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The Lost Art of Splitting Paper: Recreating the interventions of an eighteenth-century collector

Introduction

Splitting Paper & Paper Splitting: Origins and Brief History

Splitting paper is a procedure by which one makes two sheets from one. Rather than cutting the top half from the bottom half, or performing any other variation of simple dismemberment, splitting separates the recto from the verso by dividing a sheet through its thickness. The product is two thinner sheets of the same dimensions (l/w). Historically, paper was split for many reasons. The earliest paper splitting was probably undertaken for the discrete addition of margins to trimmed prints. Pierre-Jean Mariette, an eighteenth-century collector and connoisseur of prints and drawings, may have been the first to apply the technique to entire drawings (Smentek, 2008, 48). Splitting drawings has historically been undertaken by some collector-dealers to increase profit by selling multiples; for Mariette, however, this was rather a solution to the visual limitations of mounting double-sided drawings (De la Chapelle, 2015, 40). Unlike contemporaries who mounted drawings in albums, in which double-sided drawings could be set within windows cut out of pages and thereby viewed from both sides, Mariette's practice of mounting overall to boards could not accommodate such windows. Some have suggested that Mariette even split papers to preserve their appearance, by preventing iron gall ink migration from one side to the other (Smentek, 2008, 50). By the 20th c., paper splitting had become

common knowledge among restorers, and eventually, descriptions of the previously concealed process were published (Brückle and Dambrogio, 2000; Schweidler, 1938, 104-5).

The process of splitting paper is simple. The sheet to be split is glued on both sides to two facing supports. These may be pieces of paper, cloth, parchment, or rigid surfaces, among other materials. This "sandwich" is dried under pressure, and then the facing materials are pulled evenly apart, taking the split halves of the sheet along with them. The split halves are released from the facing supports in a bath of any solution in which the glue is soluble. The final product is, ideally, two, thin, split halves of the original sheet. Today, the distinction is made between the splitting of paper by hand, as undertaken by Mariette, and restorers through the mid-twentieth-century, and "paper-splitting", developed later as a mass paper treatment (De la Chapelle, 2015, 41). Dr. Wolfgang Wachter in Leipzig, Germany, and Günter Müller, in Jena, Germany, perform paper-splitting on library and archive materials. Wachter's method employs a large, assembly-line style paper-splitting machine, whereas Müller's process more closely resembles traditional hand-splitting, albeit with greatly enhanced efficiency. In both cases, the goal is to split paper in order to insert a core sheet before reattaching the split halves with perfect registration. The core mechanically stabilizes the weak original without compromising its appearance, and is theoretically reversible. A core with an alkaline reserve can lend chemical benefits as well (Brückle and Dambrogio, 2000).

The Material Science Behind the Splitting of Paper

In the most basic sense, the mechanism of splitting paper works because the strength of the bond between adhesive and paper surface exceeds the strength of bonds between fibers within the paper itself. De la Chapelle (2015) adds that the natural laminate structure of paper contributes to the ease of splitting. During the hand papermaking process, the pulp is deposited

in two layers. First, when the paper mould is dipped into the vat, a very thin layer of fibers is deposited along the laid and chain wires and conforms to its topography. Then, when the mould is lifted from the vat, this layer acts as a filter for the subsequently deposited fibers, of which there is a vastly greater quantity. When the vatman shakes the mould to rearrange the fibers, these are more mobile than the ones below, so they retain less grain direction. The discrepancy between these layers, which are more weakly bonded to each other than the rest of the sheet, aids in the splitting process. So too, she suggests, does the moisture introduced by the glue. When the paper is faced for splitting, moisture from the adhesive travels into the paper and accumulates at the interface between layers, which provides greater surface area for bonding with water. After partial drying, residual moisture in this area locally weakens the paper and facilitates even splitting (46-7). Other steps in papermaking may affect the level of contribution of this interface to the splitting process, including the exertion of pressure on the sheet during drying, and the degree of sizing.

Splitting Paper in the Eighteenth and Nineteenth Centuries

Unfortunately, Mariette and his contemporaries never recorded his technique for splitting paper. As Irene Brückle and Jana Dambrogio (2000) aptly explain this coincidence, "No doubt paper splitting was a process shrouded in mystery, even guarded with secrecy by those few who knew how to accomplish the task." It is not until the 20th c. that published, detailed accounts of individuals' splitting processes became available (Brückle and Dambrogio, 2000). There has been recent research involving the identification of drawings that were split in the eighteenth-century. No examples have gone so far as to use technical evidence to reverse engineer the process (the author harbors reservations about the practicality of this endeavor), but nevertheless, remarkable discoveries have been made. Most recently, Ariane de la Chapelle (2015) found the

verso of Raphael's *Study for "La Belle Jardinière"*, in the Louvre - the Ashmolean Museum's *The Entombment* - on the basis of their similar overall patterns of loss due to splitting, and evidence of previous ink migration (40). These drawings, which were previously hypothesized to date from the same year, can now be dated with certainty and studied in their proper context. Based on existing primary sources, which confirm that the drawing was originally two-sided, De la Chapelle was able to date the actual splitting of the sheet to after 1793 (2015, 43-4). Although the drawing once resided in the collection of Mariette, this posthumous date denies the possibility that he split the sheet. However, De la Chapelle's article demonstrates the value of identifying split sheets and importance of research into the hand-splitting of paper.

Kristen Smentek (2014), identified five drawings that Mariette split and manipulated for various reasons, according to primary written evidence and/or contemporary technical research. According to a letter from Caylus written in 1761, Mariette split a Raphael drawing of unknown medium or content (167). The 1775 sale catalogue of Mariette's collection advertises the split pen and ink and wash drawings, both entitled *Night*, by Francesco Albani (*Appendix A, Images 1 and 2*). Smentek examined these drawings first hand and observed damage related to a flawed splitting process (168). Smentek investigated other drawings from Mariette's collection and discovered more evidence of splitting flaws in Annibale Carracci's two pen and iron gall ink and wash studies for the *Tazza Farnese* and Giovanni Lanfranco's pen and ink caricatures (170-4).

For speculation into Mariette's technique, one may only consult second-hand accounts and personal notes dating from the 19th. An English restorer, W. Baldwin, was believed to be the first to split paper in 1848, by French restorer Alfred Bonnardot, writing in 1858. Bonnardot did not witness Baldwin's method firsthand, but nevertheless reveals an intuitive understanding of the process in his *Essai sur l'art de restaurer*. He starts, "Let us begin with this consideration:

when a force is applied to a solid body with the purpose of splitting it, it is always the part that is less strong… that will yield first." (Brückle and Dambrogio, 2000) Bonnardot suggested a process that involved gluing the sheet to be split to a rigid support and then gluing a piece of cloth or smooth piece of parchment to the sheet. Once dry, the facing material could be pulled away, taking a split half of the sheet with it. Finally, the split halves could be released from their supports with hot water or alcohol (Brückle and Dambrogio, 2000).

In the last quarter of the nineteenth-century, Josef Meder, future director of the Albertina (tenure between 1909 and 1923), began experimenting in splitting paper. Two of his personal notes have been studied by Brückle and Dambrogio (2000), from 1877 and 1881, in which he explains his step-by-step process. His method differs from Bonnardot's description, in that it employs two flexible supports, instead of one rigid and one flexible support. Meder de-sized the papers he was splitting with acid and alkaline baths and long baths in warm water. He used paper, with a pre-applied and dried layer of fine glue as his facing materials. When the damp paper was placed between these sheets and lightly pressed for 12-24 hours, it reactivated the glue and laminated the sheets. Once dry, the supports were trimmed to the perimeter of the core paper and the laminate was split. The split halves were released from the facing papers in a bath of warm water. Once they floated to the surface of the bath, they could be lifted out with oil paper (Brückle and Dambrogio, 2000). Similar methods were practiced throughout the early-, to mid-twentieth-century, using linen and cotton cloth, parchment, wrapping paper and celluloid as facing supports, hand-only and semi-mechanical methods, and paste and animal glue as adhesives (Brückle and Dambrogio, 2000). Some of these materials and methods could have been used two centuries earlier.

Mariette's Mistakes

As Smentek (2014) observes, "The process of splitting a sheet of laid paper is simple, but not without risks (as several Mariette sheets prove)" (48). The present condition of Albani's *Night*, from Mariette's collection, demonstrates these risks. Smentek has observed several areas of loss compensation that she attributes to areas where strips of one side of the paper adhered to the other rather than splitting down the center. Based on differences in dimensions between the two halves, she estimates that 7 cm along the edges of one half were lost during splitting (50). Smentek has also analyzed Carracci's double-sided studies for the *Tazza Farnese* firsthand, and discovered skinning in details of a drawing that Mariette masked out – an approach interpreted as a last resort after an unsuccessful and abandoned splitting attempt to remove the details completely (52). Odd, compensated losses along the edges of several Lanfranco caricatures, mounted overall to a backmat, are also suggestive of a paper splitting treatment gone awry (53-4). Smentek's research proves that paper splitting mistakes are often the only evidence we have that a drawing ever received this treatment. The author has yet to find any evidence of known splitting successes by Mariette. This may either be understood as evidence of the risks of the procedure and amateurism of the restorer, or a result of the under-identification of existing split drawings in the case of their success. Results of the author's experiment, discussed below, demonstrate the incredible similarity between successfully split and unsplit sheets and the need for better understood distinguishing criteria.

Paper Splitting at The Morgan Library & Museum

The exhibition, *Pierre-Jean Mariette and the Art of Collecting Drawings*, will be installed at The Morgan between January 26 and May 1, 2016. Focus will be dedicated to the collector's elaborate mount-making. Recent publications on the ways in which Mariette

manipulated works on paper to accommodate his mounting schema, specifically those involving the splitting of drawings, caught the attention of curators, and conservators in the Thaw Conservation Center, and sparked an interest in featuring the activity during the exhibition. A project emerged in which the technique would be enacted for the production of a short film exhibited in the gallery and on the website. Several challenges were faced in the process. First, Mariette's method remained unknown. In order to develop an accurate model, research into known early splitting methods (nineteenth-century), available eighteenth-century tools and materials, and successful modern splitting attempts, as well as consultation with a team of experienced conservators was undertaken. Three large batch tests were devised to assess multiple possible variables in materials and technique. In the end, the project was driven by the need to produce a presentable finished product. Tests prioritized variables that were expected to work, because ultimately, one trusted method had to be devised for use on an artwork reproduction.

Aim of the Experiment

The project developed two aims: product-driven and experimental (the focus of this report). Technical variables considered included: the size content of the artwork, the moisture content of the artwork before facing, the facing material, the adhesive and its concentration, the method of adhesive application, the drying method, and the drying extent. Discussion of results aims to elucidate the possibilities and limitations of hand-splitting paper with technology available in the eighteenth-century. Observations of the physical properties of the split samples are recorded with the aim of developing a vocabulary and enhanced visual literacy in split paper that may aid in the identification of split works in the future. However, no attempt will be made to link specific physical features to splitting techniques or to reverse-engineer Mariette's process. The techniques explored merely represent possibilities. Although successful splitting was the aim

of the product-driven component of the project, it must be recalled that Mariette's own splitting attempts caused damage that resulted in their identification. Thus, samples split to varying levels of success were addressed with equal attention.

Materials & Documentation

Core Paper

Based on the known examples of drawings split by Mariette, a support likely split by the collector may have been a sixteenth-, or seventeenth-century drawing or writing paper; a 100% rag, likely linen and hemp (Barrett, 2012), antique laid, handmade paper with significant gelatin surface sizing, one to two centuries old by date of splitting. This historic paper profile was considered when choosing a paper from which to run tests. Once a successful splitting technique was determined through testing, the same paper was ultimately chosen for the artwork reproduction. The historic paper was a handmade, antique laid drawing paper. It exhibited a Strasbourg bend watermark with lily (Churchill, 1935, 323-27) and a countermark with the initials "GL" (Appendix A, Image 7). The Strasbourg bend and lily type was used between the late 17th and 18th centuries, (Churchill, 1935, 84-5; Heawood, 1969, 65-6), first in Strasbourg, France, and later in England and the Netherlands. Two very similar watermarks in Heawood (1969), are dated 1725 and originate in London (Heawood, 1969, 65-6). The presence of a back-mark suggests that the paper was dried in the traditional manner of hanging over ropes in a drying loft. Ultimately, due to the relative consistency of historic papermaking processes throughout the handmade era, the chosen sample, likely from the 18th c., should be similar in composition and production to the supports likely split by Mariette. Additionally, the sample paper was more than two centuries old, thus naturally aged before splitting, such as those split by Mariette. Although there were many variables left unaccounted for, such as the comparable thickness of the sheets,

the conditions of aging, fiber composition ratios, and more, there were enough similarities from which to draw some conclusions. Sixty-five samples of paper in total were cut from the full sheets, to approximately 4 x 3 1/2 inches. These were labeled on recto and verso before each test with a single number that corresponded to the batch plans outlined in *Appendix B, Tables 1, 6* and *10.*

Artwork Reproduction

After testing demonstrated that it could be split, the same historic paper used for the samples was chosen to create the artwork reproduction. The 6 x 4 inch sheet was cut from an area that contained a watermark. The artwork chosen for reproduction was a double-sided iron gall ink drawing by Parmigianino (1503-1540) from The Morgan Library & Museum's Drawings Collection (*Appendix A, Images 4* and *5).* Alex Confer, Senior Collections Technician at The Morgan, executed the reproduction with a dip pen and iron gall ink, previously prepared in 2009 according to the "Instant Ink" recipe (Karnes, 1998). The ink resulted in bleed-through that mimicked ink migration in the original, thus allowing the demonstration of the effects of splitting on the appearance of such issues. As already mentioned, Smentek cites prevention of ink bleed-through as motivation for Mariette's splitting activities (Smentek, 2008, 50), although it is not entirely clear if she refers to true bleeding, or iron gall ink corrosion over time. In case of the former, no bleeding of immobile dry ink would be expected, but splitting may reduce visibility of ink through a sheet from the opposite side of the drawing. In case of the latter, splitting would likely play a protective role, but testing could not be undertaken within this project's timeline.

Facing Material

Historically, a variety of facing materials have been used to split paper. The experiment aimed to assess a few materials through batch testing with otherwise similar variables. The

earliest cited facing method involved using one rigid surface and one flexible sheet (Brückle and Dambrogio, 2000). No specific rigid material has been identified. Flexible materials recommended for use with a rigid support are cloth and parchment. In later nineteenth-century accounts that recommend the use of two flexible sheets, "firm" and "smooth" papers are recommended. In the earlier twentieth-century, fine linen or cotton fabric, parchment, and wrapping paper are all recommended (Brückle and Dambrogio, 2000). Facing materials most readily available in France in the late eighteenth-century include, for paper, handmade, antique laid, linen and hemp paper, for cloth, linen and/or hemp cloth, and for parchment, hand-prepared sheepskin (Hagadorn, 167). A handmade, laid paper of medium thickness, linen airplane cloth (60 threads/inch), and Crowley sheepskin parchment were chosen as sample facing materials. Paper and cloth samples were cut to approximately 4 ½ by 4 ½ inches and were labeled by number. Due to reservations about glue sticking to the parchment, only one sample of parchment was cut for testing. A large sheet of Plexi-glas was cleaned and prepared for use as a rigid support. Although not an historic material, the Plexi-glas substituted for glass.

Adhesive

In the nineteenth-century, Bonnardot and Meder both recommended using very pure animal glue. Meder also recorded a recipe involving glue, sugar, and gum arabic. In the early twentieth-century, use of either animal glue or paste is documented. Today, paper splitting treatments utilize pharmaceutical grade gelatin (Brückle and Dambrogio, 2000). Animal glues were available in Europe in the eighteenth-century (Edwards, 2001). They are fairly straightforward to make on one's own given access to animal parts. Rabbit skin glue and cow hide glue were arbitrarily chosen for this project. A 230-280 Bloom cow hide glue in dehydrated cube form, and a 325-350 Bloom rabbit skin glue in dehydrated grain form (both from Kremer

Pigments), were chosen for comparison during testing. These were prepared in the same way. First, the dehydrated glue was soaked for two hours in the appropriate volume of cool water to create the desired glue concentration. Then the glue and water were heated and stirred constantly in a double boiler over medium-high heat until all of the dehydrated cubes or grains had solubilized and the glue was fluid and homogenous.

Tools & Equipment

A hot plate was required for heating glue and water. Large beakers were used to heat the water and serve as the base of a double boiler system, while the glue resided in a smaller beaker that floated in the water. A few plastic tubs were utilized for steps involving water immersion. A smaller enamel-coated metal tub served as a basin for the hot glue while loading the squeegee. The squeegee was actually a beveled mat board, which mimicked wooden prototypes that may have been available to Mariette. For the press, felts were chosen for their strong historical plausibility, and were sandwiched between wooden boards. The press was a traditional screw press. Silicone release Mylar was used during *Test 2* only in order to leave a sample in a press overnight without it drying completely. Although this was a historically inappropriate material, it was the only means of testing a certain variable within a work schedule. An old scalpel blade was used to nick the corner of the laminated papers. The laminate was wedged between two tables for splitting. Although not all of the tools and equipment used were available in the eighteenth-century, they performed similarly to materials that were available to Mariette.

Documentation of Artwork Reproduction

Photographs were taken of the recto and verso of the artwork reproduction before splitting (*Appendix A, Images 6* and *7)* and of the original recto and original verso, and new versos, after splitting (*Appendix A, Images 8, 9, 10* and *11*). Transmitted light photography was

performed for better visualization of the watermark and wire lines of the artwork reproduction before splitting (*Appendix A, Image 12*) for comparison to those belonging to the two sheets after splitting (*Appendix A, Images 13* and *14*). The original sheet thickness, measured with a Lithco Pocket Gauge, was approximately .006 inches (thickness varied throughout with range of .0055 to .0065 inches) before splitting.

Experiment

Test 1

In the first batch, 33 samples in total were used to test five different variables, in addition to whether parchment could be used as a facing material (see the plan outlined in *Appendix B, Table 1*). First, an attempt was made to de-size half of the core papers, in order to observe the effects of size content on the splitting of paper. It was hypothesized that de-sizing the sheet may reduce the internal strength of the paper, and/or increase the strength of the bond between the paper surface and the facing sheets, therefore facilitating splitting. The paper was immersed in a hot water bath (replenished once, due to cooling of the first bath), and allowed to sit in the cooling water overnight. Once dry, the absorbency of this paper was compared to a sample of original paper with a simple water droplet test. The de-sized sheet exhibited a much higher absorbency, immediately absorbing the droplet, while a droplet on a normally sized sheet took approximately one minute for full absorption (see *Appendix A, Image 15*). Although there was an obvious difference in absorbency, it was impossible to quantify.

Paper and cloth facing sheets were both assessed, in addition to rigid supports. For half of the samples, a “rigid-flexible” technique was used, wherein the core paper was faced one on side with a rigid Plexi-glas support, and on the other with a flexible paper or cloth layer. The remaining half of the samples were faced in the “flexible-flexible” manner, wherein two sheets

of paper or cloth were used to sandwich the core paper. The moisture content of the facing sheets and core paper upon gluing was also manipulated. Before gluing, half of the core samples and their facing supports were soaked for one half hour in room temperature water and laid on blotter paper for several minutes to remove excess moisture. The remaining core and support sheets were not pre-wet; the glue was applied to the fully dry materials.

Two different glues with different Bloom numbers, but equal concentrations were tested: a rabbit skin glue (325-350 Bloom) and a cow hide glue (230-280 Bloom). Because of their different Bloom values, it was difficult to test objectively whether the glue source (i.e. species) was accountable for the relative success of the glues. 25% (w/v) concentration in tap water was used throughout. After swelling and cooking, the glue was transferred to an enameled metal try, which was placed in a hot water bath to keep the glue warm and workable during application. The water bath had to be replaced frequently to maintain an appropriate temperature. Despite heating, the glue was prone to forming a skin on its surface, which had to be broken before each loading of the squeegee. For the rigid-flexible samples, a mat board squeegee was used to apply even layers of glue to both sides of the sample, which was stuck to the Plexi-glas, and then covered with a damp or dry facing sheet. For the flexible-flexible samples, the glue was applied to the facing sheets and the core paper was sandwiched between them. The laminate was transferred to felts between wooden boards and subjected to high pressure in a screw press for approximately 10 seconds to ensure evenness of the glue layers. Finally, the laminate was transferred to a felt stack and dried overnight under comparatively low pressure.

The samples were slightly cool to the touch after the drying time. They were trimmed to the dimensions of the core paper to prevent issues with stuck facing sheets. This problem is addressed through the use of guard sheets in modern paper splitting, but trimming is the earliest

known process, recommended by Meder in the late nineteenth-century (Brückle and Dambrogio, 2000). After trimming, a blade was used to nick the corner of the laminate, as close as possible to the center of the core paper. From this corner, the two halves were carefully pried apart along one full edge. If splitting looked or felt *overly* uneven in thickness (the split sheets are never the same thickness), a new corner was nicked and splitting re-attempted. Once a full edge was split successfully, the laminate was wedged between two tables of equal height, and pulled apart across their surfaces. This ensured a 90˚ angle (from the intact core sheet) throughout splitting, and helped to ensure that even pull was exerted on both sides.

Once the splitting was complete, the more successfully split sheets were transferred to a hot water bath to solubilize the glue and release the core papers from the facing sheets. These were removed from the water with Mylar sheets, in lieu of the "oil paper" cited by Meder (Brückle and Dambrogio, 2000), and transferred to a silk screen for air drying. The samples were finally housed in pairs in Mylar enclosures for easy handling and observation.

The parchment test was performed in the flexible-flexible technique with rabbit skin glue. The core paper was not de-sized, and all of the materials were dry upon glue application. All other variables were held constant, consistent with the other tests.

Test 2

The second test was designed to eliminate the failed results of the first test and hold constant its successes while introducing new variables. 16 samples were tested in total (for the full plan, see *Appendix B, Table 6*). All of the core papers were de-sized in advance. Do to time limitations, the de-sizing method was altered; de-sizing took place over two hours, by maintaining a very hot water bath through 7 consecutive water changes. Only cloth was tested as a facing material, due to the indeterminate results of *Test 1*. Only the flexible-flexible technique

was performed. All of the facing sheets were pre-wet in a water bath for 30 minutes and laid on blotter until just damp. Only rabbit skin glue was used and was applied to the facing cloths in the same manner as in *Test 1*, with a mat board squeegee, before the core was inserted and the sandwich compacted in the screw press.

The variables introduced in *Test 2* include the adhesive concentration, drying technique, and drying extent. For rabbit skin glue concentration, 40% w/v and 25% w/v were compared. Difficulties were faced in keeping the glue of high concentration hot enough to remain workable. Cooler glue resulted in less even application and a shorter drying time. In order to test drying techniques, half of the samples were transferred to a felt stack with low pressure after glue application and initial pressing (as in *Test 1)*, and half of the samples remained in the screw press to dry overnight. Drying extent was manipulated by performing splitting of the samples half when damp, and half when dry (i.e. just cool to the touch). For the samples in the stack, half were taken out after two hours in order to be split when damp, while the other half were allowed to dry overnight. The samples in the press dried more slowly than the samples in the stacks, so it would not have been possible to remove and split half of these samples on the same day. For the samples in the press, all were allowed to dry overnight, but half were wrapped in silicone release Mylar. Although this is not an historically appropriate material, it facilitated testing of this variable when otherwise impossible within a working schedule. After the appropriate drying extent, the samples were treated just as in *Test 1*: trimmed, nicked and split, before a select few were released from the facing cloth, dried, and enclosed in Mylar.

Test 3

In the third test, old variables that tested inconclusively were revisited and new variables were implemented in a last attempt to devise a highly effective splitting routine. 16 samples were

tested in total (for the full plan, see *Appendix B, Table 10*). All of the core papers were de-sized in the original method (2 short baths of hot water, and one approximately 20 hour bath at room temperature). Only the flexible-flexible facing technique was employed, but both paper and cloth were compared for a second time. Wetting was performed prior to gluing for every sample, but in half of the samples, only the core paper was wet, while for the remaining half, both the core and facing sheets were wet. The adhesive used throughout the test was the rabbit skin glue at low viscosity (25% w/v). Glue was applied to the core paper before applying the facing sheets for half of the samples. For the remaining samples, glue was applied to the facing sheets (as had been done for all flexible-flexible samples previously), before the core material was pressed between them. The drying technique and extent were held constant. Drying took place for all samples in the screw press overnight directly against felts (i.e. no silicone release Mylar used). When the samples were split, they were still cool to the touch, but not damp. The samples were trimmed, nicked and split just as in *Tests 1* and *2*, before the successful samples were released from their facing supports in a bath, dried, and enclosed.

Splitting the Artwork Reproduction

The artwork reproduction was de-sized (some bleeding of the iron gall ink was observed), air-dried, and then pre-wet prior to splitting. Paper facing sheets were also pre-wet at this time. The artwork and facing sheets were briefly laid on blotter paper for slight drying before adhesive application. 25% w/v rabbit skin glue (325-350 Bloom from Kremer Pigments) was prepared and applied to the damp paper facing sheets. The damp artwork was laid between these sheets, "sandwiched" between felts and wooden boards and compacted tightly in a screw press to dry overnight. The next morning, the laminate was slightly cool to the touch. The margins were trimmed and a corner was nicked with a scalpel blade so that the facing sheets could be pried

apart by hand. Once one short edge was successfully split, the laminate was wedged between two tables and splitting commenced by pulling the facing sheets apart from each other at a 90 degree angle (to the unsplit layers). Once the drawing was completely split, the facing sheets were placed in an immersion bath of warm water to solubilize the glue and release the artwork. The layers were retrieved from the bath with Mylar sheets and laid on a silk screen to air-dry.

Results

In an effort to interpret complicated results throughout testing, a ranking system was devised, as follows:

- ***Fail*:** no splitting occurred; skinning and loss (i.e. areas where one side of the core paper remains attached to the other) often observed
- ***Bad:*** some splitting may have occurred, although often the extreme thinness of one side suggests that only overall skinning was achieved; often considerable loss
- ***Okay:*** the majority of the sheet underwent splitting, but there is still considerable loss
- ***Good:*** the majority of the sheet underwent splitting, but there is some loss and unevenness
- ***Perfect****:* the whole sheet underwent splitting with very little or no loss and unevenness

These rankings are assigned in the "Results" column of *Appendix B, Tables 1, 6* and *10.* In addition, every sample was closely observed for characteristic features and damage that resulted from the splitting process. Observations are noted in the "Description of Results" columns of the

respective tables. It is hoped that these observations will contribute to the formulation of a set of criteria for identifying split papers.

Test 1

Unfortunately, half of the samples in *Test 1* did not produce results. Those that were prepared in the rigid-flexible manner did not stick to the Plexi-glas well enough to provide the resistance required for splitting. The core papers and facing sheets peeled unhesitatingly away from the surface. These samples were discarded. No more attempts were made to perform rigid-flexible splitting in future tests, due to time constraints.

The remaining results of *Test 1* are as follows:

Fail: 8, 14, 22, 29

Bad: 16, 24, 31, 32

Okay: 6, 7, 23, 30

Good: 5, 13, 15, 21, 33

Perfect: None

Based on the variables associated with each sample number, these rankings could be used to take a closer look at specific variables (See *Appendix B, Tables 2-5* for assessment). Rankings were compared for different facing materials (cloth or paper), adhesives (rabbit skin glue or cow hide glue), size content (sized or de-sized), and pre-gluing moisture content (damp or dry). Ultimately, the test most strongly suggested superiority of rabbit skin glue over cow hide glue (25% w/v), and pre-wet over all-dry starting materials. Paper only slightly out-performed cloth facing material, and the one parchment sample achieved good results (however, no further

attempt was made to test parchment facing sheets due to time constraints). De-sized paper was only slightly more easily split than sized paper. Results were used to establish fixed variables in *Test 2*, as new variables were introduced.

Test 2

The results of *Test 2* are reported in *Appendix B, Table 6*, and are abbreviated as follows:

Fail: 9, 13

Bad: 1, 2, 5, 6, 8, 10, 16

Okay: 4, 7, 12

Good: 3, 11, 15

Perfect: None

Results were compared for pressing/drying methods, drying extent and glue concentration (see *Appendix B, Tables 7-9*). Overall, there were significantly better results when samples were left in the press to dry, and when samples were allowed to dry almost completely (until cool to the touch). This is likely due to the fact that the excess pressure contributes to the homogeneity of the adhesion of the laminate. Splitting when the laminate is just cool to the touch, but not damp, allows for the glue to become was mostly dry and well-adhered to the facing sheets and exterior of the core paper, while the moistness of the core paper softens its interior and facilitates splitting along its inherent layers (as described by De la Chappelle, 2015, 46). There was no clear evidence for a preference in glue concentration. Ultimately, the thinner concentration was used in *Test 3*, due to the comparatively difficult working properties of the more viscous glue.

Due to slightly worse results overall than in the previous test, and comparative difficulty of working with cloth (largely due to its limpness and tendency to stretch when wet), the decision was made to reintroduce paper in *Test 3.* The cloth did appear to affect the split paper characteristics. More cockling along the edges of the sheets split in *Test 2* suggest that these expanded more during the steps proceeding pressing than those in *Test 1*. With soaking time equal, this may be due to the greater quantity of glue present on the cloth facing sheets used throughout this batch. The absorbent, textured cloth requires more glue for even application than the facing papers.

Identical variables were run on two samples each in order to assess consistency of results. Similar, if not identical results, of samples tested with identical variables, suggest that no unintended variables (e.g. handling, human error, etc.) were significantly effecting results.

Test 3

The results of *Test 3* are reported in *Appendix B, Table 10*, and are abbreviated as follows:

Fail: 1, 2, 5, 6, 9, 10, 12, 14

Bad: 11, 13

Okay: 15, 16

Good: 7

Perfect: 3, 4, 8

The variables tested include facing material (cloth, or paper), glue application (to the core sheet only, or to the facing sheets only), and pre-wetting (of the core sheet only, or of the core

sheet and facing sheets). Results are quantified in *Appendix B, Tables 11-13*. It was concluded that paper was superior to cloth as a facing material. Paper facilitates more even, overall glue application and thus homogenous adhesion to the core sheet. Splitting with facing papers consistently produced more uniform results, and a thicker wire side, whereas facing cloths often resulted in thinner wire sides with patches of irregular thickness and many losses.

Furthermore, it was clearly better to apply glue to the facing sheets than to the core sheet. When glue was applied to the core, there was a tendency for facing papers to skin and attach to it, and for facing cloths to simply peel off, leaving the stiff, glue-impregnated sheet un-split. These results suggest that the adhesive was permeating the core sheet and strengthening its internal bonds so that they could be overcome by the adhesive bond between the core sheet exterior and the facing sheets. On the contrary, application of glue to the facing sheets before "sandwiching" the uncoated core, likely results in greater impregnation and strengthening of the facing sheets and enough solidification of the glue such that its adhesion to the core is primarily at the surface level. The pre-wetting of the core appears to be only slightly detrimental to the splitting process as compared to the pre-wetting of all materials (although the results are inconclusive). It is possible that excess moisture in the core facilitates greater impregnation of the glue, similarly resulting in difficult splitting.

As in *Test 2*, two samples were run for each set of variables in order to assess consistency of results. Each pair exhibited nearly identical results.

Splitting the Artwork Reproduction

The artwork reproduction was ultimately the most successful split among the test samples (See *Appendix A, Images 12-15)*. The full sheet split with no losses. As was typical of nearly all of the test samples (and as reported by De la Chappelle, 2015, 46), the thinner half contained the

wire side of the original sheet. This half was fairly homogenous in structure; nearly no sign of wire lines could be detected with transmitted light, although the screen topography could still be observed with raking light. Interestingly, this was contradictory to De la Chapelle's (2015) quotation from Meder, that the thinner side "carries the wire pattern" (46). It is unclear whether this thinner layer (the layer of fibers initially deposited on the paper-mould during pulling) is actually of even density throughout despite its screen-induced topography, or whether this sheet half is merely too thin throughout for density differences to be observed. The wire-lines in the felt-side half of the sheet are *clearly* visible in transmitted and raking light (in the latter especially when viewing the split side, which was closer to the screen when the sheet was pulled). Again, this contradicts De la Chapelle's article, which states that the thicker half is "usually a slightly dense fiber felt with an even, often amazingly beautiful texture" (46). A watermark in the center of the original sheet, similarly, is not evident in the thinner wire-side, but is clearly evident in the thicker felt-side, in transmitted and raking light. In transmitted light, both halves, but especially the thinner wire-side, possess a mottled, cloudy appearance due to density differences throughout. It is unclear whether these reflect differences in the thicknesses of the internal layers of the original sheet, or flaws caused by the splitting technique. The split sides of both sheets appear rougher in raking light and are more velvety to touch than the surface sides. Even low magnification reveals lifted paper fibers throughout. A shive in the paper has been partially pulled apart and is especially fibrous in appearance, even to the naked eye.

Cockling along the edges of the two halves is evidence of their expansion throughout the process as a result of prolonged wetness. Cockling is more severe in the thicker, felt-side of the sheet, and tighter along the short edges (the sample is grain long), although significant along all edges. Interestingly, the two halves of the sheet contracted to different degrees. The thinner,

wire-side dimensions after splitting, 6 1/8 in. x 4 3/16 in, are 1/16 of an inch larger in both dimensions than the thicker, felt-side, with dimensions 6 1/16 in. x 4 2/16 in. The thinner sheet contracted less while drying against a silk screen, likely due to the fact that its fewer fibers necessarily could not undergo as much bonding as in its thicker counterpart. The equal dimensional increase of the sheet suggests that the sample paper does not possess a strong grain direction. The sheet halves may have also swelled slightly in thickness. Although the original sheet measured approximately .006 inches, the two halves measured approximately .0025 and .005 inches. Measurements varied slightly throughout depending on location of assessment.

The drawing media was undisturbed by the splitting process. Bleed-through of the ink from the opposite side of the sheet split remained in the split half in areas of far enough migration. In these cases, splitting did not serve as a remedy to bleed-through as Smentek suggests (2008, 50). However, where bleeding only travelled part-way through the sheet, splitting reduced its appearance through the translucent paper, thus improving the individual images, and supporting Smentek's theory (although without playing any preventive role). Whether or not splitting could be used as a preventive measure against iron-gall ink corrosion through paper cannot be confirmed from this study, but is worth investigation. It also could not be determined whether the splitting process actually worsened ink bleed-through, although as previously stated, bleeding of the fresh iron gall ink drawing was observed in the pre-wetting bath, suggesting that it is a possibility.

Some features of the ink bleed-through still apparent after splitting may be useful criteria for identification of split drawings. Ink that migrated completely to the opposite sides of the sheet possess a fuzzy appearance in the split half, as a result of the motion of wet ink through paper via capillary action. Similar, previously unexplained, poorly-defined ink marks may be

used to identify a drawing that has been split. In the thinner, wire-side of the sheet, in areas of heavy ink application from the opposite drawing, these marks are darker in the recessed areas of the laid lines. If one were attempting to identify a split drawing on a thin paper, in which the wire-line topography is no longer distinguishable, but in which unexplained ink marks exhibit wire-line patterns, this may be significant evidence.

Sources of Error

Overall, the experiment would benefit from a greater sample size and repetition of the same tests in order to confirm result consistency. Although duplicate sets were run in *Test 2* and *Test 3*, more than two samples would help to ensure statistical significance. Ultimately, the sample size was adequate for devising a splitting method that could be relied upon for filming of a successful demonstration of the process with an artwork reproduction in the end. However, if one were to attempt a more in-depth analysis in order to attribute certain damage characteristics to different splitting techniques (e.g. in an attempt to "reverse engineer" Mariette's process), these results would not suffice. Due to the large range of techniques possible in the eighteenth-century, such an endeavor might prove impossible anyway. For example, results may vary widely depending on paper sample. Tests on papers with different rag contents, of various ages, and exhibiting different drawing techniques would be merited, among many more variables. Overall, errors throughout this experiment were likely caused by handling and procedural aberrations (e.g. allowing the glue to cool too much before changing its water bath, thereby leading to uneven application). However, as long as results are understood as just some of the possible outcomes of the hand-splitting of paper, as possible in the eighteenth-century, the existing quality of control and sampling throughout the project are adequate.

Suggested Further Study

The results have provided a large sample set from which many observations of split paper features have been recorded (in *Appendix B, Tables 1, 6* and *10*). These recommend the formulation of a set of criteria which may be used by collections to identify split supports. In addition to observations made with the naked eye, low magnification, and various angles of light (normal, raking, transmitted), macroscopic imaging with raking light may prove useful for visualizing the surface effects of the procedure. Additional transmitted and normal light imaging of multiple samples, to convey different features and damage characteristics of split sheets may prove useful for demonstrating the points recorded in the *Tables*. Beta-radiography was initially attempted in this experiment, but due to processing failure, was abandoned. It should be attempted again to supplement transmitted light photographs. Clearly defined and illustrated criteria would help to initiate surveys (perhaps first targeting Mariette's collection, or Old Master Drawings), leading to a more accurate understanding of the use and frequency of the splitting of paper throughout history. The discovery of more early examples of split drawings would in turn inform and strengthen the criteria.

The samples nearly all split such that the wire-side of the original sheet was thinner and more homogenous in thickness and the felt-side was thicker and exhibited greater differences in thickness consistent with laid and chain lines. These results support De la Chappelle's (2015) theory that splitting occurs along the natural juncture between the thin layer of fibers initially deposited on the mould and the remaining fibers (46). It would be interesting to split the thicker half of the already split sheet, in order to observe the results. If it is primarily this natural laminate quality of paper that facilitates splitting, splitting of the remaining sheets should prove

difficult, if not impossible. Such an experiment promises to shed light on the internal structure of handmade paper.

Conclusion

A method was devised in which a particular eighteenth-century paper sample could be reliably split for demonstration to a wider audience. Certain factors that most strongly influenced the success of splitting were identified. In particular, it is critical to pre-wet the facing papers and core materials so that they are damp when glue is applied. This facilitates more even application and adhesion of the core and facing materials. Dampening of the core only is detrimental to the process, likely because it fosters impregnation of the core with glue. Dampening of the facing materials only was not tested. Paper was determined to be superior to cloth as a facing material, because it facilitated more even glue application. It was critical that glue was applied to the facing sheets and then stuck to the core, as opposed to being applied to the core directly. The latter resulted in glue-impregnated, stiff cores, which could not be split due to the sizing effect on the paper. For drying and pressing methods, the screw press yielded the most success. The high pressure contributes to the evening of the glue layer throughout the laminate. Splitting when the laminate is just cool to the touch, but not completely dry, nor damp, yielded the best results. At this stage, the glue was mostly dry and well-adhered to the facing sheets and exterior of the core paper, but the moistness of the paper softened the core to facilitate splitting (likely along its inherent internal layers, as hypothesized by De la Chapelle, and supported by the physical characteristics of the test samples after splitting). Results were inconclusive in other instances. The size content of the sheet to be split did not significantly affect the outcome, although it was expected to aid splitting. It was unclear whether a high or low glue concentration was

advantageous. Although rabbit skin glue yielded slightly better results than cow hide glue during testing, the Bloom values of the glues were unequal and complicated the comparison.

Visual observations of all samples were made with the naked eye, low magnification, and in normal, raking and transmitted light. Notable observations are recorded in the "Description of Results" columns of *Tables 1, 6* and *10*. These, along with close observations of the support and media characteristics of the split artwork reproduction, above, aim to contribute to a growing understanding of the physical features of split drawings. Some characteristics are consistent. When split, the wire-side of a sheet is almost always very thin, with few, if any, remaining traces of laid and chain lines. The felt-side is thicker with distinct laid and chain lines and watermark features (i.e. density differences and topographical evidence). The split sides of both sheets exhibit fine lifted paper fibers throughout, creating a velvety, abraded surface, distinct from the surface side when viewed under magnification (but not immediately apparent to the naked eye). This may be the only evidence of splitting on the thicker felt-side, which may otherwise appear like a full sheet. Both sheets appear mottled and cloudy due to differences in thickness throughout when viewed with transmitted light. In less successful splitting attempts, this feature may be more extreme, and losses may be sustained throughout, especially in the thinner wire-side. Some unexpected features, related to paper structure, were also discovered, such as dimensional differences (l/w and thickness) in the split halves of the original sheet. The split artwork reproduction possessed stains from ink migration sustained during the execution of the drawing. These were faint and fuzzy in appearance, and contained laid and chain line patterns in the thinner half that no longer exhibited wire-line density differences itself. These observations establish foundational criteria that may be used for the identification of split supports.

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Appendix A: Images

Images 1 and 2: (left) Francesco Albani, *Night*, early 17th c., pen, ink, and wash drawing, Städel Museum, Frankfurt-am-Main. (right) Francesco Albani, *Night*, early 17th c., pen, ink, and wash drawing, Staatliche Kunstsammlungen, Kupferstich-Kabinett, Dresden. Image credit: both from Smentek, 2008, 49.

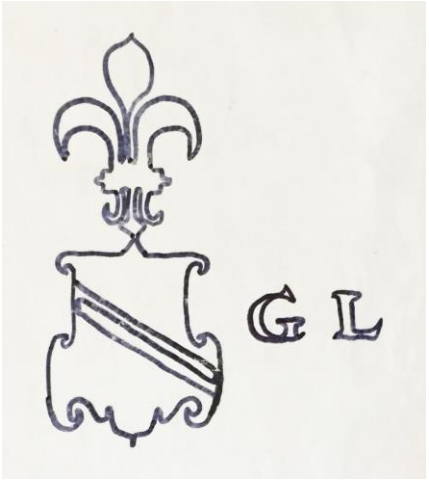

Image 3: Watermark tracing by author: Strasbourg bend with lily (left); countermark initials "GL" (right)

Image 4: Parmigianino, n.d., *Canephoros Facing Right*, Pen and brown ink, brown wash, on paper, 4 x 2 3/4 inches (102 x 69 mm). Image credit: The Morgan Library & Museum.

Image 5: Parmigianino, n.d., *Head in Profile to the Left*, Pen and brown ink, black chalk, 4 x 2 3/4 inches (102 x 69 mm). Image credit: The Morgan Library & Museum. (verso of *Image 8*)

Image 6: Artwork reproduction by Alex Confer, after *Canephoros Facing Right* (*Image 8*) by Parmigianino, before splitting. Image credit: Graham Haber. (felt-side)

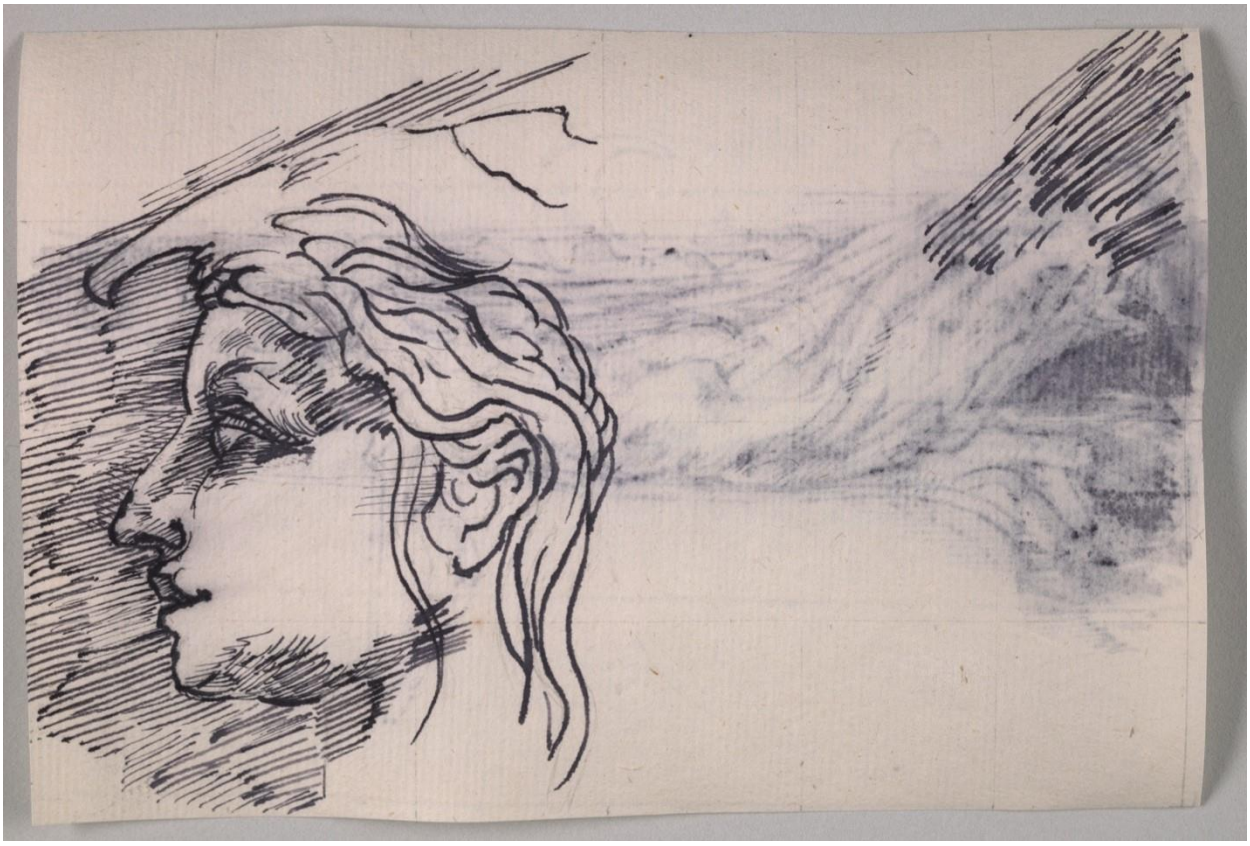

Image 7: Artwork reproduction by Alex Confer, after *Head in Profile to the Left* (*Image 9*) by Parmigianino, before splitting. Image credit: Graham Haber. (wire-side; verso of *Image 10*)

Image 8: Artwork reproduction by Alex Confer, after *Canephoros Facing Right* by Parmigianino, after splitting. Image credit: Graham Haber. (felt-side)

Image 9: Artwork reproduction by Alex Confer, after *Canephoros Facing Right* by Parmigianino, after splitting. Image credit: Graham Haber. (split side of the felt-side; verso of *Image 12*)

Image 10: Artwork reproduction by Alex Confer, after *Head in Profile to the Left* by Parmigianino, after splitting. Image credit: Graham Haber. (wire-side)

Image 11: Artwork reproduction by Alex Confer, after *Head in Profile to the Left* by Parmigianino, after splitting. Image credit: Graham Haber. (split side of wire-side; verso of *Image 14*)

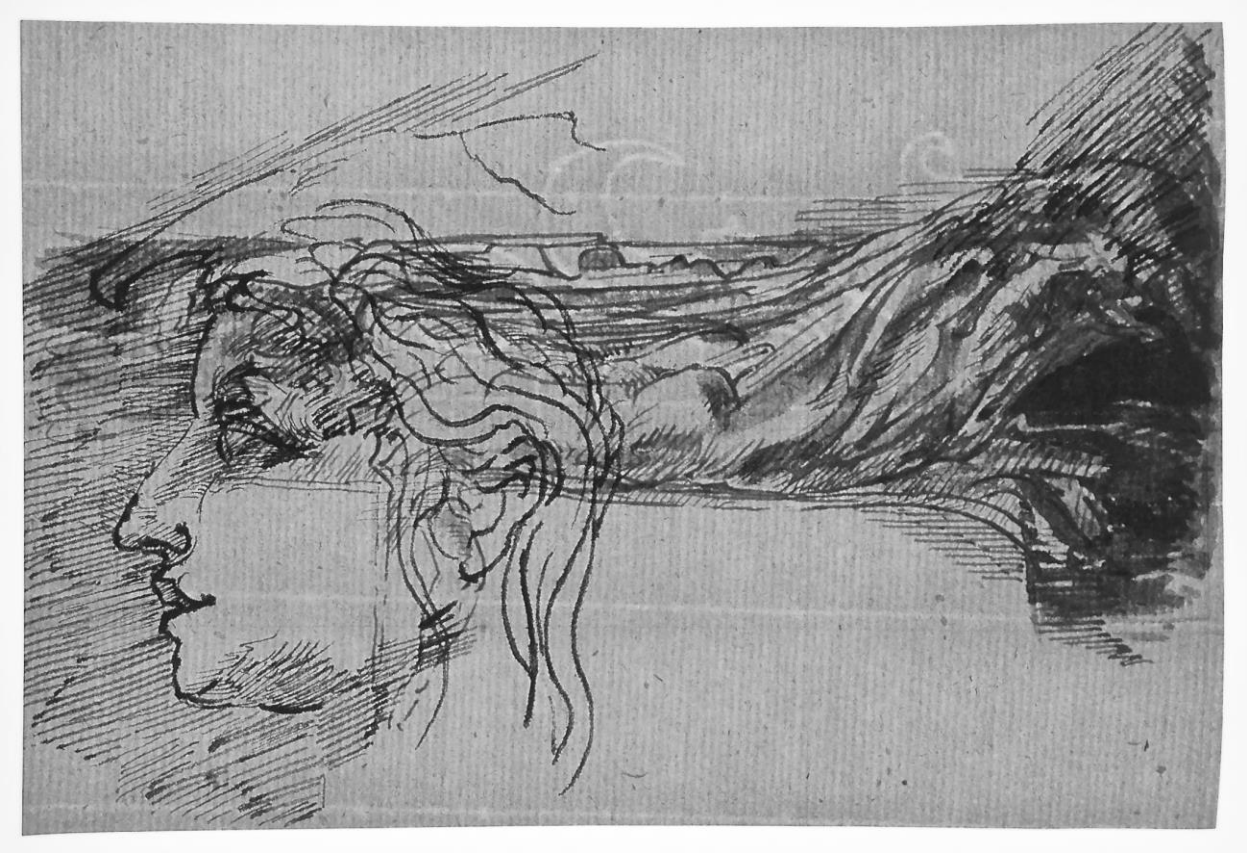

Image 12: Transmitted light photograph of artwork reproduction of double-sided Parmigianino drawing, before splitting (wire-side facing up)

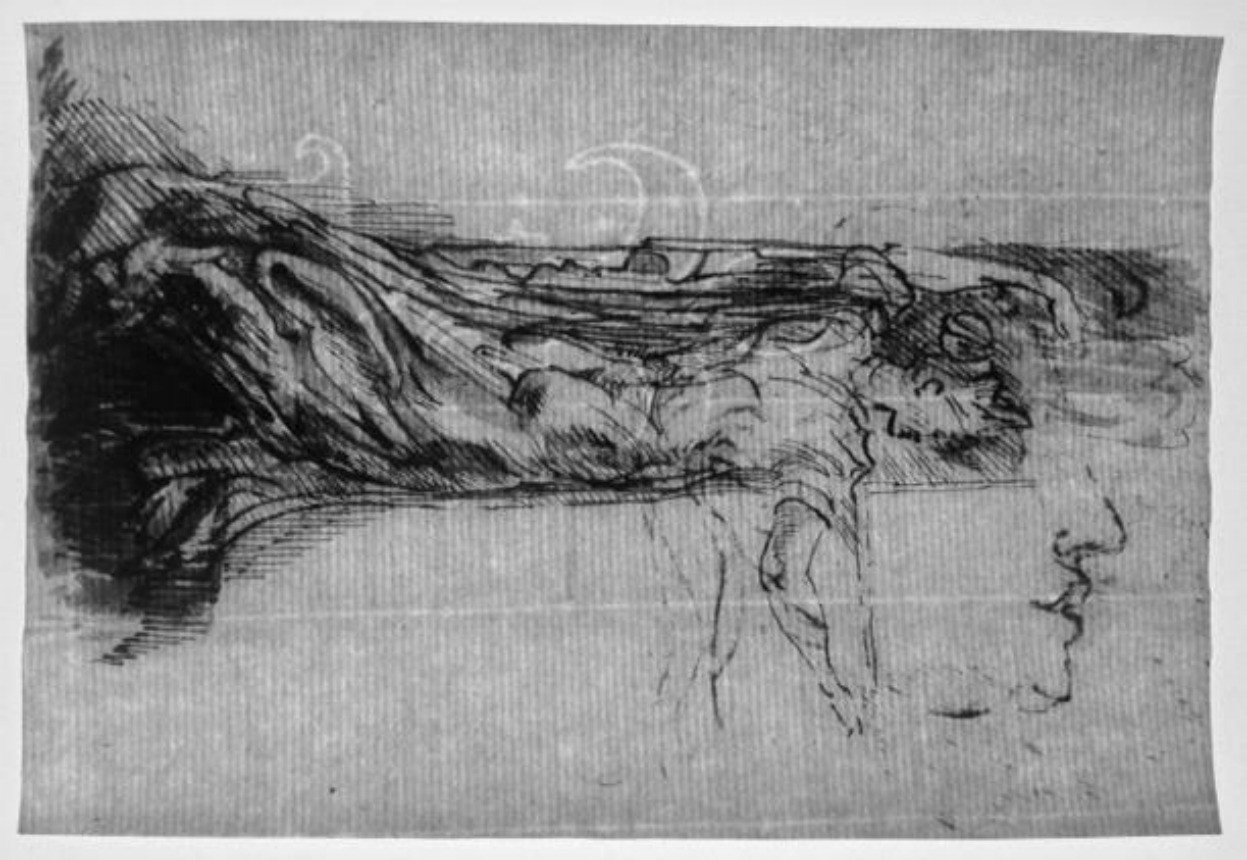

Image 13: Transmitted light photograph of felt-side of artwork reproduction of double-sided Parmigianino drawing, after splitting

Image 14: Transmitted light photograph of wire-side of artwork reproduction of double-sided Parmigianino drawing, after splitting

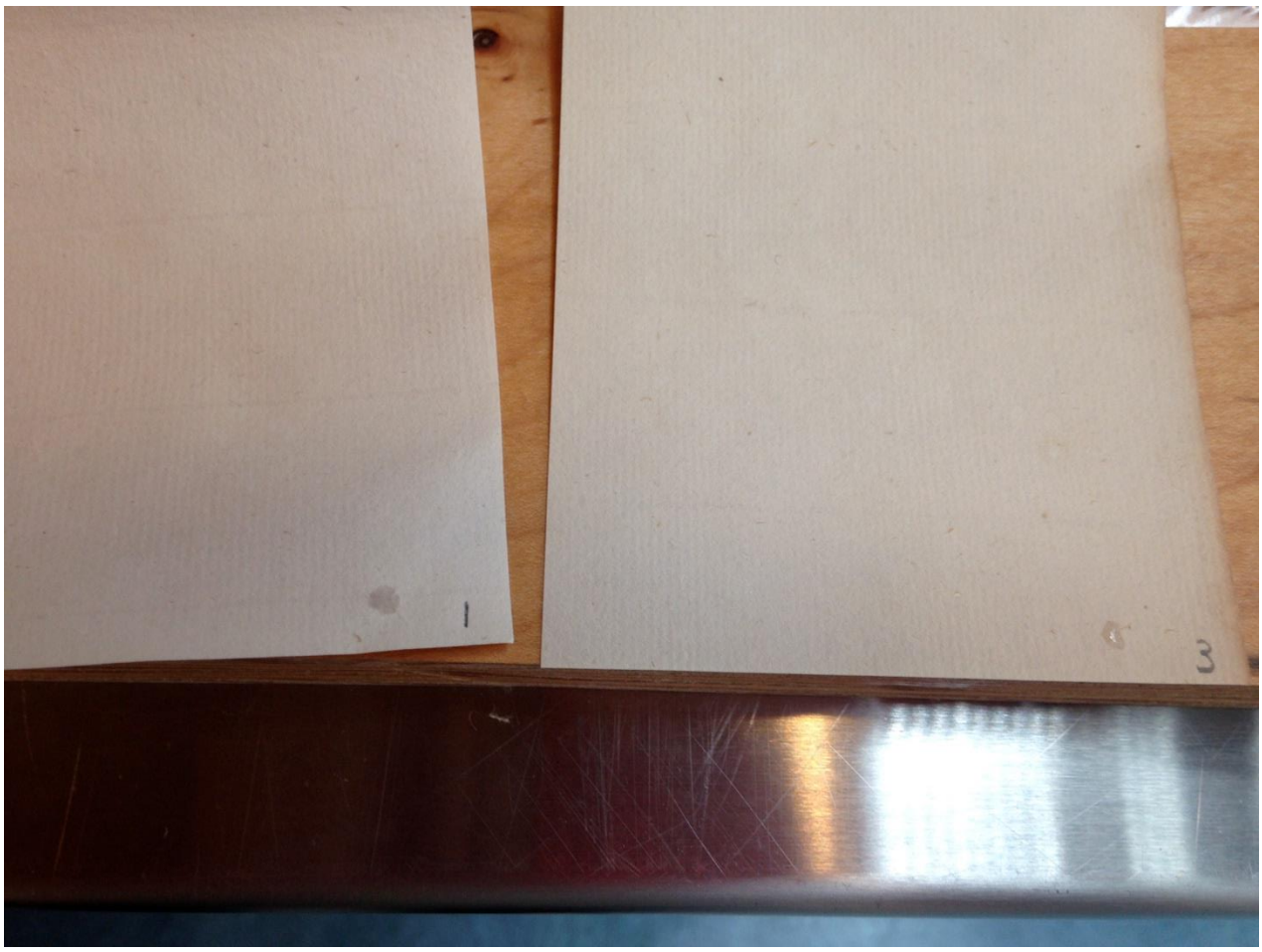

Image 15: Comparison of absorbency of de-sized sample (left) and original sample (right), via water droplet test.

Appendix B. Tables

Table 1. Test Batch 1 Plan & Results

#	FACING MATERIAL	FACING TECHNIQUE	ADHESIVE	DRYING TECHNIQUE	SIZE CONTENT	MOISTURE CONTENT	RESULT	DESCRIPTION OF RESULT
1	Paper	Rigid-flexible	RSG	Stack and weight	De-size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
2	Paper	Rigid-flexible	RSG	Stack and weight	De-size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
3	Paper	Rigid-flexible	RSG	Stack and weight	Leave size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
4	Paper	Rigid-flexible	RSG	Stack and weight	Leave size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
5	Paper	Flexible-flexible	RSG	Press, then stack and weight	De-size	Pre-wet	Good	full sheet split; two moderate areas of attachment of one side to other with corresponding losses along edges and two minor similar incidences in center (one related to presence of shive); wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification)
6	Paper	Flexible-flexible	RSG	Press, then stack and weight	De-size	All dry	Okay	full sheet split but wire side was extremely thin (so sheets were never released from facing papers for further examination); three significant areas of attachment of one side to other with corresponding losses along edges and one similar incidence in center; split sides were visibly rougher and velvety to the touch due to lifted paper fibers; with transmited light through the facing papers, the wire lines in the wire side were invisible and the felt side possessed a noticeably mottled appearance
7	Paper	Flexible-flexible	RSG	Press, then stack and weight	Leave size	Pre-wet	Okay	similar to 6 with fewer losses/attachments from opposite side
8	Paper	Flexible-flexible	RSG	Press, then stack and weight	Leave size	All dry	Fail	some skinning of core paper adhered to other facing sheet, but no actually "splitting" of the sheet ocurred; moderate loss of core sheet from attachment to opposite facing paper in corner; facing papers themselves skinned during process and stuck to core paper in areas and to other facing paper in margin
9	Cloth	Rigid-flexible	RSG	Stack and weight	De-size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
10	Cloth	Rigid-flexible	RSG	Stack and weight	De-size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
11	Cloth	Rigid-flexible	RSG	Stack and weight	Leave size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
12	Cloth	Rigid-flexible	RSG	Stack and weight	Leave size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
13	Cloth	Flexible-flexible	RSG	Press, then stack and weight	De-size	Pre-wet	Good	full sheet split; one moderate and numerous minor areas of attachment of one side to other with corresponding losses along edges; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines and watermark with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); minor tight cockling along long edges (grain short paper) of both halves, more evident in thinner sheet

14	Cloth	Flexible-flexible	RSG	Press, then stack and weight	De-size	All dry	Fail	no splitting occurred because core did not adequately stick to facing cloth; some skinning of core and attachment to one cloth did occur; process resulted in core tearing in half
15	Cloth	Flexible-flexible	RSG	Press, then stack and weight	Leave size	Pre-wet	Good	full sheet split; one moderate and numerous minor areas of attachment of one side to other with corresponding losses along edges; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); minor tight cockling along corresponding long edge (grain short paper) of both halves, more evident in thinner sheet
16	Cloth	Flexible-flexible	RSG	Press, then stack and weight	Leave size	All dry	Bad	no splitting occurred; large area of skinning of core paper did stick to one facing cloth; two long wrinkles developed in the core sheet during construction of the "sandwich", which may be related to bad results
17	Paper	Rigid-flexible	CHG	Stack and weight	De-size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
18	Paper	Rigid-flexible	CHG	Stack and weight	De-size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
19	Paper	Rigid-flexible	CHG	Stack and weight	Leave size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
20	Paper	Rigid-flexible	CHG	Stack and weight	Leave size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
21	Paper	Flexible-flexible	CHG	Press, then stack and weight	De-size	Pre-wet	Good	full sheet split; three moderate areas of attachment of one side to other with corresponding losses along edges and two minor such incidences in center; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines and watermark with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); minor tight cockling along long edges (grain short paper) and one short edge of both halves, more evident in thinner sheet, and tight pulling overall throughout thinner sheet in particular
22	Paper	Flexible-flexible	CHG	Press, then stack and weight	De-size	All dry	Fail	no splitting occurred because core sheet did not stick to facing paper on one side, with exception of two areas which resulted in localized losses to core and where facing paper stuck to cored and skinned in one corner
23	Paper	Flexible-flexible	CHG	Press, then stack and weight	Leave size	Pre-wet	Okay	nearly full sheet split with exception of one large triangluar area along the center length of the sheet, which stuck to one side and pulled the upper layer of the facing sheet with it
24	Paper	Flexible-flexible	CHG	Press, then stack and weight	Leave size	All dry	Bad	no true splitting, though large area of sheet abraded and deposited paper fibers to the other facing sheet; one medium-sized area near edge stuck to opposite facing sheet causing loss in core paper
25	Cloth	Rigid-flexible	CHG	Stack and weight	De-size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas

26	Cloth	Rigid-flexible	CHG	Stack and weight	De-size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
27	Cloth	Rigid-flexible	CHG	Stack and weight	Leave size	Pre-wet	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
28	Cloth	Rigid-flexible	CHG	Stack and weight	Leave size	All dry	Fail	no splitting occurred because animal glue could not stick to Plexi-glas
29	Cloth	Flexible-flexible	CHG	Press, then stack and weight	De-size	Pre-wet	Fail	no splitting occurred; a few patches of core paper attached to the opposite facing cloth, resulting in losses; numerous small areas of skinning scattered throughout and lifted paper fibers throughout unsplit sheet are evidence of the attempt
30	Cloth	Flexible-flexible	CHG	Press, then stack and weight	De-size	All dry	Okay	full sheet may have split, but one side is so thin and patchy that it is possible that the action was more akin to an overall skinning (i.e. doubtful that the split occurred along the natural divide between the two internal layers of the sheet); no attempt was made to remove the halves from the facing cloth; split side is velvety and rough in raking light due to lifting fibers
31	Cloth	Flexible-flexible	CHG	Press, then stack and weight	Leave size	Pre-wet	Bad	no splitting of the sheet, with a few medium-sized areas of sheet adhering to the opposite facing paper, resulting in loss and numerous small patches of skinning throughout; paper is very rough when the splitting action results in skinning as opposed to "true splitting" (compared to the split side of successfully split samples)
32	Cloth	Flexible-flexible	CHG	Press, then stack and weight	Leave size	All dry	Bad	no splitting of the sheet, with l patches of skinning throughout; paper is very rough when the splitting action results in skinning as opposed to "true splitting" (compared to the split side of successfully split samples)
33	Parchment	Flexible-flexible	RSG	Press, then stack and weight	Leave size	All dry	Good	full sheet split; three moderate areas of attachment of one side to other with corresponding losses along edges; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines and watermark with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); minor tight cockling along short edges (grain long paper) and one long edge of both halves and tight pulling overall throughout thinner sheet in particular; in margins of "sandwich", a small patch of the flesh side of the parchment delaminated and transferred to the other parchment sheet

Table 2. Cloth versus paper I

	Number of Outcomes by Ranking	
Ranking	**Cloth**	**Paper**
Fail	2	2
Bad	3	1
Okay	1	3
Good	2	2

Table 3. Rabbit skin glue versus cow hide glue

	Number of Outcomes by Ranking	
Ranking	**Rabbit skin glue**	**Cow hide glue**
Fail	2	2
Bad	1	3
Okay	2	2
Good	4	1

Table 4. Size versus de-size

	Number of Outcomes by Ranking	
Ranking	**Size**	**De-size**
Fail	1	3
Bad	4	0
Okay	2	2
Good	2	3

Table 5. Pre-wet versus all-dry

	Number of Outcomes by Ranking	
Ranking	**Pre-wet**	**All-dry**
Fail	1	3
Bad	1	3
Okay	2	2
Good	4	1

Table 6. Test Batch 2 Plan & Results

#	FACING MATERIAL	FACING TECHNIQUE	ADHESIVE	ADHESIVE VISCOSITY	DRYING TECHNIQUE	SIZE CONTENT	MOISTURE CONTENT	DRYING EXTENT	RESULTS	RESULTS DESCRIPTION
1	Cloth	F-F	RSG	high	Press then stack	De-size	Pre-wet	Damp	Bad	no splitting; large areas of skinning overall; one corner of loss; numerous lifted paper fiber patches and overall roughness observed in raking light related to skinning with corresponding velvety texture
2	Cloth	F-F	RSG	high	Press then stack	De-size	Pre-wet	Dry	Bad	splitting in lower quarter of sheet; large areas of skinning overall; one corner of loss; numerous lifted paper fiber patches and overall roughness observed in raking light related to skinning with corresponding velvety texture
3	Cloth	F-F	RSG	high	Press	De-size	Pre-wet	Dry	Good	full sheet split; a few moderate areas of attachment of one side to other with corresponding losses along edges and several minor similar incidences in center; wire side thinner sheet (extremely thin and of uneven thickness); significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along all edges of both sheets, more prominent in thicker sheet; several pulls around thicker areas of thinner sheet
4	Cloth	F-F	RSG	high	Press	De-size	Pre-wet	Damp	Okay	full sheet split; several significant areas of attachment of one side to other with corresponding losses along edges and center; wire side thinner sheet (extremely thin and of uneven thickness); significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along all edges of both sheets, more prominent in thicker sheet; pulling around areas of uneven thickness in both sheets
5	Cloth	F-F	RSG	low	Press then stack	De-size	Pre-wet	Dry	Bad	no splitting occurred; skinning of core paper overall did stick to one facing cloth; very velvelty texture of skinned core paper with numerous lifted paper fibers
6	Cloth	F-F	RSG	low	Press then stack	De-size	Pre-wet	Damp	Bad	a couple areas of localized splitting; watermark in one areas of splitting very thin along design (on thinner wire side); skinning of core paper overall; very velvelty texture of skinned core paper with numerous lifted paper fibers
7	Cloth	F-F	RSG	low	Press	De-size	Pre-wet	Dry	Okay	

										nearly full sheet split; a few moderate areas of attachment of one side to other with corresponding losses along edges towards center; wire side is the mostly thinner sheet (extremely thin, of uneven thickness), but the sheet split 2/3 "correctly" (i.e. like the others, where wire side = thin side), and 1/3 the opposite; significant loss of topography in wire side in raking light, but very evident wire lines in transmitted light (in areas of wires, very little sheet remains to hold between-wire areas together); very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along all edges of both sheets; tight pulling in areas of different thickness in both sheets
8	Cloth	F-F	RSG	low	Press	De-size	Pre-wet	Damp	Bad	two narrow areas of splitting; skinning of core paper overall; very velvelty texture of skinned core paper with numerous lifted paper fibers
9	Cloth	F-F	RSG	high	Press then stack	De-size	Pre-wet	Dry	Fail	no splitting; several patches of skinning around center and one area of loss in corner; velvety texture of abraded paper with numerous lifted paper fibers
10	Cloth	F-F	RSG	high	Press then stack	De-size	Pre-wet	Damp	Bad	no splitting; large area of skinning; velvety texture of abraded paper with numerous lifted paper fibers
11	Cloth	F-F	RSG	high	Press	De-size	Pre-wet	Dry	Good	nearly full sheet split; one area of attachment of one side to other with corresponding losses along short edge; wire side is the thinner sheet; significant loss of topography in wire side in raking light and transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along all edges of both sheets, worse along long edges (paper grain short) and in thicker sheet; pulling around areas of different thicknesses in centers of both sheets
12	Cloth	F-F	RSG	high	Press	De-size	Pre-wet	Damp	Okay	nearly full sheet split; several moderate areas of attachment of one side to other with corresponding losses along edges towards center; wire side is the thinner sheet (extremely thin, of uneven thickness);significant loss of topography in wire side in raking and transmitted light; wire side appears to have been embossed with texture of silkscreen on which it was set to dry, during drying; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along long edges of both sheets (grain short paper), more

										significant on thicker sheet; pulling in areas of different thickness in both sheets
13	Cloth	F-F	RSG	low	Press then stack	De-size	Pre-wet	Dry	Fail	no splitting occurred; slight abrasion overall with one corner of loss; very velvety texture of abraded paper due to lifted paper fibers
14	Cloth	F-F	RSG	low	Press then stack	De-size	Pre-wet	Damp	---	sample accidentally wetted after pressing and thus discarded from results
15	Cloth	F-F	RSG	low	Press	De-size	Pre-wet	Dry	Good	nearly full sheet split; one area of attachment of one side to other with corresponding losses along short edge; wire side is the thinner sheet (very thin and uneven); significant loss of topography in wire side in raking light and transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); tight cockling along all edges of both sheets, worse along long edges (paper grain short) and in thicker sheet; pulling around areas of different thicknesses in centers of both sheets
16	Cloth	F-F	RSG	low	Press	De-size	Pre-wet	Damp	Bad	a few narrow areas of splitting; some abrasion throughout; very roughly textured paper with lifting fibers

Table 7. Low versus high glue concentration

	Number of Outcomes by Ranking	
Ranking	**25% w/v**	**40% w/v**
Fail	1	1
Bad	4	3
Okay	1	2
Good	1	2

Table 8. Press drying versus stack drying

	Number of Outcomes by Ranking	
Ranking	**Press**	**Stack**
Fail	0	2
Bad	2	5
Okay	3	0
Good	3	0

Table 9. Splitting when damp versus mostly dry

	Number of Outcomes by Ranking	
Ranking	**Damp**	**Dry**
Fail	0	2
Bad	5	2
Okay	2	1
Good	0	3

Table 10. Test Batch 3 Plan & Results

#	FACING MATERIAL	FACING TECHNIQUE	GLUE APPLICATION	ADHESIVE	ADHESIVE VISCOSITY	DRYING TECHNIQUE	SIZE CONTENT	MOISTURE CONTENT	DRYING EXTENT	RESULTS	DESCRIPTION OF RESULTS
1	Paper	F-F	core	RSG	low	Press	De-size	Pre-wet core	Dry	Fail	no splitting occurred; one of facing papers skinning and attached to core sheet
2	Paper	F-F	core	RSG	low	Press	De-size	Pre-wet core	Dry	Fail	no splitting occurred; facing papers were skinning and attaching to core instead so no further splitting was attempted
3	Paper	F-F	facing	RSG	low	Press	De-size	Pre-wet core	Dry	Perfect	full sheet split; a few very minor areas of attachment to other sheet half with corresponding loss; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); some very minor tight cockling along edges (grain short paper) of thicker sheet; spot stain due to inclusion split such that inclusion and stain are on thinner sheet, and stain without inclusion are on thicker sheet
4	Paper	F-F	facing	RSG	low	Press	De-size	Pre-wet core	Dry	Perfect	full sheet split; one small area of attachment to other sheet half with corresponding loss along short edge; a few small areas of unevenness near edges throughout; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); some very minor tight cockling along edges (grain short paper) of both sheets
5	Paper	F-F	core	RSG	low	Press	De-size	Pre-wet all	Dry	Fail	small area of splitting, but otherwise facing paper skinned and stuck to core paper

6	Paper	F-F	core	RSG	low	Press	De-size	Pre-wet all	Dry	Fail	no splitting occurred; facing paper skinned and stuck to core paper
7	Paper	F-F	facing	RSG	low	Press	De-size	Pre-wet all	Dry	Good	full sheet split; a few large areas of uneven splitting; anomalously, the felt side of the sheets was the mostly thinner side (2/3 split thinner and 1/3 split thicker); the felt side exhibited wire lines very strongly with transmitted light, whereas the wire side's evidence of wire lines in transmitted light was significantly diminished; very mottled appearance with transmitted light of both sides; split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); some very minor tight cockling along short edges (grain long paper) of both sheets
8	Paper	F-F	facing	RSG	low	Press	De-size	Pre-wet all	Dry	Perfect	full sheet split; one very small area of attachment to other sheet half with corresponding loss along short edge; a few small areas of unevenness throughout; wire side thinner sheet; significant loss of topography in wire side and reduced ability to detect wire lines with transmitted light; very mottled appearance with transmitted light of both sides (especially thinner wire side); split side of both halves is more velvety to touch, has slightly rougher texture in raking light to naked eye and with 40x loupe magnification (should be observed with higher magnification); some minor tight cockling along edges (grain short paper) of both sheets
9	Cloth	F-F	core	RSG	low	Press	De-size	Pre-wet core	Dry	Fail	no splitting occurred; facing cloth cleanly peeled off one side of core due to inadequate sticking (i.e. internal strength of core paper exceeded bond to cloth)
10	Cloth	F-F	core	RSG	low	Press	De-size	Pre-wet core	Dry	Fail	no splitting occurred; facing cloth cleanly peeled off one side of core due to inadequate sticking (i.e. internal strength of core paper exceeded bond to cloth)
11	Cloth	F-F	facing	RSG	low	Press	De-size	Pre-wet core	Dry	Bad	some patches of splitting scattered throughout among overall abrasion; sheet tore in half (one side stuck to one facing

											cloth, one to to the other); paper rough due to lifted fibers
12	Cloth	F-F	facing	RSG	low	Press	De-size	Pre-wet core	Dry	Fail	no splitting occurred; loss in sheet where strip of core paper stuck to other facing cloth; some abrasion throughout; paper rough due to lifted fibers
13	Cloth	F-F	core	RSG	low	Press	De-size	Pre-wet all	Dry	Bad	two small areas of splitting occurred; sheet tore in half due to half of core sticking to one facing cloth, and half sticking to the other; no signs of abrasion otherwise, suggesting glue application/areas of adhesion were uneven
14	Cloth	F-F	core	RSG	low	Press	De-size	Pre-wet all	Dry	Fail	no splitting occurred; facing cloth cleanly peeled off one side of core due to inadequate sticking (i.e. internal strength of core paper exceeded bond to cloth)
15	Cloth	F-F	facing	RSG	low	Press	De-size	Pre-wet all	Dry	Okay	full sheet split but wire side extremely thin, almost as if there was overall skinning as opposed to true "splitting"; numerous small areas of attachment of one side to other with corresponding losses along edges and in center; split sides were visibly rougher and velvety to the touch due to lifted paper fibers; with transmited light through the facing papers, the wire lines in the wire side were nearly invisible; the wire side appears to have conformed slightly to the silkscreen upon which it air-dried after being released from facing sheet
16	Cloth	F-F	facing	RSG	low	Press	De-size	Pre-wet all	Dry	Okay	full sheet split; wire side extremely thin in bottom half, almost as if there was overall skinning as opposed to true "splitting"; numerous small areas of attachment of one side to other with corresponding losses along edges and in center; split sides were visibly rougher and velvety to the touch due to lifted paper fibers; with transmited light through the facing papers, the wire lines in the wire side are diminished; minor tight cockling along short edges of thicker felt side (grain long paper)

Table 11. Cloth versus Paper II

	Number of Outcomes by Ranking	
Ranking	**Cloth**	**Paper**
Fail	3	4
Bad	2	0
Okay	2	0
Good	0	1
Perfect	0	3

Table 12. Glue application to core sheet versus facing sheets

	Number of Outcomes by Ranking	
Ranking	**Core**	**Facing**
Fail	7	1
Bad	1	1
Okay	0	2
Good	0	1
Perfect	0	3

Table 13. Pre-wetting core only versus all materials

	Number of Outcomes by Ranking	
Ranking	**Wet core**	**Wet all**
Fail	5	3
Bad	1	1
Okay	0	2
Good	0	1
Perfect	2	1