycled paper for archival storage, as the composition of the fibres is often unknown and variable. Moreover, such paper contains a high proportion of groundwood. The recycled fibres have been refined several times, dispersed, mixed with additives and dried at high temperature. Recycled water, increasingly used in papermaking to protect the environment, contains ionic substances and organic substances of low molecular weight which pollute papers.

Permanent Paper

Permanent paper is a paper made exclusively from chemical pulp in a neutral or alkaline medium. However, it is not necessary to use rags as a raw material. Wood may thus be used provided that all non-cellulose elements and particularly lignin are removed

The first international standard for permanent paper (ISO 9706) was published by the International Standards Organisation (ISO) in March 1994, and sets out 'requirements for the permanence of paper for documents', meaning that such paper remains chemically and physically stable for a long period.

This international standard is the equivalent of the American ANSI standard Z39.48 of 1992 : "Permanence of paper for printed library materials".

For a paper to be declared in conformity with ISO 9706 (or ANSI Z39.48), it must meet the following criteria :

- the pH of the aqueous extract of the paper pulp must be between 7.5 and 10,
- the Kappa number of the paper pulp, which indicates resistance to oxidation (linked to the presence of lignin), must be below 5,
- the alkaline reserve must be higher than or equal to 2 % of calcium carbonate equivalent,
- the tear resistance must be higher than 350mN for a paper whose weight is more than 70g/m^2.

The symbol for this standard is the mathematical sign for infinity within a circle below which appear the words "ISO 9706".

Synopsis : Typology of Traditional Carriers

Carrier	Date of appearance	Manufacturing
papyrus	400 BC (Egypt)	sheets obtained by cutting stalks from papyrus into strips and by superposing them perpendicular to each other, the adherence is obtained by pressure
parchment	1400 BC (Egypt)	skin of sheep or calf stretched on a frame and from which the grease is extracted with lime
paper	200 AD (China)	paper made from vegetal fibres (mulberry tree, bamboo etc.)
rag paper (Occident)	middle of the 11th century	paper made from old linen, hemp or cotton rags. The rags contained pure cellulose, as the other vegetal substances had been removed during textile processing
mechanical pulp paper	about 1867	pulp obtained by grinding logs under a stream of water, or by grinding chips between the two discs of a refiner
chemical pulp paper	about 1850	pulp obtained by dissolving the lignin with chemicals so as to leave fibres consisting mainly of cellulose
sulphite process (acid process)	about 1874	the active substance is sulphur dioxide which during pulping sulphonates the lignin and converts it into soluble ligno-sulphonic acids which are then eliminated with some of the hemicelluloses
sulphate process (alcaline process)	about 1878 (used since 1930)	this process makes use of caustic soda which, in the presence of sodium sulphide, removes encrustants. The fibre obtained through the chemical process no longer contains lignin. At present sulphate pulps are gradually replacing sulphite pulps
permanent paper	1994	paper which is manufactured by the alcaline sulphate process and contains an alkaline buffer. This paper refers to the international standard ISO 9706

Causes of deterioration

Causes of deterioration may be either internal (endogenous), or external (exogenous).

Internal Deterioration

If the component elements of a paper are relatively pure, it has good durability and quite long life expectancy. This is the case of most of the papers made up until the 19th century. Unfortunately, the appearance of wood pulp in the 19th century lead to a reduction in quality. Paper made with wood pulp purified more or less well according to the process applied - mechanical or chemical wood pulp - then sized with rosin (pine resin) in an acid medium stand up much less well to aging than most of the papers made previously. They yellow and rapidly lose their original flexibility. Many 19th and 20th century printed or manuscript documents kept in libraries and archives are today in very bad condition and can no longer be used by readers.

Chemical deterioration of industrially-produced paper results largely from the production processes used. There are two main types of deterioration : hydrolysis and oxidation.

The glucosidic links of cellulose are stable in a neutral or weakly alkaline medium. On the other hand, they become rapidly hydrolysed in presence of a strong acid or a strong base. This can be seen in the more or less significant reduction in the degree of polymerisation and therefore of the molecular mass.

Sizing with rosin has a very negative effect on the preservation of cellulose, as aluminium sulphate, used to precipitate the resin on the fibres of paper, is an acid salt which when combined with humidity from the air turns back into sulphuric acid, a strong acid.

Hydrolysis of the cellulose is promoted by the presence of oxide groups (aldehydes, carboxyls). Moreover, the presence of transition metals (iron, manganese) catalyses the oxidation processes including that of sulphur oxide which forms sulphuric acid.

Lignin and rosin may combine to form peroxides even at ambient temperature. These are very powerful oxidation agents which react directly on the different chemical groups of the cellulose.

External Deterioration

To the internal causes of deterioration may also be added the external factors such as air pollution, bad climate or lighting conditions and attack by biological agents (see the chapter on preservation conditions).

Preventive Measures

– Lighting

Three important factors need to be taken into account : the composition of light, the intensity of lighting and the duration of lighting. Light sources are natural (the sun) or artificial (electric lights). The following measures may reduce the damaging effect of light.

– Exclude ultraviolet (UV) and infrared (IR) rays by closing window shutters or by fitting blinds in the storage areas. When on display, framed works should be protected by filter glass. Fluorescent (neon) lights emit a high level of UV and it is essential to fit them with filters. UV radiation after fitting of filters should not exceed 75 microwatt/lumen. Documents must not be placed near any heat source emitting IR radiation (incandescent lamps).

– Check the light intensity. For fragile graphic documents (drawings, watercolours, colour photographs, illuminated manuscripts), the light intensity must not exceed 50 lux.

– Limit the duration of lighting. This must not exceed 3 months for a display period of 8 hours a day at 50 lux.

– Climate Control

For correct preservation of collections of printed books, manuscripts and prints, a temperature of 18° C +/- 2° C and a relative humidity of 55 % +/- 5 % are generally recommended.

The organic materials making up the majority of documents are very sensitive to fluctuations in relative humidity, so this must be kept stable throughout the year.

– Combatting pollution

Graphic documents must be protected against air pollution. Modern air conditioning plants can be equipped with good-quality filters which stop chemical and particulate pollution. In the absence of such a system, it is even more essential to ensure the maintenance of storage areas, especially by regular dusting and placing documents in protective containers.

– Combatting biological agents

Biological agents spread preferably in dirty and damp areas. It is absolutely essential not to bring organic material (foodstuffs, unauthorised cardboard packing material) into storage areas. Also, older

documents acquired by donation or purchase must first be examined and if necessary disinfected. In case of doubt, these documents must be quarantined and their state of preservation assessed by a specialist.

Regular inspection and preventive treatment of the building (cleaning, traps, etc.) will banish harmful insects and vertebrates, while at the same time being cheaper and less harmful for staff, collections and the environment than the chemical treatment which is indispensable following an infestation.

– Handling, moving and using documents

The golden rule when handling documents is first of all to provide a clear area where the documents being moved can be laid, and secondly to pay constant attention to gestures.

When moving documents, one must avoid carrying documents of different sizes and weights together. Heavy documents must be moved on a trolley. Books must be placed upright and held firmly in position. They should not be placed on the spine or on the fore-edge, as that could break the binding at the joints. Books in boxes must be laid flat for transport, except in the case of large items for which this is not possible. In this case, the works are to be transported upright if they are mounted on panels, or rolled around a rigid tube. One must also become familiar with the types of fastening of the various containers (handle, cord, Velcro), in order to avoid their contents unexpectedly falling out.

In archives and libraries, care should be taken not to make available to a reader any document which is on restricted access, or an original document if a surrogate copy exists (microform or photograph). When giving documents to a reader, one should not place them one on top of another, nor place them on a surface which is not flat or not cleaned. The researcher must be informed of the essential rules for handling documents. The principles to follow when consulting documents are the following : it is forbidden to drink or eat near documents, to lean on documents while reading them or while taking notes, to mark documents in any way, to fold the corners of pages, etc.

Before returning documents to the shelves, one must check that protection systems are back in place (box, envelope, clasp, dividers). Documents should not be shelved too tightly or too loosely together. Force should never be used to place a document or a container on a shelf.

– Security of collections

To protect collections against theft, buildings must be equipped with security devices. This does not do away with the need for monitoring in the reading room (which requires constant vigilance on the part of the staff, and perhaps also cameras).

In every institution, the risk of fire must be minimised by the installation of smoke detectors or heat detectors. In places where graphic documents are stored, smoking should be prohibited everywhere at all times.

In addition, it is highly advisable to put in place a permanent programme for disaster prevention, and an emergency plan. Prevention is done by means of regular inspections of risk areas (for example, roof gutters which may become clogged up in autumn), whereas the emergency plan ensures that, in case of disaster, the essential human expertise and materials for rescuing documents are available.

Standards

Standards in preparation :

ISO / DIS 11799	Document storage requirements for library and archive materials.
ISO / DIS 11798	Permanence and durability of writing, printing and copying on paper - Requirements and testing methods.
ISO / DIS 14416	Requirements for binding of books, periodicals, serials and other paper documents for library and archive use - Methods and materials.
ISO / CD 15659	Standardization of permanent and durable boards used for bookbinding and document storage purposes.

Published standards :

ISO 9706 : 1994	Information and documentation - Paper for documents - Requirements for permanence.
ISO 11108 : 1996	Information and documentation - Paper for archival documents.
ISO 11800 : 1998	Information and documentation - Requirements for materials and methods for bookbinding.

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La Conservation - Principes et réalités. Sous la direction de Jean-Paul Oddos. -Paris : Editions du Cercle de la librairie, 1995.

Protection et mise en valeur du patrimoine des bibliothèques. Recommandations techniques. Sous la direction de Jean-Marie Arnoult. - Paris : Direction du livre et de la lecture, 1998.
(http://www.culture.fr/culture/conservation/fr/preventi/guide_dll.htm)

UNESCO RAMP Studies which are usually available in English, Arabic, Chinese, Spanish, French and Russian.

Publications by the Commission on Preservation and Access (Washington D.C., Etats-Unis d'Amérique) and the European Commission on Preservation and Access (Amsterdam, The Netherlands).

Website Directory

Mass Deacidification

Mass Deacidification
A bibliography and list of documents available online.
http://palimpsest.stanford.edu/bytopic/massdeac/

Mass Deacidification. An update of possibilities and limitations
Report by Henk J. Porck on the advantages and limitations of the most frequently used deacidification treatments, published in 1996.
http://www.knaw.nl/ecpa/publ/porck.htm

Technology Helps Library Save Its Paper Collections
"Bookkeeper" - new deacidification treatment based on impregnation of documents with oxide of magnesium, presented by Will Dalrymple in the Bulletin of the Library of Congress.
http://lcweb.loc.gov/loc/lcib/970421/web/deacid.html

Permanent Paper

International standard ISO 9706 : Information and documentation - Paper for documents - Requirements for permanence
http://www.iso.ch/catf/d17562.html

Discussion Lists

Book_Arts-L Archives
A list managed by the University of Syracuse and intended for art book specialists, curators etc. The list archives can also be consulted.
http://palimpsest.stanford.edu/byform/mailing-lists/bookarts/

ExLibris Archives
A discussion forum hosted by the University of California (Berkeley) on rare books and manuscripts. The list archives can also be consulted.
http://palimpsest.stanford.edu/byform/mailing-lists/exlibris/

Websites last visited : 2nd August 1999