# Diversity of Transparent Papers in Public Collections: A Conservation Challenge

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DOI: 10.48341/hkcd-k359

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*Keywords:*
Transparent Paper
Tracing Paper
Parchment Paper
Glassine Paper
Grease-Proof Paper
Oiled Paper
Varnished Paper

**ABSTRACT**

Documents on transparent paper do not form a homogeneous group that can be isolated from documents on usual paper. Generally they are scattered in various heritage collections, mixed with other kinds of graphic items or with three-dimensional objects, forming heterogeneous sets : drawings of course but also photographs, models, handwritten or printed notes, correspondence, invoices, contracts, newspapers ...

They can be grouped in the following categories: geographical maps, artists' drawings, architectural plans, technical and industrial drawings and decorative drawings.

Documents on transparent paper have other common characteristics such as their dimensions which can vary from some centimeters to a few square meters, the number of items for a single project and the periods covered which start from the 18th century to the present. But above all, their interest, with the exception of artists' drawings, is essentially documentary and historical. They rarely have an autonomous function and are linked to other documents in a chain of production of objects. Being only intermediaries in the manufacturing process, they often disappear, along with their use value. Until very recently, their number and size have led to their disappearance.

From the beginning these common characteristics combined with their spectacular deterioration due to the nature of the constituent materials and their production methods, have given them an ephemeral character. These special features make their management very complex.

The article after a brief historical and technical introduction, will describe the various categories of documents carried out on transparent paper. In conclusion, it will present the challenges that the conservation of these heterogeneous sets of documents represent in an institution.

## Introduction

The term "tracing paper", commonly used to designate transparent papers, refers to the function rather than the particular nature of the paper. A drawing can be traced on plain paper or canvas. Transparent paper can also be used for purposes other than drawing, such as electrical insulation or food packaging. The present article will limit its scope of interest to transparent papers used as a drawing carrier and will exclude other categories for domestic or industrial uses.

Transparent papers in heritage collections belong to several categories of documents that generate problems, specific to heterogeneous collections, both in terms of conservation and management. This issue is related to the problem of objects of large numbers and large dimensions with in a collection. Museums, libraries and, above all, public and private archives house these collections.

Documents on transparent paper are ephemeral items, not only because of their initial purpose, but also because of the quality of their constituent materials, which leads to their accelerated ageing. In fact, the various manufacturing techniques used to obtain transparency lead to extreme degradation processes which weaken these documents.

Considered of lesser importance because of their utilitarian vocation, the documents are not carefully cared for and are often poorly preserved. Their initial function as information vectors and their large size lead to repeated and hazardous handling, which is damaging to them and can result in their rapid disappearance.

The survival of these documentary collections is often precarious; finding solutions for their consultation and conservation before they disappear represents a challenge and a matter of urgency for heritage institutions.

The author points out that she has already developed historical aspects and production methods of transparent papers in two previous articles, so these points are only summarized here.[1] For more detailed information, please refer to the thesis mentioned in the bibliography.[2]

## Technical and historical overview

### Production

The processes used to obtain transparency are not described in detail in this article. We will simply remind that the aim of all treatments is to compact the fibers tightly and fill the voids by expelling air, to allow light rays to pass through the sheet without being scattered. By homogenizing the medium, its refractive index becomes similar to air and the paper becomes transparent.

Paper transparency can be increased either by impregnation with a fatty or resinous substance (*varnished, oiled or waxed papers*), or by intensive refining of the pulp followed by pressing the sheet (*natural tracing paper*), or by pressing the sheet after immersion in a sulfuric acid bath (*sulfurized paper*, also known as *vegetable parchment*), or by calendering a sheet obtained by intensive refining (*glassine paper* and *imitation parchment paper*), or by a mixed technique consisting in impregnating a sheet of natural tracing paper or sulfurized paper with a resinous or grease filler (*artificial tracing paper*).

*1 For further information on technical and historical aspects of transparent papers, see : Laroque, C., 2000 and Laroque, C., 2004.*
*2 Laroque, C., 2003.*

These production methods lead to papers with different physical and chemical properties. While a few clues may indicate how transparency is obtained, in general the papers are difficult to identify without analysis. For example, varnish-coated papers, when applied directly to thin opaque paper are generally identifiable. However, this is no longer the case with artificial tracing paper. In this case, chemical analysis of the components and SEM images are required.[3]

The ageing behavior of transparent papers varies from one type to another. Yellowing, loss of transparency and mechanical brittleness are the most frequent results of ageing.

The changes result from the degradation of the composition elements of the paper in combination with factors external to the material, such as its immediate environment.

The loss of initial physical properties results in a reduction in the paper's flexibility and an increase in its mechanical fragility. Paper breaks under even the slightest bending, tensile or pressure stress with consequent loss of material.

The change in optical properties takes the form of two interrelated phenomena: yellowing and increasing of opacity, with the corollary of reduced transparency. These changes can be very rapid.

## Historical summary

Technical treatises from the Middle Ages to the end of the 19th century provide various recipes for the manufacture of transparent tracing carriers.

Before the emergence of paper, parchment was used, thinned beforehand and coated with a fatty substance, varnish or glue [4].

The techniques described for making paper transparent are similar: use of drying oils such as linseed or walnut oil[5], or resin-based varnishes such as rosin, sandarac, dammar or mastic, alone or in mixtures[6].

Studies carried out at the beginning of the last century on plant fibers[7] and more specifically on cellulose and starch, led to the discovery in 1846 of the "sulfurization" process, a method that produced a translucent paper known as "vegetable parchment". This discovery is attributed to two Frenchmen, J.A. Poumarède and Louis Figuier[8]. The first patent for this process was registered in 1853 by an English chemist, W.E. Gaine[9].

A few years later, in 1859, the Englishman Taylor published a patent on the use of zinc chloride as a substitute for sulfuric acid, which produced a similar result[10]. The fibers were then said to be "vulcanized"[11].

Industrial production of parchment paper began in Europe around 1860. Germany was the most important manufacturer and later France, Belgium and Austria set up factories. The United States followed suit around 1885[12].

In parallel with the manufacture of parchment paper, research was carried out into the production of transparent paper at a lower cost.

*3 Laroque, C., 2004.*
*4 Faidutti, M., Versini C., 1979, p.57-58. Saxl, H., 1954, p.68-87.*
*5 Blanchard, Perot, E.M., Thillaye, 1856. Cennini. C., Reprint 1978, p.6-18. Merifield, M.P., 1967.*
*6 De Fontenelle, J., Poisson, P., 1828. Diderot, D. and D'Alembert, J.L.R., 1772.*
*7 Berthelot, M., Dreyfus, F.C., Derenbourg, H., 1886. Wurtz, A.D., 1876.*
*8 Poumarède, J.A., L.G. Figuier, 1847.*
*9 British Patent Nr 2834.*
*10 British Patent Nr 787.*
*11 The term « vulcanization » is used when a reagent (zinc chloride, here) is introduced to create bridges between molecular chains. In the case of paper, this involves gelling the cellulose. Le terme vulcanization est employé lorsqu'on introduit un réactif (le chlorure de zinc dans le cas présent) afin de créer des ponts entre les chaînes moléculaires. Dans le cas du papier, il s'agit de gélifier la cellulose.*
*12 Kotte, H., 1973, p.90-91.*

Around 1878, Robert Emmel, a German citizen[13], carried out studies on the effects of intensive refining of rag pulp, another method for obtaining transparent paper. The process was then adapted to chemical pulps, giving rise to *natural tracing paper*.

The production of glassine paper began late, around 1894. Scandinavians held the monopoly for most of the 20th century. The process consists of cooking a bisulfite pulp at low temperature with lime which then undergoes a lengthy refining process. Finally, the paper is strongly pressed and rubbed on a calender.

Over the 20th century, techniques became more complex by mixing processes: sulphurized or refined papers will be impregnated or coated with resins or oils to improve their characteristics[14].

After the Second World War, synthetic resins were increasingly used, alone or in blends of several polymers, to impregnate paper.

The industry of transparent paper is focusing on three markets: true sulfurized papers, which will become papers for industrial or domestic use; special papers for luxury packaging, which include glassine papers; and lastly, so-called "tracing" papers for graphic use.

Finally, transparent film, essentially made of polyester, will partially replace paper in technical applications[15].

## Various document categories

Using the word ‘collection’ to describe a group of items executed on transparent paper is rarely appropriate because the type of documents executed on transparent supports are not usually themselves a homogeneous group distinct from other works or documents on plain (non-transparent) paper. As said in the introduction, documents or works on transparent supports are found scattered within the various categories of heritage collections, mixed with other kinds of graphic documents and ephemera/supporting work. This often arises when material from specific projects is grouped together and the documents on transparent paper are considered secondary. For example architectural drawings on transparent paper may be kept with three-dimensional scale models of the building to which they relate.

There are however certain collections which usually do contain a large number of documents on transparent paper. These include architectural drawings (permanent or ephemeral architectures such as theater sets); technical drawings, such as those made by engineers; design drawings which mark the steps in the production of objects; scientific drawings, including archaeological drawings; maps; and artists' drawings.

Drawings whether on transparent paper or not, executed during fabrication of a building, a car, or a painting share certain similarities. For example, all include overall drafts (sketches, outlines that convey the author's intention), more finished drawings, and detailed drawings (usually more accurate) which mark other steps in the creative process[16].

Although museums and libraries can hold items from professions that regularly produce works on transparent paper it is primarily public and private archives or other specialized centres which house architectural, geographic and technical collections.

*13 Emmel, R., 1914, p.272-73.*
*14 Rundle, C., 1986. Van der Reyden, D., Hofmann, C. and Baker, M., 1993, p.177-206*
*15 Adelstein, P.Z., 1988. p.89-101. Anonyme, 1980, p.33-39. Page, S., 1992.*

*16 Rundle, C., 1986. Van der Reyden, D., Hofmann, C. and Baker, M., 1993, p.177-206*

These collections are by their nature heterogeneous, comprising of drawings on a variety of supports, of course, but also photographs, three-dimensional models, manuscript notes, correspondence, invoices, contracts, newspapers, etc. Artists' drawings, on transparent paper on the other hand, belong to more traditional fine art collections and are mainly found in museums.

The development of organizations such as the Committee on the Preservation of Architectural Records (COPAR) in 1970 and the creation of the International Confederation of Architecture Museums (ICAM) in 1979 have elevated the reputation of architectural drawings. Interest in architectural material by the art markets since 1975 coincides with the movement for the preservation of buildings and landscapes[17]. Technical drawings, always considered to be of low artistic value, still generate little enthusiasm. There has however been a growth in interest over recent decades in design drawings in the decorative arts.

Apart from their limited perceived value, transparent paper documents have other common traits. One of these is their non-conformity in size, they can range from the size of a postage stamp to that of a few square metres. Another, and perhaps most important aspect of works on transparent paper is that they are seen as providing documentary or historic supporting evidence rather than as works in their own right.

Thus, from the moment of their creation, these documents are ephemeral in nature, rarely existing on their own, but linked with other documents in a production chain. The drafting process, from conception to completion, of a complex product such as a car, generates dozens of drawings. As these drawings are only steps in the manufacturing process, in many cases, they have not been kept as they take up too much space. At present the use of transparent papers in all areas of traditional use is declining in favour of transparent films, microfilms, or digital images, and thus transparent papers are becoming rare.

Despite the tendency in the past for the disposal of works on transparent paper by their authors, large numbers still survive.

***Fig. 1:*** *French National Archives : Document stacking*

Another common characteristic is the size of collections of utilitarian drawings found among public records. A survey conducted in 1999-2000 by the Institute of Paper Conservation of 221 institutional collections of architectural drawings (including public and private archives, libraries, and museums) showed that collections ranged in size from 500 to more than 50,000 items, with the average being between 2,000 to 50,000 items[18]. In the literature concerning conservation and management of these huge collections, there are many examples in which the quantities of material contained in collections are as-

*17 World Heritage Convention, formally Convention concerning the Protection of the World Cultural and Natural Heritage, November 23rd 1972.*

*18 Collective, 1999. The Institute of Paper Conservation or IPC, (GB), produced in 1999 a collective work called « Care and conservation of architectural plans » which was available online at that time.*

sessed[19]. However, the nature of the support, either opaque or transparent paper, is not always mentioned. This lack of detail shows clearly that within many of these collections, documents have not always been classed according to the type of material used as a support. It also shows that these enormous collections form a highly complex whole.

Although the survey of the IPC focused only on the architectural drawings, it can be regarded as a good illustration of the body that represents the collections of utilitarian drawings.

Each group of drawings previously defined, introduced particularities of its own and which are interesting to describe. The collections are described as entities of all types of paper whether they are transparent or not. The four following paragraphs summarize these specificities. The nature of the materials employed (supports and media) will be described in detail only in the section on architectural drawings because their use is redundant in the other categories.

## Architectural drawings

Architectural collection materials produced by architects, engineers, and contractors include documents of various kinds that are predominantly two-dimensional. This is also the case for documents produced during the daily management of a company (correspondence, reports, contracts, catalogues, newspapers and records) and the materials the company produces (such as photographs, drawings, prints, books). Three-dimensional works such as models also occur.

Of all the archival material associated with projects it tended to be the drawings that were valued most and indeed retain their value for collections now. The retention of drawings has often led to the disappearance of other documents with the exception of photographs. In fact, before 1870 many architects destroyed even their drawings after the construction of the building because, estimated to be of little interest, the drawings required extensive space for their long-term storage. After 1870 in France, documents acquired a certain legal status and were thus retained[20]. Priority was given to the most highly finished drawings, namely drawings for presentation and execution because of their legal value, while sketches were often discarded. Currently, when an architect's project archive is given to a museum or archive, everything is preserved. This blend of artistic work and archival material however calls for the establishment of a criteria to set out the relative value and importance of individual works in order to solve the management problem of these collections.

### Categories of architectural drawings

The material and intellectual management of collections of architectural drawings is a complex activity. Listing and producing documentation relating to a large quantity of work requires a set of clearly defined terms, a common vocabulary, that can be used by the various people involved in managing the collections. Questions of attribution of drawings within any one project may also be problematic as several people may have been involved at different stages of production.

*19 See for extensive references : Laroque C., 2003 and in particular Alper, D., 1992, p. 173-178. Bush, A., 1986. Carlson-Schrock, N., 1988, p.3-9. Cook, P., Dennin, J., 1994, p.11-19. Hamill, M.E., 1993, p.24-31. Lavrencic, T.J., 1987, p.139-147. Rowlands, J., 1997, p.7-9. Stone, J., 1987, p.731-738. Yates, S.A., 1984, p.20-39.*

*20 Daniels, M., Peyceré, D., 2000, p.59-62.*

The establishment of computerised catalogues in the form of databases facilitating research in multiple collections has accelerated the formation of an agreed terminology by historians. The nomenclature given below corresponds to the traditional method of the production of drawings by hand[21].

*1. Preliminary sketches*

These drawings show the initial ideas of the architect and are often executed on any support, even one of poor quality.

***Fig. 2:*** *Administrative Library of Paris: 1937 Exhibition, Project for the Gateway to Overseas France, preliminary sketch*

*2. Study or production drawings*

These drawings are developed during the project. They are made to scale and are more accurate and precise. They are often made on transparent paper to allow details of previous sketches to be traced.

*3. Presentation drawings*

These drawings are made at a later stage in the project and are frequently carried out by a specialized draughtsman; indeed, in architectural firms, collaboration between architects and draughtsmen is common and often freelance draughtsmen are involved[22]. These drawings are often made in colour and are executed on good quality opaque paper or transparent paper mounted on card. These are usually drawings of building elevations and may be intended to obtain the approval of a sleeping partner; the execution of the drawing and layout are very highly finished. Presentation drawings are only a small part of the production of an architectural firm.

*4. Working drawings*

These drawings are carried out once the project has been finalized, after the client's approval and before construction. They are made either by the firm's team or by freelance draughtsmen. They are detailed scale drawings which give final dimensions and symbols. They are used, as in the case of reproductions made from originals, during the construction of a building and are given to the construction company to be used as working drawings. This functional aspect has obviously a direct impact on their conservation. These drawings to scale are very often the only remaining evidence of a building after its construction, as reproductions made from them are legal documents required by French law in order to obtain building permits and to be granted permission by local councils for the newly built building to be signed off on completion of work[23]. Scale

*21 Daniels, M., Peyceré, D., 2000, p.23-32.*

*22 The name of the architect or the name of the firm is inscribed on the bottom right and that of the designer on the left.*

*23 These documents must be kept for 30 years; in the event of a claim, they can be used to determine re-*

drawings are mostly done in graphite on transparent paper while final working drawings are executed in ink on drafting cloth.

***Fig. 3:*** *French National Archives : Fonds Nenot, La Sorbonne, presentation drawing*

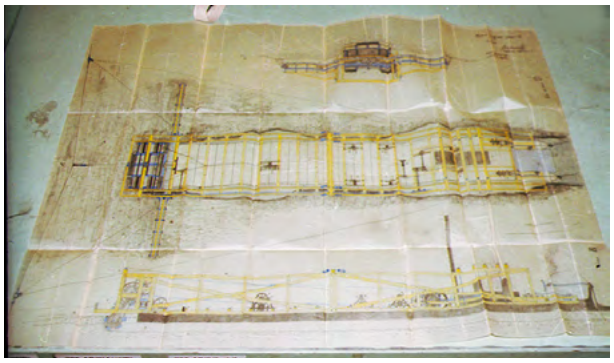

***Fig. 4:*** *French National Archives : Dredging boat for the Loire, working drawing*

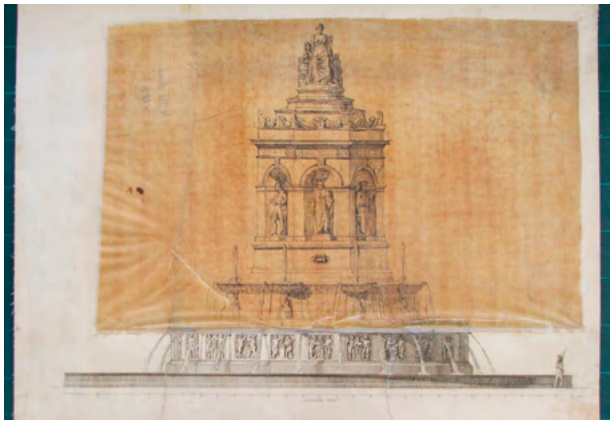

***Fig. 5:*** *French National Archives : Fountain project in Paris*

*5. Archive drawings*

These drawings are made once the building has been completed and resemble the presentation drawings closely. Used for publicity or to provide a record, they will be replaced in the 20th century by photography.

*sponsibility between the designer - the architect - and the builder - the contractor - for design faults and poor workmanship.*

***Fig. 6:*** *Administrative Library of Paris : Detail of urban planning*

***Fig. 7:*** *Vivenel Museum, Compiègne : Sarnus Door in Pompei ; final drawing*

*6. Other*

This category may include conceptual drawings of unrealised projects such as student drawings, drawings for competitions which are unsuccessful, travel sketches, controversial or imaginative drawings, collages or photomontages. There are often several versions of the same drawing, for example presentation drawings on lined paper, copies made on drafting cloth for use as working drawings and reproductions made from drawings on cloth which give specifications for heating, lighting, etc.

## Materials for architectural drawings

The nature of materials and tools used in the production of architectural documents has evolved over time. Indeed materials traditionally used by architects such as graphite pen-

cil, black and coloured inks and tracing papers are at present being largely replaced by felt tipped pens and transparent plastic films.

It is not unusual to see certain architects favouring specific materials and techniques. Frank Lloyd Wright, for example, particularly appreciated the hard and smooth surface of tracing paper which permitted incisive pen and ink lines to be drawn. Although he did use other supports, such as white or coloured watercolour papers, Asian papers and drafting cloth.[24]

Nancy Carlson Schrock examined the materials constituting the Peabody collection in Canada, and noted that over a 47-year period the firm used the same materials for the same phases of work: preliminary drawings were made on transparent or opaque papers; presentation drawings with watercolour wash were traced on a drafting cloth which allowed for reproduction due to its transparency; working drawings were first executed in graphite pencil, then in coloured ink and watercolour wash on opaque paper, and later executed on a commercial lined paper[25].

*1.Supports for architectural drawings*

Architects, in the same way as artists, choose their drawing supports according to two main criteria: the surface qualities required for a given technique and the overall strength to withstand the rigours of working methods where scratches and holes are caused by drawing materials such as the compass, rollers and pens. In addition, cost plays a role in the selection process as the quantity of material used by architects' firms is not negligible. Architects have therefore represented a significant market for paper manufacturers for more than a century, at least from the second half of the nineteenth to the last decades of the twentieth century. Competition between different paper manufacturers can be seen in artists' supply catalogues, which, along with technical manuals for architects and the original documents themselves, represent the main source of information as to the most popular materials and techniques.

The quality of a support varies with the type of drawing. Studies and detailed drawings for construction are executed most often on opaque drawing paper, transparent paper, or plastic film, while presentation drawings are executed on high quality paper, drafting cloth, or transparent paper lined on board.

A list of supports found carrying architectural drawings from the 18th century would include:

- Handmade or commercial watercolour and drawing papers in sheets or mounted on canvas.
- Machine-made papers of various qualities in rolls for large formats.
- Drawing paper in booklets.
- Printed papers of various kinds, such as squared graph paper.
- Trade artist boards for illustration purposes.
- Transparent papers of various kinds, in sheets or laminated on board or on canvas.
- Very thin papers called 'silk paper' stretched around or laminated on watercolour paper, canvas, or paperboard.
- Drafting cloth made from bleached cotton or linen and slightly bluish in colour to increase transparency in the

*24 Mac Clintock, T.K., 1986.*
*25 Carlson-Schrock, N., 1988.*

actinic light. Drafting cloth was coated with starch sometimes including wax, resin, or oil, and calendered[26]. Some cloths were coated with cellulose nitrate. Before being used for drawing, the surface was lightly sanded with powdered chalk or coated with a layer of ox-gall to reduce its smoothness. Sometimes the coated face received the drawing and coloured wash was laid on the reverse. This material was seen as being stronger than transparent papers for reproduction. Drafting cloth was used until the twentieth century before being replaced by films[27].

- Plastic films such as cellulose acetate were used around 1950 and polyester were used from 195528.

*2. Media and tools for architectural drawings*

Media used for architectural drawings vary depending on whether they were to be used as underdrawing (graphite pencil, charcoal, metalpoint, chalk, "transfer medium"[29], "transfer ink"[30]), or as final media (watercolour in pen and wash, inks, coloured pencils, gouache and more recently felt tipped pens and transfer letters).

Pens, ruling-pens, brushes and pricking wheels were the tools most commonly used by draughtsmen.

Materials for erasing included chamois leather, sandpaper or bread, rubber eraser (after 1839) and later after the second world war, synthetic resin erasers and fibreglass pencils. The frequent use of these abrasive substances has often left its mark on the drawings.

At the turn of the twentieth century, the range of practices became restricted as architects turned to dry techniques, especially the graphite pencil, for the execution of working as well as presentation drawings in order to reduce working time. The development of diazotype which allowed the reproduction of graphite pencil lines also encouraged architects to favour the use of graphite.

*3. Major photo reproductive processes for architectural drawings*

The processes used in the reproduction of drawings are constantly evolving. It seems likely that large-format photocopying will replace the other processes. At present, the processes fall into three chronological groups:

- Pre-19th century, where copies were made by hand by tracing an original.
- Post 1850, when the heliographic wet development processes were developed.
- Early 20th century to 1960, when the diazotype process was used.

The principle of photo-reproductive processes was that a support coated with a photosensitive chemical was placed in contact with a drawing on a transparent material then exposed to light. The sensitive layer was affected by light and the new image appeared after the support was developed either in a bath or through contact with the vapours of a chemical reagent. The drawings appeared in different colours depending on the nature of chemical process used and the method of direct or indirect exposure to light. Initially

*26 Patents : Matsuura, 1933 Japan 101.637 and Murck, 1935, US 20018638.*
*One of the most famous factories is Winterbottom in Manchester, where production began between 1853 and 1872.*
*27 Lubick, A., 1999, p.40-42. Price, L.O., 1999, p.82-87. Sugarman, J.E., 1986, p.39-60.*
*28 Adelstein, P.Z.. 1988, p.89-101.*
*29 Transferring a drawing to another support using rubbed pencil.*
*30 Inks with added sugar.*

all elements of this procedure needed to be made, then after 1876 commercially made pre-sensitised papers were used and exposure was carried out under electric light. From 1920 machines were used to produce reproductions in a continuous fashion.[31]

The ageing properties of these documents are directly related to the method of production which also determines whether they can be stored safely in contact with other materials within the collection. Their preservation requires consideration and care similar to that given to photographic materials.

## Technical drawings

Among all examples of objects stagnating in the storage areas of heritage institutions, technical graphic documents are undoubtedly among the most neglected. As utilitarian documents produced in large numbers, they take a large space in terms of volume in the institutions.

As intermediaries between creation and production, intended by their very nature to disappear in favor of the final product, they have embarrassed rather than interested persons in charge of storing them.

But, historians' scientific interest has been growing over the past half-century. As in the case of ethnographic heritage, or more recently industrial heritage, we are witnessing a growing awareness of the importance of preserving these fragile witnesses of our bygone past. Sometimes the sole survivors of a heritage that has totally disappeared - demolished buildings, destroyed objects, totally altered landscapes, intermediate states of paintings that no longer exist - they are the only reference points for studying the structure of a town, an object, an industrial activity, a geographical area, etc.

The term 'technical drawings' covers a very wide field, extending from industrial drawings (i.e. plans of machinery), through design drawings in the decorative arts (such as jewellery, precious objects such as fans, bookbinding decoration, domestic decorative elements such as blinds, lamps, screens, or crockery) and fashion design drawings, to botanical, zoological or archaeological survey drawings[32]. As with architectural drawings, they reflect the stages from design to production of objects.

During the last decades, certain types of technical drawing have gradually changed status. This has been seen for example in the enthusiasm for ships' plans which are increasingly regarded as artistic drawings[33]. As with architectural drawings, ships' plans are rather sophisticated drawings, detailing structural, mechanical and internal designs.

In a similar way, drawings from the decorative arts directly related to popular areas such as fashion, jewellery and furniture are sought after by admirers of beautiful watercolours and can often be seen in exhibitions on these themes[34].

At the end of the 19th century, Berthelot already considered technical drawing to be primarily a vehicle of communication between two steps of production: conception and manufacture[35].

*31 Arnow, J., 1982. Bayer, S., M., 1980. Brunner, F., 1984. De Gorter, B., 1949. p.1-11. Griffith, S.R., 1968, p.199. Kissel, E., Vigneau, E., 1999. Proutfoot, W.B., 1972. Wallace, D.K., 1933.*

*32 Before the invention of photography, explorers were accompanied by draughtsmen.*

*33 Lyon, D.J., 1983, p.73-77*

*34 For example in the exhibition «Les bijoux de Cartier » at Petit Palais Museum in Paris, in 1989 or in the exhibition on Registered trademarks in Paris Archives in 2003.*

*35 Berthelot, M., Dreyfus, F.C., Drenbourg, H., 1886 : « In architects' offices and in machine shops, tracings are made in large numbers to distribute the work to contractors and fitters ».*

Technical drawing is seen to participate in the harmonious organization of the work of various players using codes understood by all and which call to mind materials, surfaces, etc. It is essential they provide clear information. Drawings which are simplified to allow a better reading of the structure of objects may be accompanied by explanatory text[36].

The division between inventor and manufacturer goes back to the eighteenth century during which time technical learning began in the arts and craft schools and descriptive geometry appeared[37]. It was at this time that industrial drawing began to develop growing in response to changes in industry[38]. The 19th century saw the development of companies specializing in technical drawing, coinciding with the growth of new activities, such as the construction of railways. Drawing instruments were perfected in response to new requirements for precision, particularly in engineering drawings[39]. In large construction offices, the tracer superseded the draughtsman and often the former was a woman, charged with making a copy in ink on transparent paper of a pencil drawing. Transparent papers offered, in addition to reproduction of drawings, the possibility of easily updating work[40].

Prior to the use of photocopiers, technical drawings on transparent paper, like architectural drawings, were intended to facilitate the quick reproduction of plans for distribution among the various people involved in the production or manufacturing process. Like architectural drawing collections, technical drawing collections include sets of different kinds of drawings which can be divided into originals and duplicates. In many cases the originals have disappeared and originals and duplicates are often seen as having equal documentary value. Copies may take the form of photoreproductions, photocopies, microfilms, prints or photographs.

Depending on the date of production, reproductions are made either on rag papers or machine-made papers. Original drawings were executed on opaque or transparent papers and on coated drafting cloth, or sometimes cardboard. The transparent papers were thin and sometimes impregnated with oils or resins, natural tracing papers, vegetable parchment or imitation parchment paper[41]. The media were similar to those used in architectural drawings: carbon black inks, coloured inks, graphite pencil and watercolour[42].

Dimensions of technical drawings are variable; large-format drawings could sometimes reach several metres, for example the ships' plans drawn to scale directly on the floor before being redrawn on paper

***Fig. 8:*** *Seine Department Archives : Textile designs, factory models*

*36 Lambert, S., 1986.*
*37 See in particular the work of the mathematician Gaspard Monge.*
*38 Lavoisy, O., Vinck D., 1997, p.1-19.*
*39 Baynes, K., Hugh, 20th c., without date. F., Hambly, M., 1991. Scott-Scott, M., 1986.*
*40 Lavoisy, O., 2001, p.7-10.*
*41 Laroque, C., 2003.*
*42 Booker, P.J., 1979. Dickenson, H.W., 1949-50, p. 73-84. Page, S., 1997, p. 67-73.*
*43 Lavoisy, O., 2001, p.15.*

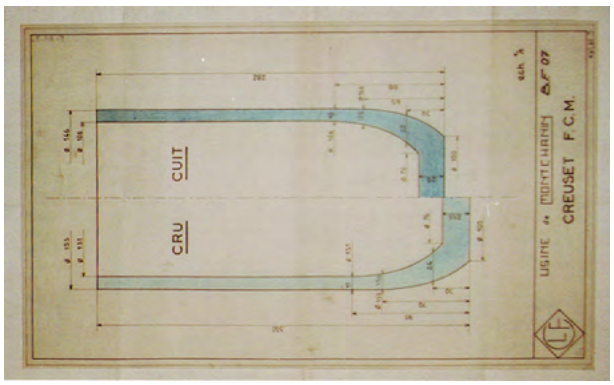


***Fig. 9:*** *Le Creusot Ecomusée : Melting pot, drawing of manufactured part*

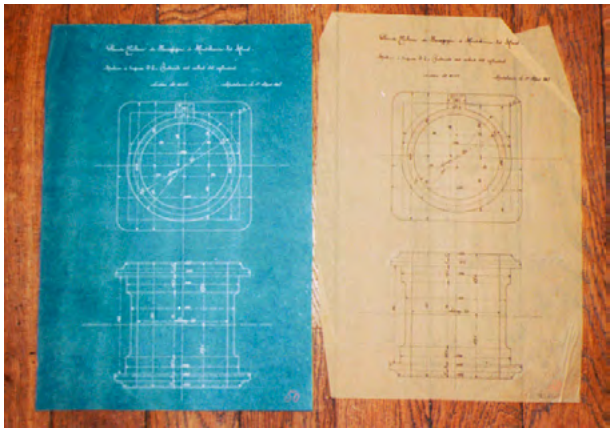

***Fig. 10:*** *Le Creusot Ecomusée : Pipe machine circa 1901, drawing and print of manufactured part*

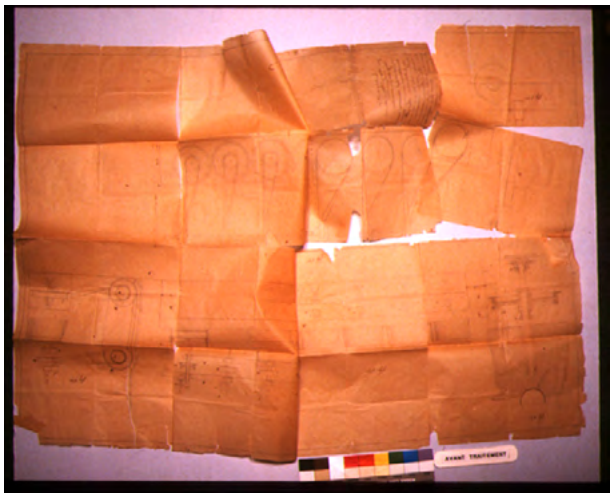

***Fig. 11:*** *Dijon Musem : Grey's mustard machine*

***Fig. 12:*** *City Library, Douai: Robaux Album Nr2, copy of seals*

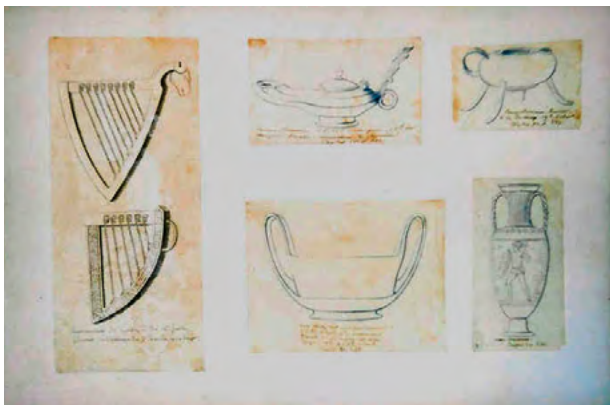

***Fig. 13:*** *Louviers Museum: Archaeological survey album*

***Fig. 14:*** *Petit Palais Museum, Paris: Hair comb by E. Grasset, Cartier collection.*

## Geographical drawings: maps

Archival collections relating to geography, and in particular maps, also include various types of materials. As in the case of architectural records, a nomenclature exists which corresponds to the stages of production of records which facilitates their categorization.[44]

*44 Ehrenberg, R.E., 1982, p.12. Friis, H.R., 1950, p.135-155.*

*1. Field documents*

Field documents are supporting material used in the mapmaking process. This category includes sketches done in the field such as perspective drawings of landscapes giving an idea of the general topography, mostly carried out in graphite pencil or ink, sometimes with watercolour highlighting; field notes were usually held within sketchbooks and including measurements, geologic descriptions and quick sketches; and more recently aerial photographs.

*2. Processed documents*

This includes accurate manuscript maps with precise measurements and executed in graphite pencil and finished in ink, based on field surveys and photographs; graphic documents to various scales; and more recently raw digitized data.

*3. Reproductions*

Reproductions of maps include copies made by hand, non-printed copies (such as photographs, diazotypes, blueprints, photostatic prints, microfilms), printed copies (such as intaglio etchings, lithographs, or photogravures), globes and models and computer-assisted maps. Only a fraction of this type of document is intended for permanent collections as a large portion of the documents used in the production of the final document itself disappears; this is particularly true for intermediate drawings used in the printing process. The majority of transparent papers occur in this category because the cartographer uses its transparency deliberately in the reproduction of originals on opaque paper, by tracing or producing an intermediate duplication support. The drawings can be very neat, heightened with colour, or on the contrary very stylized. These linear drawings were used in the same way as plans for plant or architectural drawings, as masters for duplication by photomechanical processes.

Articles specifically relating to maps on transparent paper are non-existent although such drawings are found in large numbers in collections[45]. This phenomenon is probably due to a catalogue description of the support and the distinction between drawings on opaque or transparent papers being considered unimportant. Likewise, articles which deal specifically with conservation problems of sets of maps are also rare; thus Ehrenberg chose to deal with the problems of managing collections of both architectural and geographical drawings together in a single manual because, he said, these documents have many similarities, they give particular information in a form more pictorial and symbolic than written and their dimensions affect their storage[46].

Another similarity between maps and architectural drawings whether on transparent paper or opaque supports is the fact that in both additions changes frequently occur. During building work, architects often consider alternatives to architectural elements by overlaying at the appropriate places different elements drawn on flaps of paper. Maps drawn on opaque paper sometimes include pieces of transparent paper upon which changes have been noted and which are adhered over the original.

*45 Information on cartography is available through two major professional journals published in England: "Imago mundi, the journal of the international society for the history of cartography" and "The Map Collector".*
*The Newberry Library research center in Chicago, in existence since 1972, the National Cartographic Information Center (NCIC) in the USA, and the German Coronelli Gesellschaft are all research tools in this field.*
*46 Ehrenberg, R.E., 1982.*

The nature of supports and media in geographical drawings does not vary much from that found in architectural drawings: handmade or commercial drawing papers of variable quality, in sheets, rolls or sketch-books; transparent papers of various kinds; drafting cloth and plastic films. The media most commonly encountered is the graphite pencil, coloured pencils, black or coloured inks, watercolour, gouache and more recently felt-tipped pens.

***Fig. 15:*** *Douai Library: Cadastral map*

***Fig. 16:*** *Plans-reliefs Museum, Paris: Fort de Joux Work plan*

***Fig. 17:*** *Plans-reliefs Museum, Paris: Map of Verdun*

## Artists' drawings

Technical treatises for artists written between the fifteenth and nineteenth centuries offer various recipes for manufacturing transparent paper[47]. However, it is mainly from the end of the eighteenth century that artists made regular use of transparent paper. Collections of the 19th and 20th centuries, therefore, comprise the largest numbers of drawings on transparent paper as older drawings, after their useful lives were over, were destroyed by their makers or others, shortly after an artist's death.

Artists used the transparency of paper for tracing purposes of all sorts, as an intermediate tool in the preparation of a final drawing or painting, or in the creation of a collection of models, or as aids in the printmaking process.

In technical treatises, the materials mentioned for impregnating papers and making them transparent are those used by artists in workshops without care as to their longevity or compatibility with the paper support, such as linseed or nut oils, used alone or mixed with resins and varnishes of various kinds in solvents such as turpentine. Artists also used ready-made transparent papers purchased from colourmen. The nature of documents on transparent paper accordingly varies depending on when it was made[48].

*47 Anonymous, 1778. Arsenne, L.C., 1985. Boutard, 1838. Cennini, C., 1978. Cooley, A.J., 1845. Corneille, J.B., 1684. De Fontenelle, J., Poisson, P., 1828. Merrifield, M.P., 1967. As in the case of architectural drawings, there are problems of authorship, as the people involved in the production of cartographic documents are quite numerous. The field survey is carried out by the explorer, the topographer; the preparation of handwritten maps is entrusted to draftsmen, copyists (abbreviated as in the case of art engravings as del. or delin. for delineavit); the transfer of handwritten maps onto copper plates, lithographic stones, photogravure plates is carried out by engravers (abbreviated as sc., sculp., scrip. for sculpsit or scripsit respectively), lithographers or photoengravers; publication is in the hands of a publisher or public*

*1. Original drawings on transparent paper*

Drawing has been seen since the fifteenth century the core subject for artists, craftsmen, and engineers[49]. The apprentice painter was invited to copy the works of the masters, namely paintings, sculptures and drawings. The training taught in art schools which emerged in Europe during the sixteenth century was based on copying[50]; and this would remain the cornerstone of artistic education until the twentieth century. These drawings for the most part, were not 'mechanical replicas' of their models.

Constable identifies four main stages in the execution of a painting[51]. First, the artist carries out a series of preliminary sketches of the future composition which translate his/her idea. Then, there are studies of the various parts with variations which are combined to create a smaller version of the painting. The drawing is then transferred to the painting support. Finally, the artist executes the painting with constant reference to these drawings. Drawings are done at each stage and in this context, transparent papers could become precious tools for rapidly reproducing elements of the composition, or for easily transferring all or part of the composition.

This is evidenced by Berthelot in his *Encyclopedia*[52]:

> *It is also sometimes necessary for the artist to trace an initial sketch in which he finds certain qualities and that he could not identically reproduce if he did not have recourse to this artifice. In the oeuvre of the Masters, there are many tracings of first ideas constantly revisited and modified by their authors.*

Many of these drawings on transparent paper have disappeared, and the vast majority of older tracings preserved in collections date from the eighteenth and nineteenth centuries. Yet this practice was widely used long before that time and even the most famous artists will have followed this. Leonardo da Vinci suggested the use of tracing as practical training in perfecting forms[53].

Throughout the neoclassical period[54], and a large part of the nineteenth century, many French artists such as Pierre Narcisse Guerin (1774–1833), Francis Xavier Favre (1766–1837), Anne Girodet de Roucy Trioson (1767–1824), Jean Baptiste Regnault (1754–1829) and especially Jacques Louis David (1748–1825)[55] or Cecil Pierre Puvis de Chavannes (1824–1898) used oiled or varnished papers for their sketches. From 1816, in fact, the sketch was one of the official tests of the Académie des Beaux Arts[56].

These sketches which were therefore preliminary steps in the execution of a painting were considered to be works in their own

*agency; distribution is carried out by the distributor. In general, the person who carried out the field surveys is designated as the map's author, but all other participants may be mentioned on the map. The author, designer and publisher are mentioned in the title block or title. Information concerning engravers and copyists is relegated to the bottom margin, or to one of the edges, in the form of initials.*

*48 Laroque, C., 2003.*

*49 Treatises for goldsmiths, cabinetmakers, upholsterers and engineers proliferated in the 16th century. They revealed the work tricks and proposed mechanical solutions to problems. By the end of the 17th century, drawing had become an integral part of a cultured gentleman's education throughout Europe.*

*50 The Academia del disegno was founded by Cosimo de' Medici in 1563, the Académie royale de Paris in 1648 and the Royal Academy of London in 1728.*

*51 Constable, W.G., 1979.*

*52 Berthelot, M., Dreyfus, F.C., Derenbourg, H., 1886.*

*53 Da Vinci, L., 1987, vol. 2 p.251.*

*54 Around 1750 – 1830.*

*55 We know 600 drawings by David on tracing paper, which were copies of refined personal drawings, improved in line with the neoclassical aesthetic of "contour juste". See Wisdom, J.M., « French nineteenth century oil sketches: David to Degas ». Exhibition catalog. 1978, Chapel Hill: The William Hayes Ackland Memorial art center, University of North Carolina.*

*56 Jan, P., Richir, H., 1989. Paillot de Montabert, 1829.*

right, sitting on the border between painting and drawing. They were often executed on oiled paper, the artist considering that the colour of the oiled paper contributing to the effect of the sketch. Intended to seduce, these drawings were very carefully executed. It should be noted that these sketches on paper mounted on canvas around a stretcher have sometimes been mistakenly catalogued as easel paintings.

As a primary support for a sketch but also as a means of recording a composition, transparent paper can be seen to have played a significant role in the execution of paintings. It was also often used to make a finished drawing from a first sketch by tracing and keeping only the essential elements. Evidence of this can be seen by comparison of preparatory drawings with underdrawings in paintings; the former was often done in graphite pencil, as a 'draft composition', while underdrawings were most often executed using pen and are by contrast linear and more exact Thus, in the final sketch before execution of a painting, the artist kept only the relevant parts of the composition. The artist then worked in pen and ink to obtain a clear drawing. This practice was fairly common. The final drawings may have been squared or pricked for transfer of the composition in its entirety or section by section.

The practice of building a collection of drawings (personal drawings, copies or drawings purchased) was adopted by artists from the fifteenth century onward. Many artists drew from life and reused their drawings. The most famous sketchbooks are those of Leonardo da Vinci, but it is known that Rembrandt van Rijn organised his drawings thematically as did Henri de Toulouse-Lautrec later (1864-1901). These drawings represented a source from which the artist could extract material at discretion and that could be traced by the artists to create or improve a composition using their own drawings. These collections of drawings could be transmitted from master to pupil and used by other artists. Tracings also served to lift details from drawings for use in other compositions. It is known that Théodore Géricault (1791–1824), Gustave Moreau (1826–1898), Félicien Rops (1833–1898), Puvis de Chavannes and Edgar Degas (1834–1917) kept details from their works for reuse elsewhere.

Transparent paper had yet another use in perspective drawing; the paper was stretched onto a frame in front of which, a piece of wood was placed through which a hole had been punched through which we can set the desired points for tracing. Another method was to stretch the paper directly on a glass plate, hold the glass plate in front of the image and create the drawing by using the transparency of the glass[57]. These drawings belong both to the categories of original drawing and drawings for the model book.

For some artists their choice of transparent paper has been not for its transparency but its texture[58].

### *2. Tracings using transparent paper for model books*

Diderot, in the *Encyclopédie*, tells us:59

> *The manner of tracing using a pen or pencil on oiled Serpente paper is very convenient for artists: it provides them with a quick and easy way to trace the lines of drawings or prints of which they have the enjoyment for*

*57 Ayres, J., 1985, p.63-66.*
*58 For example Sonia Delaunay.*
*59 Diderot, D., D'Alembert, J.L.R., 1772.*

*only a short time. I have known artists who had made themselves very good collections of similar tracings and found this a great advantage and a source of much pleasure to be able to look at them on occasion.*

Indeed, as mentioned earlier, until the end of the 19th century training in the academies was based on copying particularly the Old Masters. Residents of the French Academy in Rome from the eighteenth to the early nineteenth century therefore copied a great deal from the print collections, both to perfect technique and to build formal and iconographic repertoires[60]. These drawings were generally executed in graphite pencil or more often in ink and/or wash sometimes with white heightening. The method of using a tracing does not damage the original as may happen when tracing from an original with a pointed nib. It should be noted that these drawings could also be a useful aid to a less talented draughtsmen. The technique was also used by engravers or etchers for the same purpose: to create collections of themes from engravings of Old Master paintings or from original drawings[61].

### *3. Transparent papers as intermediate tools for printmaking*

Transparent papers were also used to transfer drawings onto printing plates. These drawings have not survived because they were regarded merely as aids, thus were discarded after use. The original drawing was made with the aid of a camera lucida, then copied onto transparent paper[62]. An intermediary copy was made by transferring the traced drawing to opaque paper: at this point the image was inverted. The intermediary copy was redrawn onto a copper plate covered with varnish and when printed the image appeared in the same orientation as the original.

Diderot gives us an accurate description in the *Encyclopédie*[63]

*The etchers who need a very fine line, to make this accurately on their varnish, with the minimum thickness possible, do not make this line with a pen but with a point. They use varnished paper for this . . . Take thin paper varnished with the turpentine spirit . . . apply this paper, which must be dry and which is extraordinarily transparent, to the drawing or the painting: then draw objects you see through it with pencil or India ink. Then removing your paper from the original, turn it; the lines that you have formed and which you will see through will appear arranged contrary to what they are in the original; apply on the plate the side of the paper on which you have drawn; put between this varnished paper and the plate a sheet of white paper having rubbed the side that touches the plate with red chalk or graphite; attach together your two papers with some wax so they do not vary and trace with the point pressing a little more than you would if there was only one paper on the plate; you will have a tracing as it needs to be so that the objects in the print will be as they are on the drawing.*

Berthelot who believed that, 'tracings are essential to the etcher when he wants to give an exact reproduction of the work which he intends to interpret', described the same process with some variations a century later[64].

*60 Jan, P., Richir, H., 1989.*
*61 The Louvre Museum owns a collection of 90 pen, red chalk and black stone drawings by Michel II Corneille said the Young (1642 - 1708). He reproduced artists such as the Carracci, Dominiquin and Poussin.*
*62 Camera lucida : Gettens, R.J., Stout, G.L.,1966, p.289.*
*63 Diderot, D., D'Alembert, J.L.R., 1772.*
*64 Berthelot, M., Dreyfus, F.C., Derenbourg, H., 1886.*

The use of these papers in the etching process is so common that colourmen from the beginning of the nineteenth century proposed the sale of transparent papers in their catalogues and their use is still recommended today[65].

Transparent paper found yet another use in the lithographic printing of drawings. The colours of the final print are differentiated by tracing from the original on transparent paper. These tracings help the artist and the printer to determine the order in the printing sequences of colours and identify their exact location[66].

***Fig. 18:*** *Vivenel Museum, Compiègne: Copies of Italian paintings 17/18$^{th}$ c.*

***Fig. 19:*** *Petit Palais Museum, Paris: Study by Puvis de Chavannes*

***Fig. 20:*** *Vivenel Museum, Compiègne: Portrait of Bonaparte by Charles Hoffbauer*

*65 Krill, J., 1987, p.126. Béguin, A., 1977, p.81*
*66 Antreasian, G.Z., 1971.*

***Fig. 21:*** *Opéra Library, Paris : Sketch for the vault of the Opera's grand staircase by I. Pils*

***Fig. 22:*** *Private collection, Paris: Greek frieze*

## Storage and principles of archival arrangement as conclusion

This final chapter deals only briefly with the thorny problem of storing documents on transparent paper, which is identical to that of storing paper documents of all kinds, in large volumes and of large dimensions, but increased by the greater fragility of transparent papers. This issue has been the subject of numerous publications, only a few of which are cited here.

Understanding the origins of drawings on transparent paper is essential for any head of a collection wishing to establish a procedure for the conservation and classification of the types of documents described above. The challenge is particularly acute for archives and libraries, that house very large, untidy collections of varying value, whereas museums generally house selected collections in smaller quantities.

The difficulty encountered in arranging collections that we will call more generally "technical collections" is linked in particular to the multiplicity of formats, the presence of very large formats, their volume and their relative intellectual value, as we have already mentioned[67].

And as stated in the introduction to this chapter, the fragility of documents that have been severely degraded because of the nature of their components or by the handling to which they have been subjected, adds a further level of complication.

Two simple and essential principles apply to the intellectual classification of architectural and technical archives, and these

*67 Ahmon J., 2012, p.15– 21. Carlson-Schrock, N., 1994. Harvey, R., 1992. Langelier, G., Wright S., 1981, p.47-58. Natsikou A., Tsantiri K., Zervos S., 2021. Ritzenthaler, M.L., 1993. Wilson H. 2015, p.54-64*

same principles apply to the classification of all archival documents. These practical concepts ensure that each document is firmly linked to the group of documents of which it is a part, and that the meaning of each document enhances the understanding of those to which it is associated. When these principles are respected, the relationship of each document to the whole is always evident, and their meaning and importance can be preserved[68]. This need not to separate documents belonging to the same project, is particularly necessary for technical documents which only have meaning within this group.

However, storing can sometimes be a challenge : how can we find a method that both physically protects the documents and facilitates their consultation and eventual display?

If the classifying system for accessing documents is of first importance, several systems are possible but are often contradictory[69].

One of the systems is to begin by sorting documents according to their value, then grouping them into standard categories, then separating documents which will be consulted from those which will never be used, to arrive at the quality or level of storage needed[70].

In light of this, the importance of understanding the exact nature of the documents and their significance in relation to the whole collection is fundamental. For example, some of these documents retain legal value ; it is therefore necessary to set up a system that takes into account the rules for legal requirements as well as the needs of the various users[71].

Thus, the various partners - archivists, curators, restorers, registers - must agree first on the best compromise to facilitate access to documents at minimum risk[72].

Alper suggests, for example, that criteria of size and chemical stability should precede intellectual classification in the choice of how to group documents[73].

Carlson Schrock, for her part, recommends first, sorting documents by their value, then grouping them into standard categories, with physical separation by format. She also suggests separating documents that will be consulted from those that will never be consulted, in order to choose the level of storage quality[74].

Finally, if we refer to the survey carried out in 1999 by the Institute of Paper Conservation (IPC)[75] on the conservation of architectural drawing collections in various countries, an analysis of the majority responses reveals several important points that have not fundamentally changed until today :

- Overwhelming majority of old buildings, are used to house collections.
- The climatic environment is not controlled.
- Documentation concerning the collections is not computerized.
- Substitute documents, photographs, microfiche and photocopies do exist.
- Restricted access to documents is due to their poor state of preservation.
- The buildings rarely have a separate storage area for documents, which are kept in a large multi-purpose room.

*68 Ehrenberg, R.E. 1975, p.55-71. Ehrenberg, R.E., 1982. Daniels, M., Peyceré, D., 2000.*
*69 Heiser-Sufrin, A., 1992, p. 12-14.*
*70 Carlson-Schrock, N., Campbell Cooper, M., 1992.*
*71 Daniels, M., Peyceré, D., 2000, p.65-70.*
*72 Verheyen P., Davis C., Olson D., 2003, p.131-136.*
*73 Alper, D. 1992, p.176.*
*74 Carlson-Schrock, N., Campbell Cooper, M., 1992, p.9-13.*
*75 Collectif, 1999, IPC.*

- Documents are stored flat or rolled on various types of furniture.
- Specific conservation materials are not systematically used.

Although this survey is over twenty years old, the situation is not fundamentally different, and the management of these imposing collections still suffers from the same ills: their sheer volume, their low artistic and intellectual value, and the budgets that should be devoted to them.

***Fig. 23:*** *Disorder in a storage area*

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## About the author

Since 2021 **Claude Laroque** is retired from Paris I Panthéon-Sorbonne University as Senior lecturer emeritus where she was in charge of the Book and Paper department.

She holds a Master in conservation and a doctorate in Art history from Paris I University entitled “Les papiers transparents dans les collections patrimoniales, composition, fabrication, degradation, conservation”.

Since 1986 she teaches preventive conservation within the ICCROM program “Prema” (Preventive conservation in sub-Saharian African countries) and in other universities such as Torun University (Poland) or Belgrade University (Serbia), University of Amsterdam (Nederland).

Between 1999 and 2009 she created and directed a course addressed to technicians in preventive conservation (Mention complémentaire Entretien des collections du patrimoine).

From 1998 to 2004 she organized in Paris an international course entitled “From East to West: Japanese conservation techniques – Western prints and drawings”.

Since 2005 she shares her research

times between Asian papers manufacturing and Western paper technology.

Between 2009 and 2016 she was Head of the Research project “Asian papers: building a database of historical and technical information on papers from Asia” (creation of two data bases on Asian papers : Khartasia (https://khartasia-crcc.mnhn.fr) and Khartasia-Kagi : (https://khartasia-kagi.univ-paris1.fr).

Between 2014 and 2020 she organized and edited annual one-day conferences around paper at HiCsa (Histoire Culturelle et Sociale de l’art : Research Center in art history from Paris I University).

Beside her teaching activity, since 1983 until now, she works as free-lance paper conservator of prints and drawings in various French public institutions.

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