SIDEDNESS
WIRE AND FELT SIDE OF HANDMADE PAPER
Hanging wet paper to dry on horse-hair rope (treble-lines) p.16
**Wire Side Clues**

- More pronounced felt hair marks relative to verso (pp. 6-7)
- Laid lines visible passing through drip watermarks (pp. 8-13)
- Back mark convex (pp. 16-21)
- Lighter spectrophotometer readings relative to verso (pp. 24-25)
- Paper curls towards wire side, sometimes glued during sizing pp. 14-15
- Laid lines apparent in chalk drawing (p. 9)

**Felt Side Clues**

- Less pronounced felt hair marks relative to recto (pp. 6-7)
- Laid lines NOT visible inside drip and flaw watermarks (pp. 8-13)
- Back mark concave (pp. 16-21)
- Darker spectrophotometer readings relative to recto (pp. 24-25)
- If there are two watermarks in one sheet (main and countermark) then the main mark is right reading (from wire side) and the counter mark is reversed (right-reading felt side) – often the papermaker’s initials. (p. 3)

---

**Contents**

- Introduction 1
- Paper’s two-sidedness: defining wire and felt side 3
- Look-through 5
- The two-sidedness of papermaker’s felt 6
- Determining wire or felt side: vatman & coucher drips 9
- Case study: determining wire or felt side from drip evidence 10
- Wire or felt side: drip watermark characteristics 13
- Wire-side-up 14
- Folded, glued edges an indication of the wire side 15
- Back mark as an indication of sidedness 17
- Spurs hung on treble-lines create back marks 18
- Using manufacture flaws to identify wire and felt side 22
- Wire and felt side color & value shift 28
- Wire or felt side: destructive method 26
- Wire or felt side: Torn edges 28
- Wire or felt side: Graphite toning 29
- Overview – Characteristics of wire side & felt side 31
- Acknowledgments 32
Introduction

In early 2017, Timothy Barrett\(^1\) and I present at the Paper Conservation Symposia on Technical Art History at the Metropolitan Museum of – at the invitation of Marjorie Shelley\(^2\). There we described the current state of our research regarding early European paper. Tim’s presentation, Aesthetic Considerations in Making Paper, and mine, Recreating 16th-century Drawing Papers for Contemporary Artists, described our findings and hopefully shed light on some of the many issues surrounding early European papermaking.

At the close of our presentations, a conservator in attendance posed a paper-sidedness question:

What are the various techniques for distinguishing a sheet’s felt side from its wire side in a non-destructive manner?

Neither Tim nor I had a satisfying answer, despite it being a relatively straightforward question – It was a papermaking detail on which we had not focused. Of course, we had the conventional explanation of casting raking light across the sheet to gauge which side the laid lines appear most strongly. But this method is not a universally effective solution since not all early papers have a noticeable surface laid pattern. Having pondered and researched this question for over 18 months as I continued my investigation of early European papermaking, I can now say that this seemingly simple question is not so “straightforward” as I first imagined. This document represents my effort to describe the parameters of sidedness and begin formulating answers to that question, though it by no means can be said to be a fully comprehensive response. The ideas presented here may spark others to shed light on the endlessly intricate question of handmade paper’s sidedness.

Donald Farnsworth
2017

---

1 Timothy Barrett: Director, Center for the Book, University of Iowa
2 Marjorie Shelley: Sherman Fairchild Conservator in Charge, Paper Conservation, the Metropolitan Museum of Art
The term “wire” side (aka the right side) in handmade paper refers to the side of the paper that touches the mould’s wire covering when the sheet was formed and, therefore, the side that is face-up after couching (transferring the paper from the mould to a felt).

Except for French drawing papers and countermarks, watermarks are sewn wrong-reading to the mould’s wire surface so that when couched onto a felt, the watermark is right-reading. Most likely, if you hold a sheet to the light and see a watermark right-reading, you are looking at the wire side (aka the right side). The downward-facing side, the side touching the felt as it was couched, is called the felt side (aka the wrong side).

There are textural differences between the wire and the felt sides, which can be either very obvious or extremely difficult to discern. Often, under raking light, the wire side reveals its laid lines more prominently than the felt side. The degree to which the laid lines show depends upon many factors, including the furnish’s processing and composition and the weight of the paper. Felt hair marks, if present, can be seen on both sides but tend to be stronger on the wire side (see p. 6).

All sheets in post and pack pressings are oriented with the wire side facing upwards – just as they were couched. After pack pressing, sheets are folded onto the “T” – wire side inwards – (separately or in spurs). The T holding the draped sheet(s) is lifted as the sheets are hung on treble lines (horsehair rope) so that the wire side is touching the rope. When dry, the sheets form into a “U” shape. Once pulled from the treble lines, the “back is broken” as the sheets are laid out on a flat surface - wire side up (like the letter U forced to lay flat). The natural curve of the splayed sheets impersonates the “good draping” of a bound book. The natural treble-line-curvature usually ensures the wire side is bound on the inside of the folded leaves of a signature. Again helping to guarantee “good draping.”

Paper’s two-sidedness: defining wire and felt side

1. Furnish (aka stock): The raw materials for papermaking in liquid form – pulps, dyes, additives and other chemicals blended together ready for papermaking.
2. Felt hair marks: The marks left on paper during its manufacture, caused by coarse felts.
When a paper is formed on a laid mould, the initial dip starts with the lead (long) edge of the mould pulled towards the vatman from the rear of the vat through the furnish. Water rushes across the laid lines in a perpendicular direction, fibers alight parallel to the chain lines, and lay across the laid lines’ gaps, preventing the fibers from tangling in the slots between each laid line. This fiber alignment helps the coucher make a clean transfer of the newly formed sheet from mould to felt. When the pulp first impacts the mould surface, the fines fall through the screen; very quickly after that, a fiber mat starts to form, trapping the fines on the sheet’s upper side (the felt side). The vatman shakes the screen side-to-side and forward-to-back, crossing the grain. A more pronounced grain direction will be found on the wire side, while a more random fiber orientation is found on the upper, felt side.

Figure 8: Furnish flow on the laid mould covering causes a heavier build-up of fibers washed to the drainage spaces (between the laid lines and on either side of the ribs). Those varied fiber densities generate the visible shadow of the laid lines and the thick/thin profile of “antique” laid paper.

Look-through

As the sheet forms, draining “white water” follows the path of least resistance, flowing through the spaces between the laid lines and pulling fibers that follow the water’s movement. Therefore, we find that a thinner mat of fiber accumulates on the chain and laid line wires as more fiber builds up in the spaces between the wires. This choreographed dance and flow of water and fiber happen in a mere eight seconds of sheet formation as fibers are swept along, following the white water as it drains through the sieve slots of the screen. The flow of draining water draws fibers in the flow direction, away from the wires into the laid line slots, sorting the fines and fiber into the thick-and-thin pattern, which creates the light and dark image of the watermark and laid lines when the paper is held up to the light.

A further complexity occurs when the draining water, having made it past the laid screen, hits the wood ribs to which the chain lines are sewn. Like a rushing river pounding against a protruding rock, water flows around the ribs, depositing fiber in its wake and causing a shadow line of thicker fibers seen on either side of the chain/rib lines (Figure 8, left).

Examining a paper held to light reveals many signs of its manufacture. One might find vatman or coucher’s drips, watermarks, laid lines, production flaws, wove screen pattern, or possibly “wild” or “cloudy” textures. Each of these marks has a story to tell.

Furnish for paper with a “good look-through” – i.e., a visible laid pattern and watermark – must contain shorter fibers that have been beaten with more force in a less dense suspension. (Beaten with more fly-bar to bedplate pressure to promote cutting and shortening of the furnish fibers.) Shorter fibers provide a better look-through because they readily accumulate and settle according to the laid lines and watermark’s topography, creating a sharper image. Long and unruly fibers with higher tear strength do not build up in the low points of the screen nor thin out in the highs points as do shorter fibers, but rather drape themselves across the wires of the screen (during formation), diminishing wire pattern detail. When held up to the light, a sheet made from long-fiber furnish will appear cloudy or, as some say, “wild.” In such a sheet, laid lines, chain lines, and watermarks are unresolved and hard to distinguish.

Meanwhile, despite the attractiveness of a paper with a sharp, clear laid pattern and watermark, it may not be the strongest paper one could choose, as measured by a robust tear strength. Still, such a paper often has a nice rattle and good tensile strength. Like fine winemakers, papermakers blend their pulps to create a furnish that will yield a paper with the characteristics we have come to expect – a fine balancing act indeed.
Numerous heritage sheep breeds (usually raised in harsher climates) have a coarse, protective outer coat and a more refined, insulating inner coat. The thick, coarse outer coat is efficient at shedding water and was ideal for early European papermakers using less efficient wooden screw presses. Papermakers transitioned to the more delicate inner wool as advances in mechanical presses became available. Coarse felt hair marks often seen in early European papers diminish and disappear in the mid-1700s concurrent to technical screw press improvements.

For functional reasons, papermakers’ woolen felts (blankets) have two sides; a finer nap on one side and coarser on the verso. Felts are “thrown,” fine-fleece-up on each successive couched paper. Having more surface area than the coarser side, the fine-nap-side holds the sheet to the felt as each felt is removed after pressing. For that reason, when parting sheets from the post, the exposed sheet remains affixed to the lower felt rather than clinging to the lifted felt’s underside.

In an ideal Renaissance papermill, with felts in good condition and the coucher laying felts properly, the fine and coarse felt hair marks impressed into the sheet provide another sidedness clue. As mentioned above, when a sheet is formed, the fibers touching the laid screen create the wire side, and the opposite side, inverted and couched onto the felt, is the felt side. Considering felts are thrown fine side up, the felt side will take on the more delicate fleece’s impressions, and the wire side will have the imprint of the coarser wool. The image shown above is the wire side, as indicated by its coarse felt hair marks and indented chain lines – coarser and more robust than the felt-side (p. 7), which shows the more delicate felt hair marks.

The two-sidedness of papermaker’s felt

---

* The fine wool fibers, found on the couching side of the papermaker’s felt, have a lower micron value than the coarse fleece on the verso. The finer fibers make a denser felt mat, with more surface area, hence the “clingier” side of the felt.

---
We can certainly see that Georges Seurat chose the paper's wire side for many of his chalk works on Michallet paper. This is evident by the strong laid lines present in his conté crayon drawings. In other cases, it can be challenging to discern the wire and felt sides from one another. A close examination of the phenomenon known as vatman’s drips (aka vatman’s tears), when present, will help us determine which side an artist used. Vatman’s and coucher’s drips occur when droplets of water or furnish fall onto the surface of a newly formed or couched sheet. This round drip mark’s size and clarity are determined by the height from which it falls and the drop’s volume. Whether the vatman or coucher made the drop is significant. The drop pushes fibers aside to form a crater-like dent, round and thinner than the rest of the sheet.

The vatman’s drips fall on the felt side, dripping from his hands, arms, and from the deckle as it is being removed. It is easy to do: the vatman passes the mould to the coucher by pushing the mould with the inner left corner of the deckle, sliding the mould along the stay, while at the same time raising the far end of the deckle to free it from the mould. The deckle will be placed on the second (paired) mould to form a sheet as the previous sheet is tilted on the asp and later couched. When the deckle is lifted from the mould, dripping wet, droplets often fall on the sheet during this maneuver (mould-to-coucher and deckle-to-paired-empty-mould). Meanwhile, the coucher throws a felt (coarse side down) to cover the previous sheet and takes the mould from the asp.

While holding the mould vertical to the post, the coucher plants one long edge of the mould onto the felt and, in a smooth, arcing action, presses the loaded mould onto the felt, transferring the sheet from mould to the fine nap side of the blanket (couching). In this repetitive dance, drops can also fall from the mould as a sheet is couched. Unlike the vatman’s drips that fall on the felt side, these coucher drips would be falling onto the wire side of the newly couched sheet (wire side up).

Knowing at what stage of paper formation these drips occurred can lead us to draw conclusions about which side of the paper was disrupted and, therefore, at which side of the sheet we are looking.
Case study: determining wire or felt side from drip evidence

For example, let us consider a single leaf from a quarto dating to the 1730s. In the first image on the page opposite, we can see the crater topography and the fiber disruption (image 1). In the second image (a backlit view of the same area), we can see visible laid lines that have not been disrupted by the drip (image 2), indicating that the falling drop of water landed on the top surface of a newly formed sheet – the felt side (the vatman loosed the drop). Further, we note no disruption or crater dimensionality in the verso (image 3), the wire side.

In this example, the force of the falling water – combined with the build-up of fiber and fines, along with the accelerated evaporation along the ridges of the crater (greater surface area) – accumulated more pigment, fines, and impurities to the rim of the crater, yielding the darker, tidemark-like edge to the drip mark. This edge pigmentation is more likely to happen on the felt side – the side with the greatest concentration of fines.
Wire or felt side: drip watermark characteristics

The vatman’s drips (above) make their mark on the felt side surface of a wet sheet still on the mould. The drip does not disrupt the laid lines. Additionally, the drips produce a soft-edge displacement of fiber divots due to the wetness of the sheet. Once the sheet is dry and finished, these will appear as ‘soft focus’ drip watermarks. Notice that the laid lines are not interrupted (above right).

A coucher’s drip makes its mark on the wire side surface of a couched sheet. These drips fall on a sheet just after couching. With less water to absorb the force of the impact, these drips displace fiber like a meteor colliding with the moon, producing a rim-edged crater. When dry and finished, these drip watermarks will have a hard-edged rim and the laid lines will be disrupted - not existant within the crate.
Handmade sheets air dried unconstrained tend to curl towards the wire side, arcing parallel to the chain lines. This curvature is due to the surface grain directionality of the wire-side fibers. As the sheet is formed, the fibers that make contact with the mould’s laid screen are lined up in parallel to the vatsman’s dipping motion, while fibers that do not come into direct contact with the wires are distributed more randomly.

During drying, fibers tend to shrink and become narrower in diameter. Since the fibers on the wire side are parallel, not randomly distributed, the shrinkage is more pronounced on that side. The net result is a contraction of the paper inward toward the wire side’s surface, causing a wire-side curl effect. In some instances, as you will see, this offers a sidedness clue.

1. Due to handmade paper’s predilection for curling toward the wire side as it dries, from time to time, we find sheets with fixed, folded corners, as seen in the image above. The paper’s curl in waterleaf and sized sheets can be very tight and spring-loaded, making it difficult for the sizing and finishing departments to flatten. It is not uncommon to find the insistent curling of the sheets’ edges fixed in place by sizing and compressed into permanent folds during the standing press’s finishing pressure. The book binder’s plow trims off most folded edges that arise in this manner; those that remain are most often curled or folded to the wire side.

2. The concave back mark troughs visible at the top of the page, denoting that this was the rope side when the spur was hung to dry, known to be the wire side. (See “Back marks as an indication of sidedness,” p. 17.)

3. Not shown here: when backlit, the right-reading watermark also corroborates our wire side conclusion.
Back mark as an indication of sidedness

Back is the word handmade papermakers use to describe the arch or ridge formed in a spur when it dries hung over a rope or pole.

With this drying loft process in mind, and the understanding that the “back” refers to the dried paper’s arch, it follows that the “back mark” refers to any marks left as a result of the formation of a back during drying or, more accurately, while “breaking” and flattening out the back. The back mark forms and appears rather suddenly as the spur is splayed and forced flat. A convex topography of ridges appears on the top of the back’s arch, while concave, furrow-like textures form along the back’s inner or underside arc.

Knowing how loft dried papers were couched, pressed, and hung to dry gives us insight into back mark formation, enabling us to determine sidedness from the back mark’s enduring ridges and troughs.
**Spurs hung on treble-lines create marks**  
Hanging sheets after pack pressing – Wire side in, touching the horse hair rope

---

1. **After forming, couching and pressing** the sheets are oriented wire side up

2. A “T” is placed off-center on the “pack” of pressed sheets

3. The top sheet (or spur*) is folded over the T

4. The T is lifted separating the sheet(s) from the pack

5. The sheet or spur is hung to dry on the treble-lines (horsehair rope) wire-side-in

---

D id papermakers, accidentally or otherwise, ever flip the paper at some point during the pressing or hanging stages so that the felt side was facing inward when suspended on treble-lines? Not likely, since the choreographed movement of forming, couching, pressing, and drying paper tends to follow the path of least resistance, minimizing the risk of damaging the newly formed paper.

To wit:

- Forming and couching wire side up is a given – the historical process.
- Flipping the post is impossible.
- Flipping the post is impossible.
- Flipping the sheet during parting would be more likely to damage the sheet and an unneeded motion.
- To invert the pack before or after pack pressing is risky and unnecessary.
- Sliding the T under the paper rather than folding the paper over requires extra steps and can damage the sheet.

Therefore, I remain firm in my position that the wire side is always on the inside, closest to the treble-line loft drying rope, and the felt side is on the outer side facing out from the rope or pole. Felt side up and wire side touching the rope or bar is the drying orientation of Renaissance paper as the back forms on treble-lines.

---

*Spur: multiple sheets pressed together to dry as a group (generally 3 to 8 sheets)*
The diagram on page 18 provides a clear picture of how pressed sheets were hung and dried on horse-hair treble lines; specifically, the arched position the paper was in when unbreakable hydrogen bonds were formed; and in what orientation the wire and felts side were at the time of hanging and drying.

**Back mark sidedness:** The two sides of a sheet bearing a back mark will express the mark differently. The side closest to the rope (wire side) exhibits a back mark with a series of concave striations, like miniature dry riverbeds. Meanwhile, the opposite side (felt side) exhibits the inverse: a reticulated and raised series of convex ridges like a tiny mountain range.

**Excluding back mark impostors:** The back mark’s parallel wrinkles are in directional agreement with the surface grain (on the wire side) of the paper and also in alignment with the chain lines, the “T” as it lifted the paper to the horsehair rope treble-lines on which the paper was hung. Therefore we may safely assume that any fold, crease, join, or wrinkle not in linear agreement with these artifacts – i.e., marks skewed or perpendicular to the chain lines – were not caused by drying loft ropes and are not back marks. Further scrutiny reveals that back marks are integral to the paper; they are part of the birth of the sheet, not comprised of broken, cracked, or torn fibers.

**Felt Side example:** Convex back mark

**Wire Side example:** Concave back mark
Using manufacture flaws to identify wire and felt side

A case study

Where 14th to 18th-century Western works on paper are concerned, conservators, archivists, and connoisseurs can use various nondestructive methods to determine the wire and felt side of a sheet, leaf, or bifolium. This information can provide a more detailed description and documentation of a work on paper, incunabulum, or codex. The following example demonstrates the features found in one leaf to determine sidedness decisively.

We will look at a single bifolium consisting of one sheet from a gathering spanning pages 3 - 6. The leaves in these examples were photographed in direct, backlit and in raking light.

Evidence of felt side:

C1. The abrasions are not evident on this side of the leaf.
C2. No visible chain line.
C3. A convex back mark, decisively identifying this as the felt side. (As described on pages 17-21.)

Backlit (show-through) information:

A1. Finger-sized abrasions on the sheet are our first clue. The scratches interrupt the laid lines, suggesting that the paper was distressed on the wire side (probably by the coucher during manufacture).
A2. In this backlit view, we note the location of the chain lines. A3. There is little to learn from the back mark in this backlit view.

Back mark: A convex back mark across the top of page 6 indicates we are looking at the felt side of a quarto leaf. Therefore, the spread (pages 4 and 5 in the photo above) should show indications of wire side. Let’s investigate and see what we can find focusing on the recto and verso of page 3 and 4.
When a sheet is formed on a paper mould, water drains through the wire side. Initially, longer fibers are taken out of suspension while “fines” (tiny particles of finely divided cellulose and hemicellulose) wash through the laid screen slots. As the sheet builds up, fewer fines fall through the laid wire gaps and become trapped in fiber’s subsequent buildup. Such fines possess exposed oxidation sites as a result of processing. Fines are no longer intact, encapsulated fibers (having broken off from the beautiful and intricate helically wound cellulose structure). These cell wall fragments and severed polymers (with their monomers broken and exposed) are prone to degradation from environmental acids and microbial excrement. They are, therefore, likely to turn brown (and brittle). We can predict that the accumulation of fines on the felt side will oxidize faster than the longer, intact cellulose fibers of the wire side (with comparatively fewer fines). In short, we can theorize that the presence of fines in the felt side of a handmade sheet will cause it to grow progressively darker with age than the wire side.

While such a value discrepancy may not be discernible to the human eye, it is light work for a sphere spectrophotometer.* To test our hypothesis, we took spectrophotometer readings from both sides of 20 pre-Industrial sheets of paper from my collection. The sidedness of each sheet was determined using the methods described above and corroborated by the following criteria (viewed backlit or under raking light):

- Back mark concave and convex ridges
- Watermark indentations, right reading watermark
- Countermark indentation
- Chain line indentation on wire side
- Laid line texture on wire side.
- Coucher drip disrupting wire side
- Felt hair marks stronger on felt side
- Microscope analysis of fiber alignment

Without exception, the wire side Lab measurements were lighter and less colorful than the felt side (i.e., the wire side L values were higher, and the a and b values were closer to 0), as predicted.

In addition to this discoloring and darkening from oxidation, if the paper were pigmented (blue paper, for example), the colorant, along with fines, would be concentrated on the felt side, lowering the “L” value and elevating the a and b values (in both the positive and negative direction – away from 0.00). The presence in some papers of an antioxidant like MgCO3 could minimize this shift in value and color sidedness, but combined with the other previously discussed techniques, paper’s sidedness is likely easy to discover.

**Reflective vs. spherical spectrophotometer:** Spectrophotometers are useful and nondestructive tools for detecting differences between the two sides of a sheet. Although 10 times the cost of a standard reflective spectrophotometer, a sphere spectrophotometer’s readings are not influenced by surface texture: it can measure light reflected at all angles to calculate color measurements that closely match or exceed what a human eye would see (in the Lab color space). A 45° reflective spectrophotometer, most commonly used for measuring color on smooth or matte surfaces, would have trouble accurately measuring the textural surface of handmade paper in the angling light and not textural shadows, showing the results.
Wire or felt side: destructive method

Beautiful “look-through” (the attribute of showing discrete laid lines and watermarks in a well-formed sheet of handmade laid paper) is caused by a buildup of fibers on the wire side of a sheet-like a miniature landscape of parallel mountain ranges. It is possible (though destructive) to remove these features by placing the paper on a light table, then using a one-sided razor blade held vertical and perpendicular to the laid lines, shaving the paper thinner on each side. Scraping the wire side will remove the darker (thicker) aspect of the laid lines, whereas scraping on the felt side will not.

After forming and couching, this sheet was allowed to air dry without pressing, showing us the surface laid pattern topography of the wire side.

Wire side scraping has removed laid lines

Felt side scraping has removed not laid lines

Hammersmith, Kelmscott (1892) Wire side scraping has removed laid lines on this thin sheet.

Scraping or shaving the surface of a laid paper 90° to laid lines, on hard, smooth surface.

Shaving off the peaks of a laid paper (opposite page) will remove laid line look-through
If there is a tear in a document with a skived or sloping edge tapering to the back or front side, one can determine felt side from wire side by observing the feather of the edge. The wire side will have greater feathering (fewer fines, more fibers).

Using a pad of thick paper wrapped with suede and rubbed with graphite creates a nice pad for accentuating the textures of a sheet. Holding the pad perpendicular to the paper and toning it by rubbing in circular motion brings out the surface texture of the paper, which can even indicate sidedness.

More feather on the right hand tear means that the wire side is facing up.

wire side.

felt side.
Overview:
Characteristics of wire side & felt side
in a finished sheet of paper

Wire side:

- Chain lines and laid lines indented (if visible)
- Wire side fibers are more aligned, like combed hair (tending to be more parallel to the
  chain lines combined with the swirl of pulp in the vat during the vatman’s dip)
- Fewer fines* - more fibrous when viewed under a microscope
- With fewer fines, the wire side tends to be a lighter value.
- The curl (if any) is towards the wire side (parallel to chain lines)
- Couching on the shorter nap (more delicate wool) side of the felt and laying (throwing)
  subsequent felt coarse-hair-side-down on newly couched paper produces stronger felt
  hair marks on the wire side.
- Concave back mark topography

Felt side:

- Fibers more randomly arranged when viewed under a microscope
- More fines - areas where the “normal” fibers are hidden by smaller, shorter fibers
- With more fines that oxidize faster, felt side is the darker side
- Couching on the shorter nap (finer wool) side of the felt produces finer felt hair marks on
  the felt side.
- Convex back mark topography

*Fines: particles found in white water; finely divided matter; cellulose, hemicellulose and additives (i.e., MgCO3, fillers,
pigment).
Acknowledgments

Text & illustrations: Donald Farnsworth
Editor: Nick Stone

Magnolia Editions Staff:
Directors: Donald & Era Farnsworth
Master printers: Tallulah Terryll & Nicholas Price
Artist in residence: Guy Diehl
Tapestry finishing: Alyssa Minadeo
Interns: Arlene Kim Suda, David Wild, Willem Smith-Clark, Sam Pelts

with thanks to:
3-D Printed mould files: Brian Queen, Nicholas Price
Consultation: Timothy Barrett, Nick Pearson
Felt supplier: Lana Dura
Italian felt making: Cristina Biccheri
Italian research & assistance: Elizabeth Wholey, Gianni Berna
Consultation: Curators from the Paper Conservation Department,
    Sherman Fairchild Center for Works on Paper and Photographic Conservation,
    The Metropolitan Museum of Art
Pure linen: Rough Linen, Marin, CA
Pure linen: Jacquard Fabrics, Healdsburg, CA
Flax and hemp half stuff: Celesa, Spain