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OBSERVATIONS CONCERNING THE CHARACTERISTICS OF HANDMADE PAPER--*The Library of Congress October 1999*

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INTRODUCTION

The Endpaper Project at the Library of Congress began in the fall of 1989. It was described in a paper presented by Terry Boone at AIC in 1993 and then again by Mary Wootton in 1996. In addition, we published an article in the Winter 1996 issue of Hand Papermaking magazine. These papers were co-authored by Jesse Munn, Terry Boone, Barbara Meier-Husby, and myself. As described in those papers, the Endpaper Project involved our efforts to work with hand papermakers to develop papers appropriate for our work with rare books. We have noticed significant differences between papers made in the 15th through 18th century and those made in the 19th and 20th century. These differences frustrate our attempts to do sympathetic repairs to a large number of the books in our collections. We would like to show you some of what we have observed about these differences in our efforts to develop specifications for ordering paper.

(Slides: Left, "Spirituali", Italian book paper 1575. Book that was dissassembled and folios sent to papermakers to replicate in the Endpaper project. Right, 2 modern handmade papers)

WORKING AND AESTHETIC QUALITIES

As conservators, our highest priority is to use papers that meet standard requirements for permanence and durability. And it is just as important that the papers have appropriate working and aesthetic qualities for use with our collection materials. When we are repairing or rebinding an historic book we naturally turn to handmade papers to use as endsheets. This is because we hope, and expect, that a handmade sheet, although it may be new, will have qualities sympathetic with the older text paper. But the characteristics of handmade papers vary considerably and so must be carefully selected.

(Slides: Left slide, Assortment of pamphlets re: permanent paper. Right slide, U.S. Acts of Congress, 1797-1799. Open to title page and machine-made endpaper. Note textures of the two papers.)

(Slides of atlas structures)

For a functioning artifact, like a book, it is essential that any new material work in unison with the old. The weight, thickness, strength, drape and stiffness must be carefully considered when choosing a new paper to use in conjunction with an old paper. We often see damage in our Library which has resulted from the use of

repair materials with working properties incompatible with older, original materials. In addition to the working properties and strengths of new materials, the aesthetic qualities of a book's endpapers and binding are essential to maintaining its artifactual integrity.

(Slides: Left, Bellamy Band Book, 1799, rebound with endsheets from Endpaper Project. Right, volume ca. 1585 (Italian?) with highly calendared, machine-made endpaper.)

We wouldn't put a Rembrandt painting in a metal frame from a kit. It is no more appropriate to bind an incunable, or even a 16th or 18th century book, in bright, stiff, modern, endpapers. We choose an endpaper that reflects the working qualities such as weight and drape of the text paper, but also the aesthetic qualities of the books' paper, such as color, opacity/translucency and texture.

(Slides: Left, book with original endpapers, Venice 1745. Note the lively surface texture of the papers, the evidence in the surface texture of the laid lines and the lumps of fiber. Right, book with modern library endsheets, stiff sheets of machine made paper glued onto the first and last sheets of text.)

We began the Endpaper Project by surveying handmade papers that were commercially available. We evaluated these modern papers alongside an assortment of 15th to 18th century books from our collections. During this process, our close examination of the older papers heightened our awareness of the aesthetic characteristics of papers. These characteristics reflect the technology and materials available in the place and period when a paper was made.

(Slides: Left,
Right, Italian 1763 w/Edinburgh handmade paper, Barcham Green).

EARLY PAPERS

Early book papers, those made in the 15th through the 18th centuries, are distinguishable to us because of their rich textures, their luster and their toughness. These qualities are the result of fibers used, their preparation, and the machinery and drying methods employed.

(Slides: Left, 15th century book paper. Right, 18th century book paper, English.)

To make papers, linen and hemp rags were sorted for quality. Rags of the finest cloth were used for making "fine white" papers, the coarser and dirtier rags were used for making either "coarse white" or brown paper. Our observations indicate

that books were printed primarily on coarse white papers, although both fine and coarse white papers were used.

(Slides: left, La Lande, Art de Faire Papier, 1761: Pl. I, fig. 1, sorting rags. Right, Diderot, L'Encyclopedie, 3rd ed., 1774. Detail, Pl. I bis, sorting rags)

The rags were cut and fermented to break down the cloth.

(Slides: Left, Diderot, 1774, detail, Plate III, Cutting rags. Right, La Lande, 1761, detail Plate I, cleaning rags)

Stampers were used for beating the rags into pulp. Fibers beaten with wooden stampers could be long and fibrillated because the stamper action brushed out the fibers instead of cutting them. The resulting fibrillated fibers bond well with other fibers, producing a strong paper.

(Slides: left, Diderot, 1774. Detail, Pl. IV, stampers. Right, Richard de Bas paper mill in France, a papermaking museum. Note that these stampers are museum artifacts no longer in use.

After forming, the papers were pressed between wool blankets called felts. The texture of the felts used in drying can be very important in the appearance of a paper.

(Slides: Left, La Lande, 1761, Plate XI, fig. 1, papers being couched and pressed. Right, Hayle Mill, England, 1980, couching

Many early felts were non-woven. Some were woven. The texture derived from the hairs of non-woven felts is described by John Krill, of Winterthur, as a "chicken skin" texture and is very distinctive in early papers. You can also see the impression of woven felts in the surface of papers. Before loft drying, papers were generally pack-pressed which somewhat diminished this felt impression.

(Slides: Left, volume, Augsburg, 1482. Notice the impression of the felt hairs in the paper's surface texture. Right, Spanish book paper ca. 1787. Notice the impression of the woven felt that was used in pressing the damp sheet.)

Papers were hung over ropes to dry in groups or "spurs" and then stacked to mature. They were gelatin sized by dipping in groups, then were dried again.

(Slides: Right, Diderot, 1774. This illustration shows these groups of paper, called "spurs" being hung over the ropes to dry. Left, book 1726, English. Shows crease marks across title page from hanging over ropes in loft drying.)

Many early papers were burnished by hand using smooth stones. By the mid 16th century they could be hammer glazed. Hammer glazing was first introduced in Germany in 1540. The hammer was operated by water power. Polishing by hand gave a streaked and uneven appearance. Hammer glazing gave a more uniform surface over the entire sheet.

(Slides: Left, La Lande, 1761, Pl. XIV, fig. 1. Papers being glazed by hand. Right, La Lande, 1761, Pl. XIV, fig. 2. Illustration showing papers being hammer glazed.)

The resulting papers had imperfections. They had clumps, knots and swirly fibers. But they were strong, supple, lively papers with a complex surface texture.

(Slides: Left, Venetian book, 1745. Notice surface texture. It is a bit rough and has irregularities, lumps. Right, look-through of paper, Italian? ca. 1477. You can see how the fiber is unevenly distributed. There are clumps and knots.)

The Hollander beater replaced stampers in many mills and considerably speeded up the beating process. It was so effective at cutting up the pulp that many mills also saved time by eliminating the long fermentation process.

(Slides: Left, Diderot, 1774, Pl. VIII. Illustration of a hollander beater. Right, A modern hollander beater.)

The Hollander was in use in Holland by the late 17th century and was in use in other parts of Europe by the mid-18th century. The Hollander beater could create a cutting action, which resulted in shorter, less fibrillated, fibers. This contributed to less swirly fibers, fewer clumps and more refined, possibly weaker, pulp.

In the 18th century there was a general refinement of the papermaking process. 18th century papers retained the distinct surface texture of the chain and laid lines of the paper mould mainly because the drying process remained unchanged until the end of the century.

(Slides: Left, Italian paper, 1763. Note the very refined surface texture of the paper, no lumps. The texture of the chain and laid lines is apparent. Right, This is a look-through slide of this same paper. Notice how evenly distributed the fibers are. There's no swirling of fibers and there are no clumps.)

However, the calendar roll, for glazing the surface of papers, came into use around 1720. This created an even surface finish for those papers which were to have a

highly pressed finish.

(Slides: Left, La Lande, 1761, Pl. VI. Illustration of the calendar roll. Right, English paper, ca. 1760 exhibiting a glossy finish.)

At the end of the 18th century there were several developments that would change papermaking. In 1795 the hydraulic press was invented. This allowed papermakers to apply tremendous pressure to squeeze moisture out of paper which hastened the drying time and produced flatter papers. This also reduced the surface texture created by the laid moulds.

(Slides: Left, slide of hydrolic press, Hayle Mill, England, 1980. Right, slide of a paper's surface texture that is flatter.)

Cotton became an important source of pulp in the 19th century. Papers made from cotton tend to be more opaque, with less luster, than papers made from linen, although this is hard to distinguish in gelatin sized papers because gelatin adds its own luster. Papers made with cotton also tend to be softer than linen papers unless the linen has been overprocessed.

(Slide: cotton plant)

Laid paper moulds went through a revision in the late 18th century. In many early papers, pulp accumulated around the wooden ribs of the mould as it was draining.

(Slides: Left, laid paper mould. Right, Diderot, 1774, Pl. IX. Illustration of paper moulds being made.)

This resulted in the appearance of shadows along the chain lines.

(Slides, look-through: Left, Italian, 1763. Right, Italian paper, 1745. Notice the accumulation of the fibers around the chain lines.)

The addition of a coarse screen under the woven laid screen in the late 18th century, slowed down the draining of the pulp which resulted in less accumulation of fibers around the chain lines.

(Slides: Left, photo of a mould with the added screen. Right: handmade paper ca. 1826, from Taft papers, Manuscript Division, Lib. of Congress. Notice the even distribution of fibers, no accumulation around the chain lines.)

The first handmade wove papers were also developed in the latter part of the 18th century. Wove papers were designed to show no chain and laid lines.

(Slides: Left, slide showing wove mould.

Right, look-through of a handmade wove paper ca. 1823.

Change slides

Left, look-through wove paper, handmade 1816.
Right, Look-through of a machine-made wove)

19th CENTURY

In the first decade of the 19th century the papermaking machine came into use in Europe. By 1820 papermaking machines were being made in North America. Accounts of early machine-made papers describe them as "in texture...perfectly smooth and even", possessing " beauty, regularity and strength"(*Hunter, Papermaking, page 353*). All early machine-made papers were wove papers.

(Slides: Left, model of original papermaking machine by Nicholas-Louis Robert 1798. Right, photo of a machine made wove paper)

There was some nostalgia for the laid papers, though, and the "dandy roll", which was patented in 1825, made a rolled impression on the newly formed web of paper that could give the paper the appearance of laid paper.

(Slides: Left, watermark being soldered onto the dandy roll
Right, machine made paper ca. 1918 showing laid pattern made by dandy roll.)

While machine papermaking was taking hold, handpapermaking continued. But the comparison between machine-made and handmade papers influenced the hand papermaking industry. The primary consumer of white paper was the printing industry which required the smoothest possible sheets. The goal for handmade papers became to match the aesthetic challenge presented by the machine-made papers. Papermakers attempted to make smooth, even sheets, without any shives, clumps, knots or other imperfections.

(Slides: Left, Richard de Bas mill. Workers parting sheets in traditional manner.
Right: Handmade paper ca. 1823 (from Taft papers, Manuscript Division). Notice, despite the "antique mould", the very even distribution of the fibers here. The fibers are cut quite short to make them even and smooth. This is evident in the fact that you can see the stitch marks in the watermark.

The "knotter", which came into general use around 1819, removed clumps and foreign substances from the pulp. This enabled papermakers to get a clean sheet more easily and is still used by many hand papermakers today.

(Slides: left, knotter vibrating. Tub allows fibers to pass, but traps clumps on top of screen. Hayle Mill 1980.
Right, handmade paper ca. 1819 (from Taft papers, Ms. Div.). Note the processing of the pulp, free of knots or clumps of fiber, very even. Note also the ties where the chain lines are secured to the mould. These details are evident because of the processing of the paper fiber--short fibers and very clean pulp.)

So by the 19th century hand papermaking had undergone changes. Pulp often contained cotton instead of linen rag. Fibers, which were beaten short with a Hollander beater, made smooth, even sheets. The revised mould design allowed for a more even distribution of fibers than had previously been possible. After forming the sheets, the hydraulic press squeezed water out of the felted stack so papers dried more quickly when removed from the felts. The pressing also made them smoother and flatter.

By the middle of the 19th century, machine-made papers were dried on heated drying cylinders. Some large hand papermaking mills were able to afford such machines which further contributed to flattening the lively texture out of the sheets.

(Slides: Left, diagram of a Fourdrinier papermaking machine, P.H. Glatfelter Co. Note the large cylinders for drying.
Right, heated, felt covered drum dryer. Used for all but "rough finish" papers at Hayle Mill.)

20th CENTURY

The technology and aesthetic for hand papermaking today is relatively unchanged since the 19th century. Hand papermakers, who serve primarily the fine printing industry, strive to create, even, flat sheets, free of irregularities. The fine printing industry values these features.

(Slides: Left, look-through, handmade paper ca. 1600. Note the roughness of the fiber preparation, the clumps and knots, the accumulation of fibers around the chain lines, also sprung wire in mould. Right, look-through EPP handmade paper 1992 .
Compare with the 1600 paper--very even fiber preparation, very clean pulp.)

The changes in drying methods for handmade papers have resulted in surface textures which lack the lively character of earlier papers.

(Slides: Left, Italian book paper 1745, notice the surface texture.

Right:

Some handmade papers are restraint dried, with heat, between drying boards that leave a distinctive impression in the surface of the paper, rather than the laid impression of the mould. This drying method can also make the paper stiff. Technology for papermaking was revised over the centuries, but changed dramatically in the 19th century. The working and aesthetic qualities of paper, which are the result of the interaction of all aspects of the papermaking process also changed.

(Slides: Left, slide showing texture of pressing boards in the surface texture of paper. Right, book with very stiff handmade paper. Pages don't flex well.)

19th and 20th century handmade papers are aesthetically very different from papers made in the 15th to 18th centuries. They reflect an aesthetic developed as a result of competition with the papermaking machine and technological developments that enabled matching those aesthetics. Often, they can appear very similar to machine-made papers and are even hard to distinguish.

(Slides: Left, "lookdown" of handmade paper 1903
Right, "lookdown" of machine made paper 1972 (Curtis Rag paper)

Change Slides

Left: look-through of this same handmade 1903.
Right: look-through of the same machine-made 1972)

Notice that the distribution of fiber is so similar in these two papers. It becomes difficult to tell whether a paper is a handmade paper or a machine made paper.

Change Slides

Left, Laid handmade paper Ca. 1826.
Right, machine-made paper ca. 1851

Notice the similarity of the fiber preparation in these two papers, the evenness of the fiber distribution. Notice, however, how the handmade paper has crisper, finer detail in the watermark. The laid impression and the watermark for the handmade paper are created by the dandy role--the roll presses the fibers down to make the pattern. It is a blunt impression. In a handmade paper the fibers accumulate around the wires of the mould for a finer impression.

Change Slides

Left, Look-through, handmade paper ca. 1845 (Spain)
Right, Look-through, machine-made paper ca. 1859 (Taft papers, letter ca. 1859).

These two papers illustrate how difficult it can be to tell the difference between a handmade paper and a machine-made paper. If you look carefully at the handmade paper you can see the impression of the wire stitching the chain lines to the mould. Notice how the watermark impression is finer, crisper. The watermark on the machine-made paper is so similar, but it is blunter, not nearly as crisp. We know that this a machine-made paper because of a stationary stamp, but it would be hard to tell without multiple clues.

In recent years, most handmade papers available to conservators have tended to work better with 19th and early 20th century books than with earlier materials.

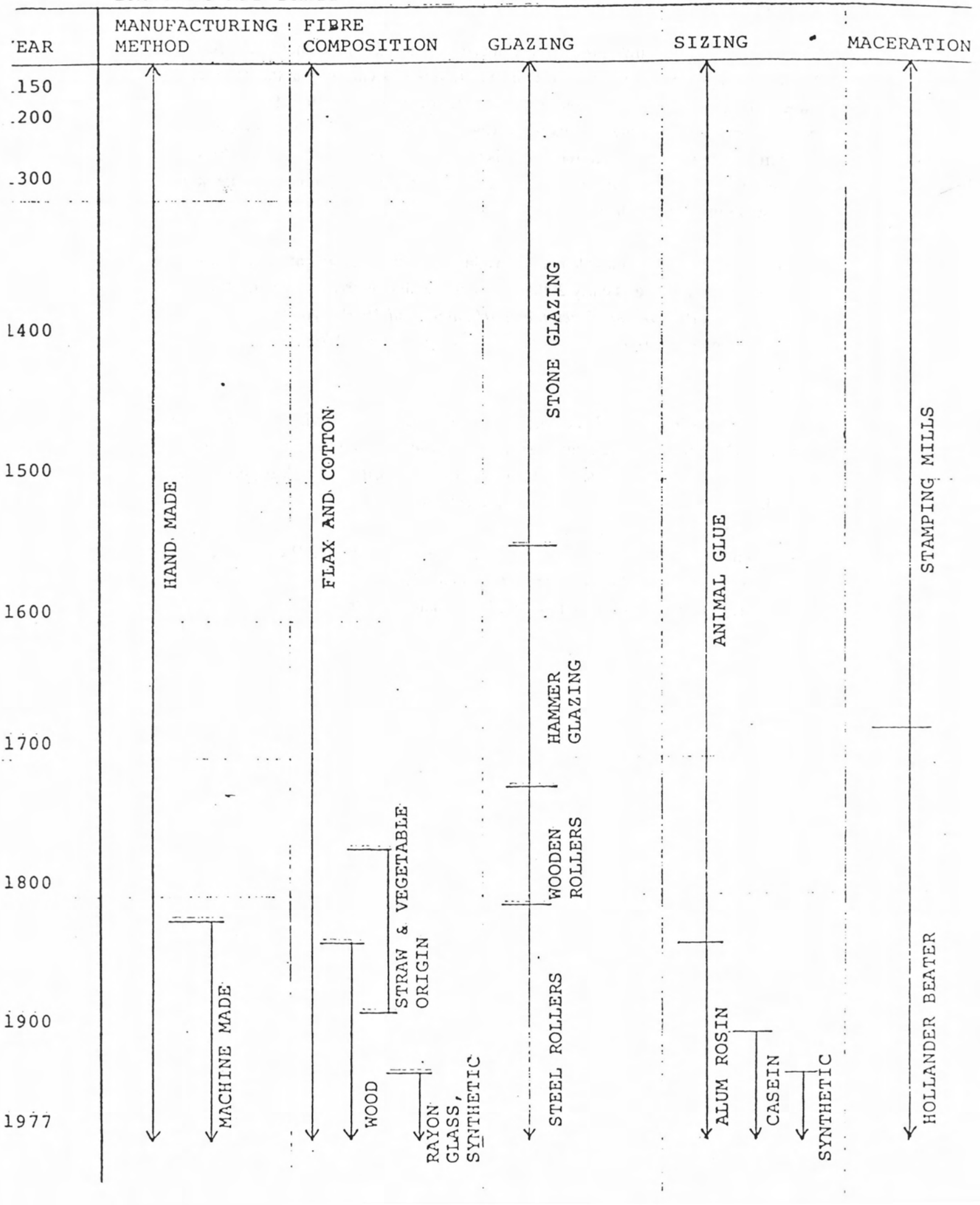
(Slides: Left, Barcham Green paper--Hammer and Anvil-- with 1894 handmade American. Right, Same BG paper with 1768 Italian.)

Our project has been intended to encourage papermakers to provide us with papers that have a wider variety of characteristics. In particular, we have attempted to examine the qualities of earlier handmade papers in our efforts to ask papermakers to make papers that have some of those characteristics.

slide: Spirituali, Italian, 1575.

This is a book dated 1575, that we purchased and disassembled. We sent folios, along with written specifications describing what we saw as the characteristics of this paper, to five papermakers as a sample for them to replicate.

THE MANUFACTURING OF PAPER IN THE WEST
CHRONOLOGY OF MATERIALS AND METHODS' ACCORDING TO HUNTER, BROWNING AND BRITT



paper description form

Describe this hand made book paper from Italy (1754) in your own words taking into consideration the following four categories.

SURFACE TEXTURE

Hard, rough uneven surface & wt numerous knots, slubs, schives

LOOK-THROUGH

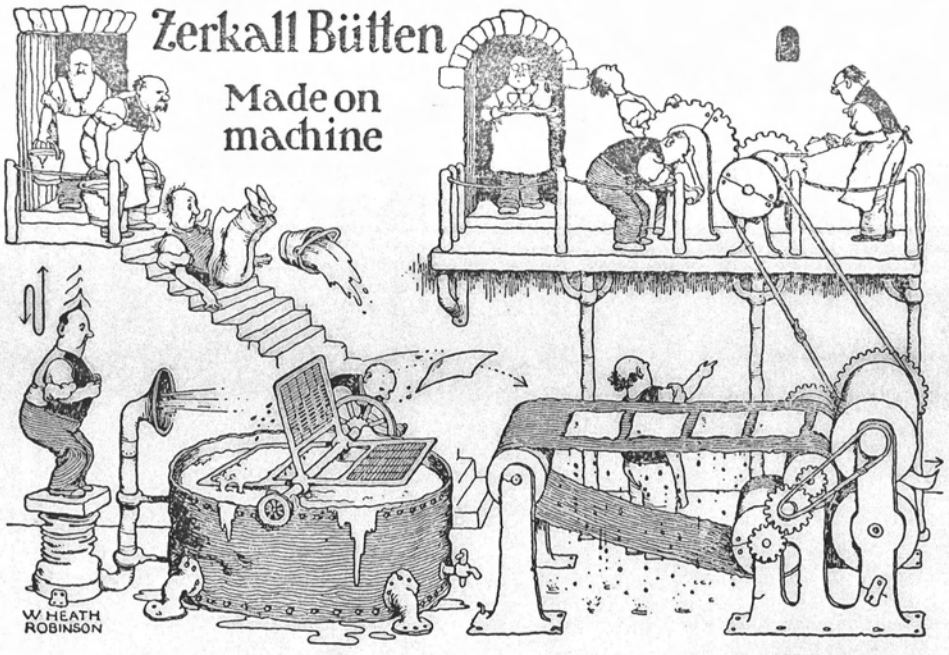
relatively even formation, laid paper

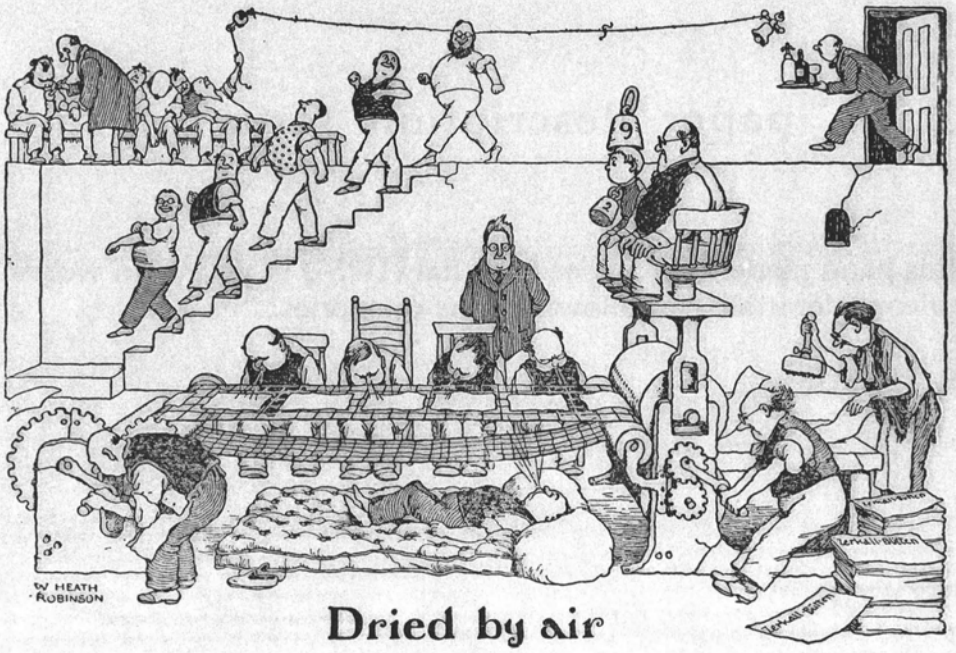
OPACITY/TRANLUCENCY

yes

HANDLE/DRAPE/FLEXIBILITY

strong, tough surface feel, stiff does ink stripe easily (grain // spine), crisp sound





Dried by air

paper description form

SURFACE TEXTURE

LOOK-THROUGH

OPACITY/TRANLUCENCY

HANDLE/DRAPE/FLEXIBILITY

SURVEY SHEET FOR SELECTING ENDPAPERS

VOLUME	1574	1686	1763	1768	1791	1822	1888	1913	Total 1st/2nd	Group Total
Part 1: Color choice	9 14	15	10	6	15	15	6	3		

Part 1: For each volume choose an endpaper that is the best **color** match.
DO NOT LET THE OTHER PAPER CHARACTERISTICS INFLUENCE THIS DECISION, this data will be used to help define base value and tone of color needs that can then be modified by the consumer.

A. Write your color choice using the paper's number in the correlating box.

B. Tally, write in the total column the two papers you chose most often, then we will fill in the group's tally.

Part 2: Paper Choice

Part 2: Select one endpaper for each volume based on the following **physical characteristic** categories: surface texture, look-through, opacity/translucency and handle/drape/flexibility (also listed below.) Having already noted your color preference do not allow color to influence your choice. Also, do not allow the weight/thickness and the mould style (laid or wove) to influence your selection.

A. Write your paper choice in the correlating box.

B. Tell us why you chose that particular paper by indicating the preferred physical characteristic in order of priority. In the correlating boxes rate the importance of the categories by applying the numbers 1-4 using #1 as your highest priority and #4 as your lowest.

C. Fill out the "Total" box - identify your 1st and 2nd most common paper choices in the "Total" column.
- identify your 1st and 2nd most common physical characteristic categories choices.

Part 2: Paper Choice	5	4	14	2	2	15	0	1		
PHYSICAL CHARACTERISTICS VOLUME	1574	1686	1763	1768	1791	1822	1888	1913	Total	Group
1. SURFACE TEXTURE: fiber size, composition, inclusions like shives, slubs, luster, hard, soft, toothy, effects of burnishing, glazing, finishing processes, felt impression, pressing surfaces.										
2. LOOK-THROUGH: fiber size(s) and composition, fiber dispersion patterns, regularity, wildness, chain and laid lines, shadows, screen mark.										
3. OPACITY/TRANSLUCENCY: evenness of fibers, uniformity of dispersion, swirls, clumping, wildness, three dimensional light transmission qualities.										
4. HANDLE/DRAPE/FLEXIBILITY: strength, resilience, density, pliancy, rattle, toughness, bulky, thick, thin, compact, soft, weak, limp, crisp, stiff, wildness.										
VOLUME	1574	1686	1763	1768	1791	1822	1888	1913		
COMMENTS:										

COLOR CHOICE - GROUP TALLY

Paper	1	2	3	4	5	6	7	8	9	10	11	11a	12	13	14	15	1st/2nd choice
1574																	
1686																	
1763																	
1768																	
1791																	
1822																	
1888																	
1913																	

PAPER CHOICE - GROUP TALLY

Paper	1	2	3	4	5	6	7	8	9	10	11	11a	12	13	14	15	1st/2nd PREFERENCES
1574																	
1686																	
1763																	
1768																	
1791																	
1822																	
1888																	
1913																	

ENDPAPERS

1. Edinburgh by Barcham Green	9. Delphi by Twinrocker
2. LC 94 by Dieu Donne	10. LC White by University of Iowa
3. Old Cleeve by Griffin Mill	11. Cobscook by McGregor & Vinzani
4. Georgian Laid by Barcham Green	11a. Old Cobscook by McGregor & Vinzani
5. Cockerell by Barcham Green	12. NE Conservation Light by McGregor & Vinzani
6. B9G by University of Iowa	13. Hobart Dark by McGregor & Vinzani
7. Vellum Wove by McGregor & Vinzani (toned by LC)	14. Gregorian Laid by Dieu Donne
8. Gregorian Wove by Dieu Donne	15. Spirituali by Dieu Donne

PHYSICAL CHARACTERISTIC PRIORITIES - GROUP TALLY

VOLUME	1574	1686	1763	1768	1791	1822	1888	1913	1st/2nd choice
1. Surface Texture									
2. Look-through									
3. Opacity/Translucency									
4. Handle/Drape/Flexibility									

HOW DO WE LOOK AT PAPER? THINGS TO CONSIDER

1. SURFACE TEXTURE (or LOOK-DOWN)

The texture on the surface of the sheet is best seen by holding the sheet at an angle in a slightly raking light and is referred to as the "look-down" of a paper. The texture is influenced by the fibers that make up the sheet, the fiber size and shape, knots, slubs, shives. The paper mould may be visible, as well as the drying felts or pressing surfaces, machine drying, dandy roll or other applied surface impressions. We can also see if there is a patina to the paper from burnishing, glazing, plating or gelatin sizing.

a. Surface feel: Aside from the visual texture it is useful to feel the suface texture of the paper with your fingers. What does the paper feel like? Is it toothy, smooth? Does the paper surface feel hard or soft?

2. LOOK-THROUGH

In looking at the overall appearance of a sheet we're noting the fiber dispersion and the translucency or opacity of the sheet. The look-through is seen by holding the sheet up to transmitted light to see the fiber dispersion patterns, regularity or wildness, the amount of detail shown of the chain and laid lines, whether there are accumulations of the fibers around the chain lines (called "shadows"), whether it is a cloudy sheet or has swirly fibers, whether there are knots or fiber clumps.

3. OPACITY

Hold the paper up to the light and notice the three dimensional light transmission qualities incuding the evenness of the opacity or translucency. Are there areas of translucency while other areas are more opaque? Is it evenly opaque or is it too visually dense to see through at all? Are the fibers climping, or swirling or have wildness?

Place the sheet over an opaque piece of paper and view it flat. Can you see through the sheet?

4. HANDLE/DRAPE/FLEXIBILITY

a. Working characteristics/strength: Gently manipulate the sheet between your fingers stretching the paper slightly. This gives you a feeling for the characteristics of the paper fibers. Does the paper feel tough? resilient? strong? soft? weak?

b. Drape: The drape of the sheet is extremely important to examine in chosing an endpaper to put in a book that will have a compatible working quality with the original paper. Is the paper stiff or does it flow easily? By flexing or rolling the paper parallel with the grain, assess how well the paper handles. Is it limp? Is it pliant? Is it stiff? Crisp?

c. Stiffness: Stiffness is resistance to flexing. It is affected most by the following variables: fiber orientation, density, fiber bonding, restraint during drying.

We are tempted to associate the stiffness of a sheet of paper with its thickness, but sometimes thinner papers are stiffer than thick papers.

d. Rattle: The property of a sheet which produces noise when the sheet is rolled, moved or shaken. It is dependent on many properties among which are density, stiffness, sizing.

WEIGHT/THICKNESS

People handling paper often refer to the weight of a paper when they are referring to its thickness. The weight of the paper is technically called "basis weight" which is the amount of pulp in the paper relative to a standard size (grams of pulp/meter squared).
Thickness is technically called "caliper" and refers to a measurement of the height of a sheet's surface.

DENSITY

The density of a paper is its weight-to-volume ratio, ie. how much pulp there is for the volume of the sheet. Some papers are "bulky" and lack compactness, They can be thick, but light weight. These papers are often very pliant. Other papers may be thin and dense, compact.

COLOR AND TONE

a. Hue: color bias, quality that distinguishes one color from another.
Determine the color bias using the following categories:
orange/red, violet/red, greenish/blue, violet/blue, orange/yellow, greenish/yellow.
b. Brightness: quality of light to dark, compared to grey scale.
c. Intensity: Quality of saturation of color, chroma.
d. Variation: Quality of different light reflections on and through the surface of the sheet. Consider qualities of translucency, opacity (opacity can contibute to a flatness of color and a deadness to the overall sheet). Do different fibers contribute different colors to the sense of overall color, liveliness?

Look at the overall sheet. Is it wild, with planar distortions, or is it flat? Other details that should be noted are flecks, shives or clumps in the paper furnish.