Enhanced Method for Air-Drying Early European-Style Paper

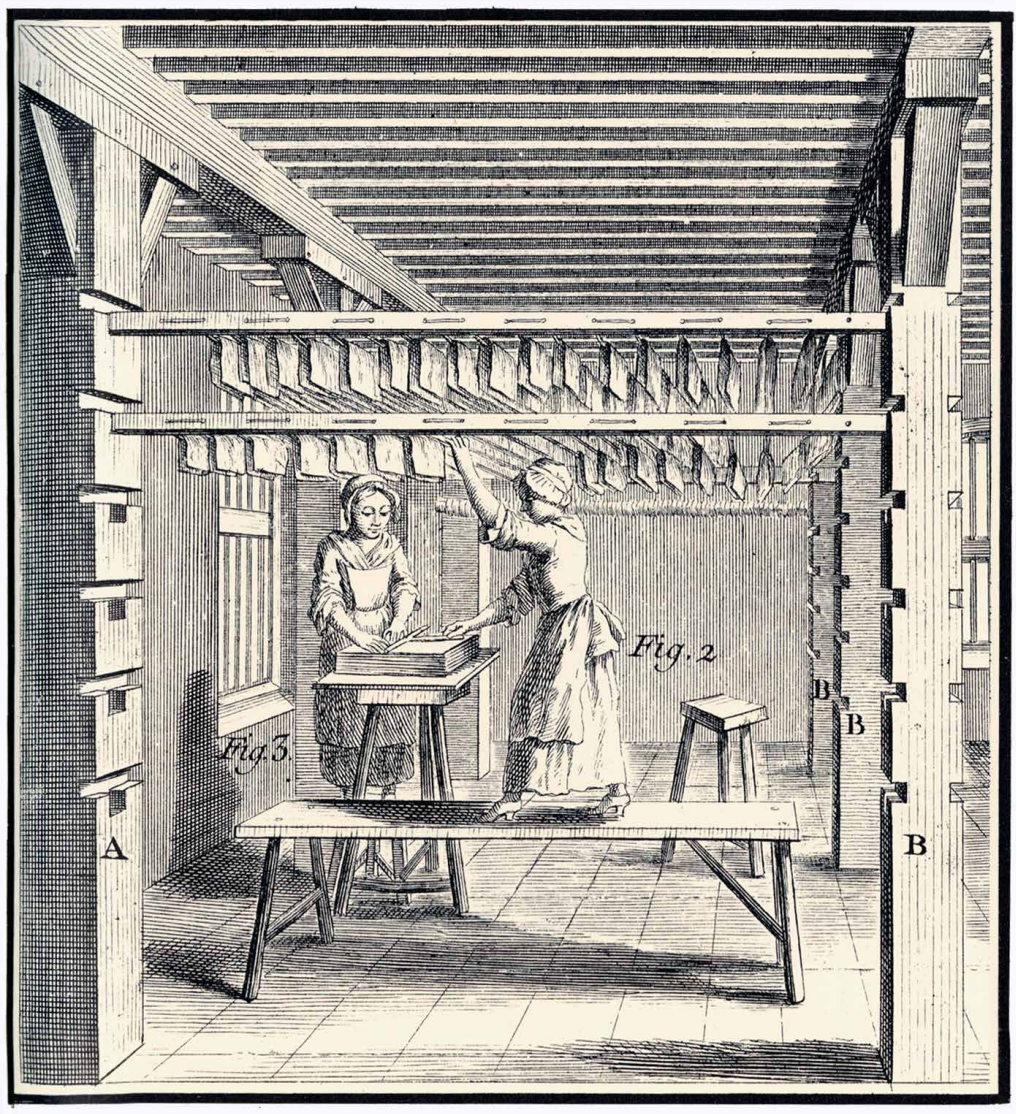

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Image credits: Donald Farnsworth, Guy Diehl, Nicholas Yeager, Max Thill, and Era Farnsworth. Version date: December 10, 2023.

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Acknowledgments

I would like to extend my gratitude to several individuals whose contributions have been invaluable to our work at Magnolia, an art projects company dedicated to producing editions, materials for large-scale art projects and public installations.

Firstly, Max Thill, a paper conservator and artist, and Guy Diehl, an artist, have participated at almost every step in the discovery, drawing, painting, and stress-testing of our papers. Their collaborative efforts at Magnolia, especially the drawing sessions where Guy and I work side by side, have been instrumental in understanding the paper's impact on our art. Max's exceptional talent is further highlighted when he produces astounding drawings on the test sheets we develop together.

Alyssa Minadeo, our seamstress technician, has made significant innovations which have helped to greatly improve this drying process and the final outcome of the paper.

I also wish to acknowledge Nicky Yeager, who volunteers and assists us in a role historically known as the *upper end boy* in British paper mills. Beyond this, Nicky's skills as a bookbinder, calligrapher, and editorial skills contribute to this document and our in-house dialogue.

Special thanks go to Tallulah Terryll and Nicholas Price, both Master Printers at Magnolia Editions, as well as Era Farnsworth, our managing director. The mantra of creating equal stresses on materials, a concept emphasized by Tallulah and Nicholas, has been a driving force in our collaborative work influencing this specific drying technique. Their talent and guidance have been fundamental to our success.

Lastly, I would like to express my deepest appreciation to Era Farnsworth, not only my wife but also an art collaborator and partner. Her brilliance and contributions enrich every discussion, guiding and shaping our collective path in art and life.

Introduction

At the Magnolia Paper Studio in Oakland California we have been working to discover, recreate and understand the early European papers that contributed so much uniqueness and subtlety to the drawings of the Old Masters. Along the way, we trip over, stumble upon, and document findings uncovered in this seven year effort. This article covers a novel drying method we recently put into practice.

In refining the air-drying process for early European-style paper, this method aims to achieve improved outcomes compared to traditional techniques.

The resulting air-dried sheets exhibit the following characteristics:

1. Maintain felt hair marks
2. Exhibit reduced cockling
3. Increased dimensional stability
4. Require less drying space
5. Form a post half the normal height
6. Reduce the time and labor needed for hanging wet sheets
7. Minimize handling damage from post to drying loft
8. Does not create a back mark.

Forming a sheet on an antique laid 18 x 24-in papermould

I. Traditional Methods
(Background)

Sheet formation in the Western tradition

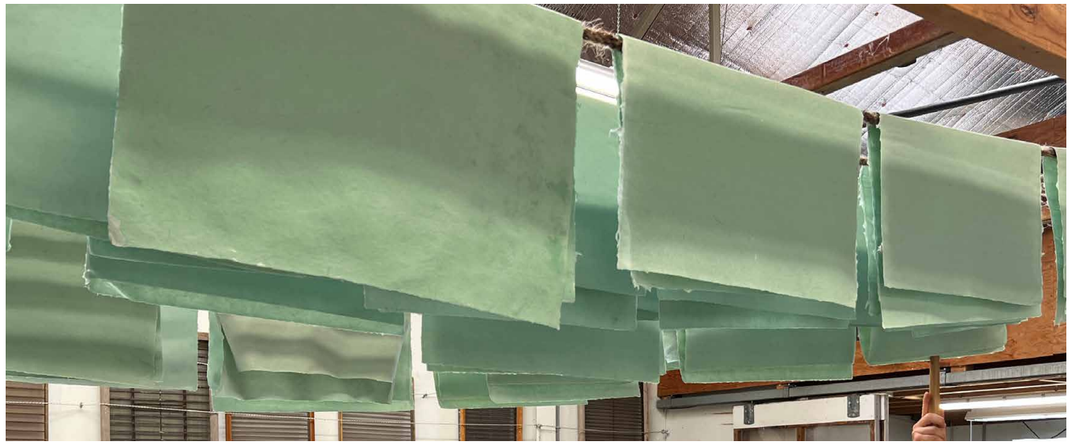
The early European process of papermaking involves forming and couching sheets from a fast-draining linen and hemp furnish.[1] The sheets are couched on felt, building a post of interleaved felts and couched Sheets. After pressing the post, the sheets are parted and repressed then hung on horse hair rope (treble lines) in groups (spurs) or individually.

Draining: One sheet draining, leaning of the asp, while a second sheet is formed.

Couching onto coarse woolen felts building a post

[1]Fast draining furnish with Canadian Standard Freeness of ±300CSF (Shopper = 40.3).
see: Freeness, *Handmade Paper Method Cinquecento*, pp.95

Drying challenges with unconstrained air-drying



Sheets hung on treble lines to dry (unconstrained and free to cockle and warp)

Air drying Western papers without constraint, presents both advantages and disadvantages. Notably, the surface texture found in air-dried linen and hemp sheets (made from a *free* furnish) retains the detailed hair texture of the woolen felts the sheets were pressed between.[2] These felt hair marks provide character to the paper that lends subtlety and nuance to any drawing created on its surface. Conversely, unconstrained air-dried sheets allow the fibers to bond, shrink, and collapse. The results of unconstrained drying lead to a less dimensionally stable sheet of reduced dimensions that tend to cockle.[3] Paper dries with a memory so that even if a curled air-dried sheet is moistened and flattened, it will tend to revert to its original curled shape.

Once dried, the sheets exhibit a beautiful surface texture, but have shrunk and cockled requiring aggressive flattening

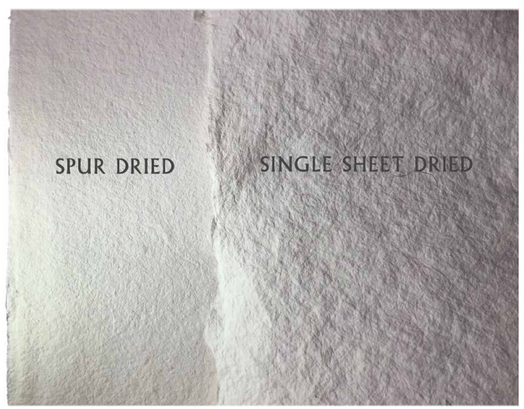
[2] Felt hair marks *Handmade Paper Method Cinquecento*, pp.17
see also: *Determinate Hand Papermaking*, pp.150
[3] Dimensional stability, *Determinate Hand Papermaking*, pp.28

Traditional drying of paper in spurs hung on treble lines

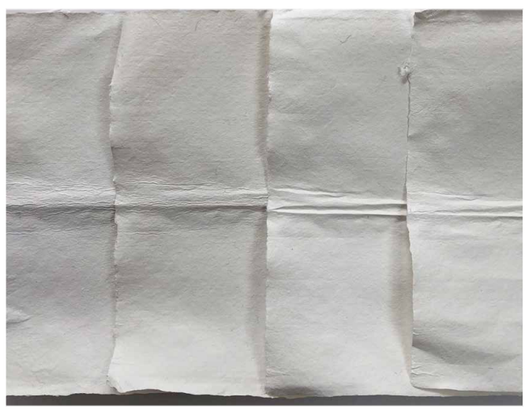
Spur dried sheets taken down from the ropes (treble lines) slightly smoother, somewhat constrained — the spur's back yet to be broken

Spurs open with the "back broken"

Early papermakers addressed these issues by pack pressing sheets without felts and hanging them in small groups, called *spurs*, over horse hair ropes (treble lines). In this method the sheets constrain one another as they dry which reduces surface texture and cockling. While this improves dimensional stability, it creates back marks where the spurs touch the rope.[4]



Spur dried sheets exhibit a finer surface texture



A separated spur showing a decreasing intensity of back mark for sheets further from the rope

[4] Back marks, *Handmade Paper Method Cinquecento*, pp.33

Undesirable characteristics
back marks, cockling and curling

Some of the many types of back marks that are created when spurs are dried hung over horse hair rope

Desirable characteristic*
felt hair marks

**Desirable from an artist's point of view*

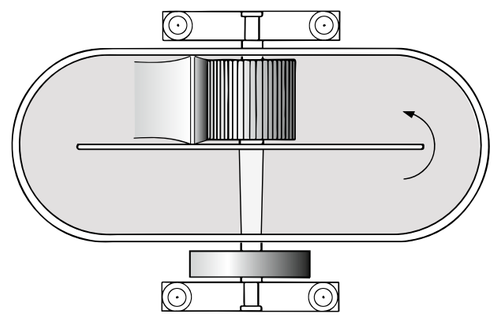
Drying Japanese washi on boards is not possible with processed Western fibers

Hand beating kozo

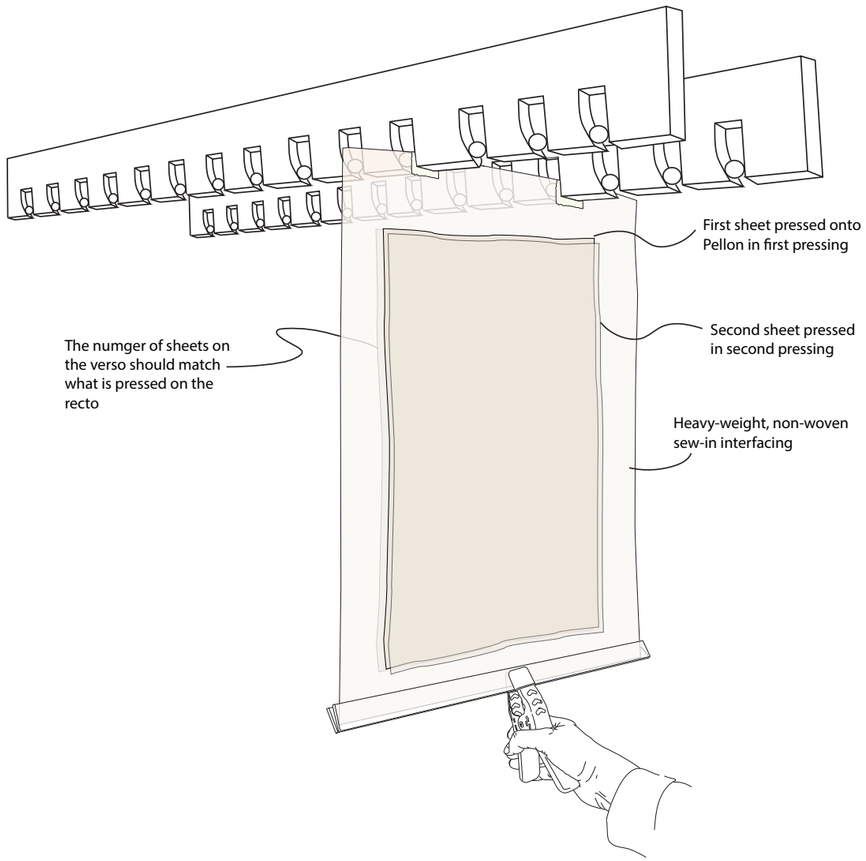
Brushing paper onto drying boards

Unlike Japanese washi, Western rag paper requires more aggressive processing. The mechanical beating and pounding in Hollander beaters, refiners or stamper mills swells the paper fibers with moisture, causing the sheet to shrink more vigorously as it dries and expand more unevenly when re-moistened. A solution to this cockling is constraining wet sheets under pressure in a stack dryer, forcing sheets to remain flat as they dry. ***However, stack drying under pressure obliterates the delicate felt hair marks in the surface texture — these marks are a vital feature differentiating Renaissance papers from modern handmade paper.***

The stamper mill at Le Mouln du Verger, France



Hollander beater diagram



II. A New Method

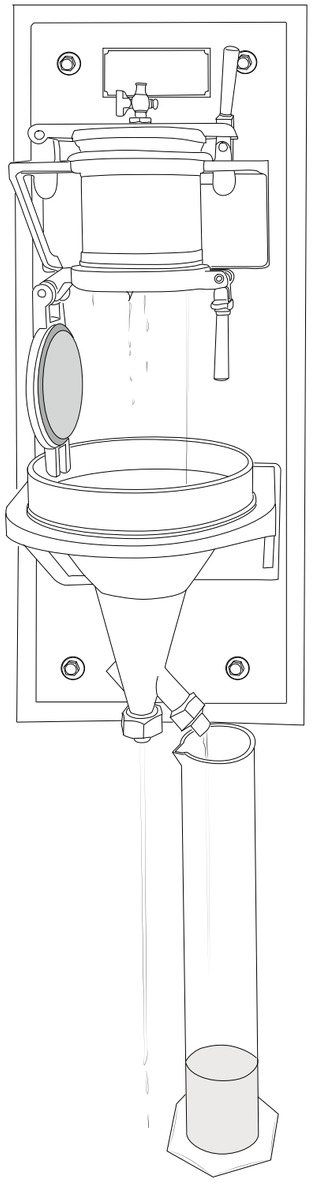
We are grateful to early papermakers who made lasting sheets (of what we now call *archival paper)* and to the artist who remind us with their trail of sanguine chalk drawn on these papers surfaces, to scrutinize and study of the unique strength and textures of Renaissance paper. Slowly we follow the breadcrumb trails left for us by these artisans across time. By example, they advise, watermarking sheets, drying sheets stuck together to counteract various physical and chemical forces of cellulose fibers that come into play. Then after slow drying, re-moistening with hot animal skin sizing and drying a second time. The technique described here takes us only to the first drying – the making of waterleaf paper.

This new method involves drying sheets together, on a common support to counteract shrinkage and maintain flatness. The sheets are couched onto ***heavy-weight, non-woven sew-in interfacing****, forming a post with alternating layers of paper, felt, and interfacing and balance one another and maintain flatness.

*Fruedenberg S80 Heavy-weight sew-in interfacing

Two-sided drying on heavy-weight interfacing

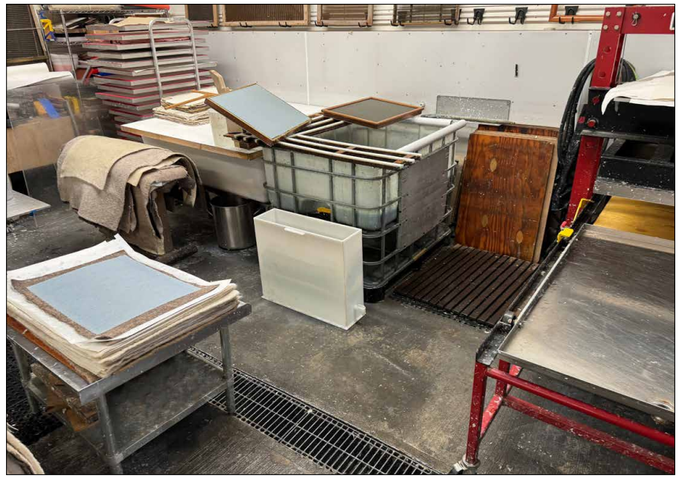
(Non-woven, sew-in interfacing) to create a flat, dimensionally stable, air-dried rag paper:



Canadian Standard Freeness (CSF)

The CSF measures the drainage rate of pulp, indicating the level of fiber processing. Less processed pulp yields more dimensionally stable sheets.

In this method for drying paper, we use a mixture of linen and hemp to create sheets from a furnish with a Canadian Standard Freeness around 300CSF (Schopper Riegler: 40.3). This technique favors a free pulp, which drains faster and scores higher on the CSF test, over a slow-draining furnish. Excessive beating can lead to a slow-draining pulp. Over-beaten pulp is prone to excessive shrinking. If a sheet shrinks too much, it does not effectively retain the detailed felt hair marks imprinted during the pressing process. Shrinking sheets even risk detaching from the interfacing and potentially falling to the floor of the drying loft.



[4] Freeness, *Handmade Paper Method Cinquecento*, pp.95

Building a post

Forming sheets on paired 18 x 24-in moulds (two moulds one deckle)

Max Thill couching every ±35 seconds. Here couching on felt

A post suitable for drying on interfacing is made by the following steps:

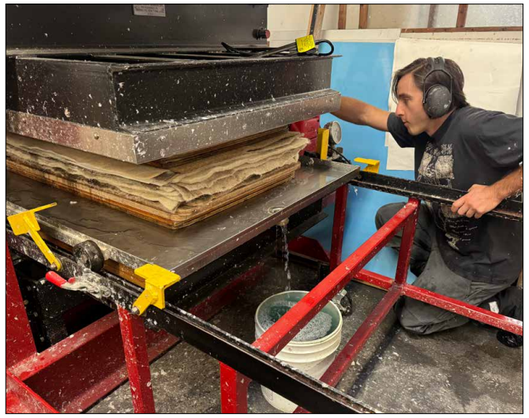
- A sheet is formed at the vat and drained while the coucher throws a felt
- The slightly drained sheet is taken from the asp and couched on the woolen felt
- A moistened sheet of interfacing is laid, covering the newly-couched sheet of paper
- A second sheet is formed and couched directly on the interfacing (in alignment to the first sheet)*
- A woolen felt is laid on top covering the second sheet
- This cycle is repeated to build the post.
- The post is pressed.

Nicky Yeager laying a sheet of interfacing

Max Thill couching on the interfacing layer

* Note: Couching on moist interfacing: To avoid air bubbles early sheets are couched with strong pressure. After the post developes a natural arc, gentile couching is recommended, This avoids disrupting the paper's integrity (squishing and making stretch marks)

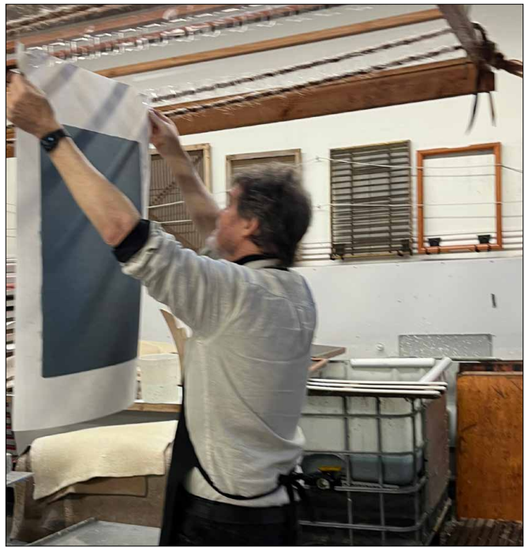
Pressing and hanging sheets to dry



Pressing the post to 50 tons

Separating the layers after pressing:

- The top felt is removed, exposing the top sheet pressed onto Interfacing.
- Lifting the interfacing lifts the first (top) sheet and the second sheet (clinging to the verso of the interfacing).
- The interfacing with the two sheets adhered is hung to dry.



Parting - lifting two sheet at once and hanging to dry

The interfacing is secured with two Plexiglas strips clamped at the bottom edge using a hand clamp, ensuring the interfacing remains planar. As the sheets dry, they stick lightly to the non-woven polyester surface of the interfacing.

When pressed sheets hang and dry attached to the interfacing, a dimensionally stable support, they are constrained in a way that maintains their flatness, enhances their dimensional stability, and significantly reduces shrinkage compared to sheets dried without any constraint.

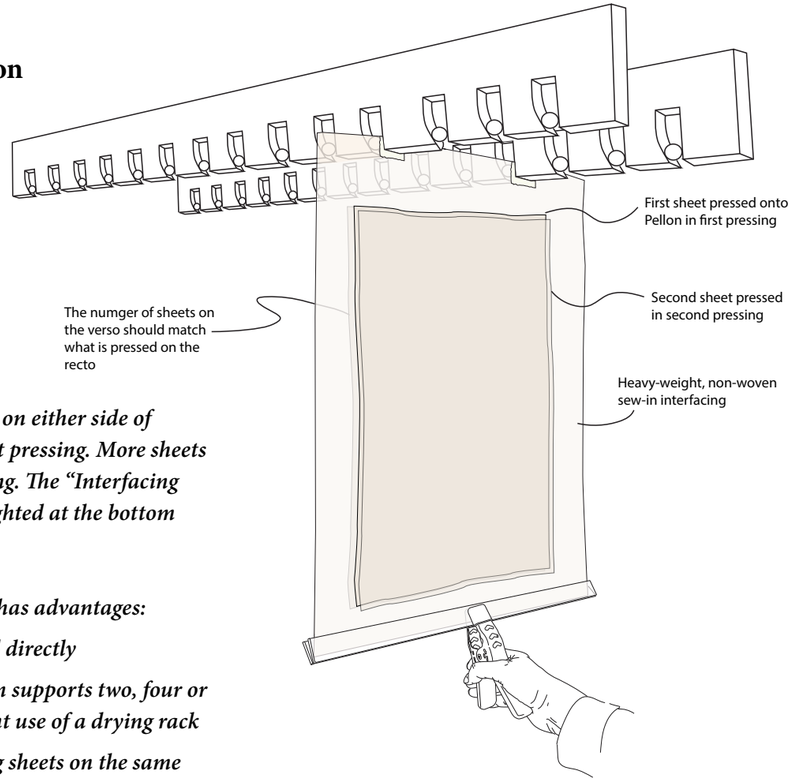
By couching and pressing the sheets onto both sides of a interfacing support, the drying forces are balanced. This drying approach has shown better results than drying paper on just one side of interfacing.

Longer drying times are recommended to ensure the complete curing of the sheets to reduce the risk of cockling.

32 sheets hung, two sheet per interfacing requires a relatively small space

16 sheets of interfacing holding 32 sheets of paper

Drying rack configuration



Two sheets couched and pressed on either side of heavy-weight interfacing on first pressing. More sheets can be added in a second pressing. The "Interfacing Spur" suspended vertically, weighted at the bottom edge and allowed to dry.

Drying sheets with this method has advantages:

- *The wet sheets are not handled directly*
- *Each slot in the hanging system supports two, four or six sheets, allowing for efficient use of a drying rack*
- *Bottom weighted and opposing sheets on the same interfacing produces flatter sheets*
- *Felt texture surfaces are retained.*

Clamping weight to bottom of interfacing support.
Two sheets pressed and gently adhered on both sides of a single sheet of interfacing; hung until dry.

Era Farnsworth inspecting the blue sheets

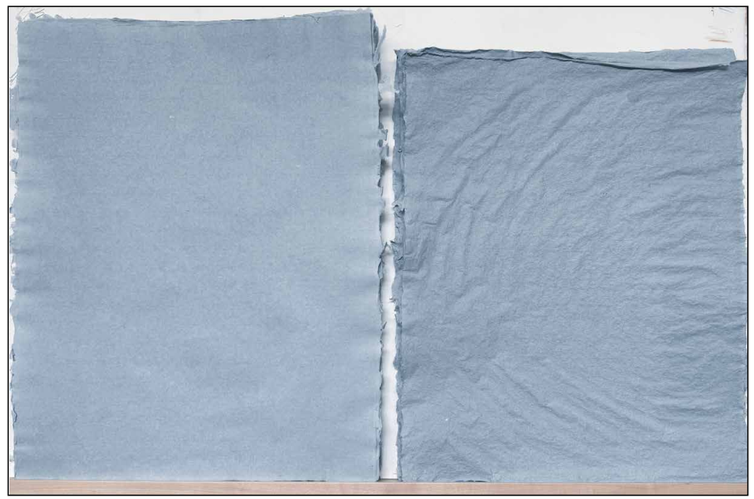
Dried sheets look slightly cockled, but lay flat once separated from the interfacing

A laser thermometer, is used to determine the paper's state of dryness. Moist surfaces have lower temperatures (indicating evaporation).

Parting the dried sheets

Parting the dried sheets:

1. After a few days of drying, remove interfacing from the drying rack and lay flat
2. Remove the sheet on the underside first by lifting and pealing the interfacing back as shown in the photo above. This avoids crimping the paper
3. Next, remove the top sheet by peeling from the interfacing diagonally, as shown.



Left: Interfacing constrained, air-dried sheets—Right: air-dried sheets (unrestrained)
Note the reduced dimensions of the unrestrained sheets .

Natural textures maintained

Felt side and interfacing side texture in our tests display a subtle variation. (Photos taken in raking light.)

Felt side (note felt hair marks)

Interfacing side

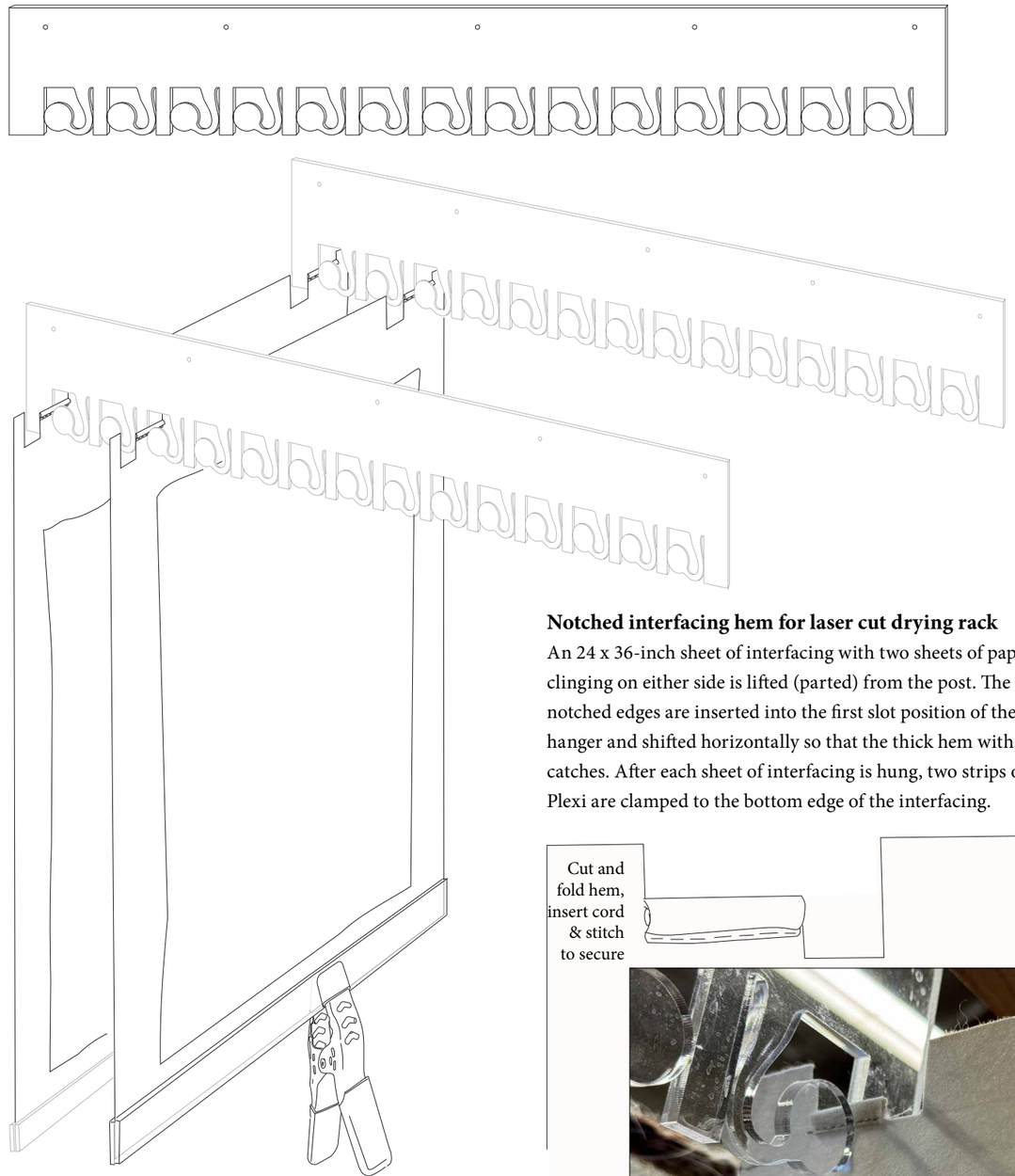
At Magnolia Paper Studio, we use coarse heritage wool felts to impart a distinctive hair-marked texture to the paper surface. In the drying system described here, the felt hair marks appear on the paper surfaces that are in contact with felt, and a smoother but surprisingly natural texture is imparted to the verso that contacts with the interfacing.

Processing variables affect the final sheet:
Fiber choice, beating time, beater force, beater viscosity, additives, sheet formation, sheet thickness, pressing, humidity, air movement, and drying speed will affect the outcome.

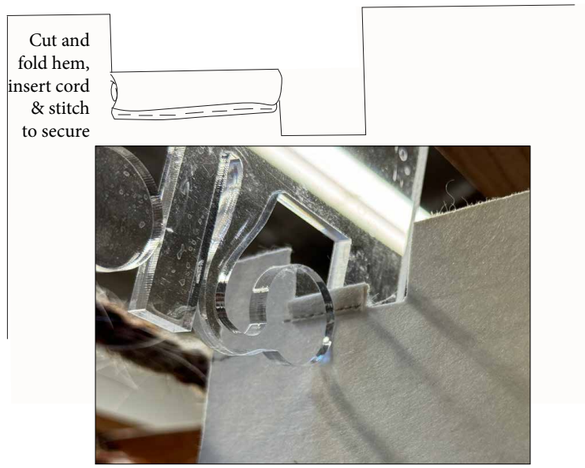
— Donald Farnsworth

The Plexi hanging system used in this demonstration

Diagram of a laser cut hanging rack



Notched interfacing hem for laser cut drying rack
An 24 x 36-inch sheet of interfacing with two sheets of paper clinging on either side is lifted (parted) from the post. The notched edges are inserted into the first slot position of the Plexi hanger and shifted horizontally so that the thick hem with cord catches. After each sheet of interfacing is hung, two strips of Plexi are clamped to the bottom edge of the interfacing.



Notes

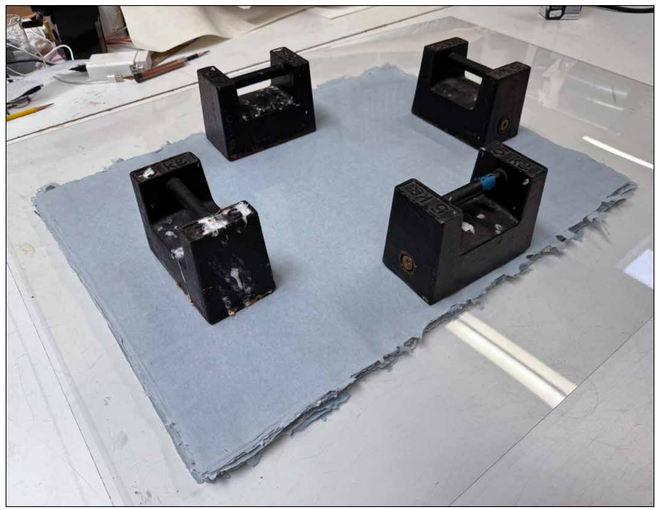
Heavy-weight sew-in interfacing vs Evolon

Evolon® vs. interfacing

At Magnolia's Paper Studio, we use Evolon AP (168gsm) as blotters and heavy weight interfacing as a support.

Evolon, a durable, washable, and non-woven textile, is known for its remarkable water-holding capacity, holding up to 300 times its weight in water, and offers excellent breathability. These features, combined with its strong wicking abilities and stable dimensions, render it an effective blotter and as a substrate/support in papermaking. It outperforms interfacing as a blotter and is excellent for air-drying purposes, especially when a smooth surface texture is desired. However, papers dried on Evolon display a mechanical surface pattern of tiny parallel lines, which may not be suitable for all applications.

Heavyweight interfacing we use to support for some paper projects and as a support for air-drying paper. It creates a more natural surface texture. For smoother finishes, albeit with micro-banding, we press and dry paper onto Evolon.

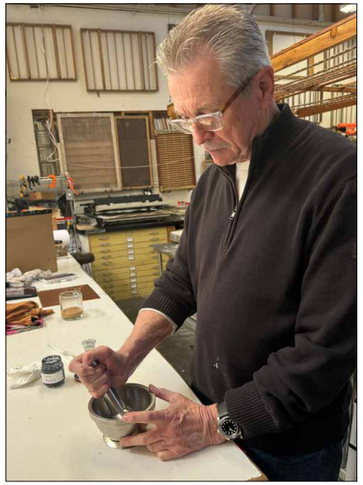


Weighted sheets left to cure

Notes

Preparing a blue furnish:

Processing indigo blue pigment/dye, blending and beating with blue linen cloth, flax and hemp fiber (half stuff), chemical buffers and retention-aid. This is the blue furnish from which the sheets are formed.



Guy Diehl crushing indigo

Crushed indigo — beaten and blended with flax

Shredding blue linen fabric

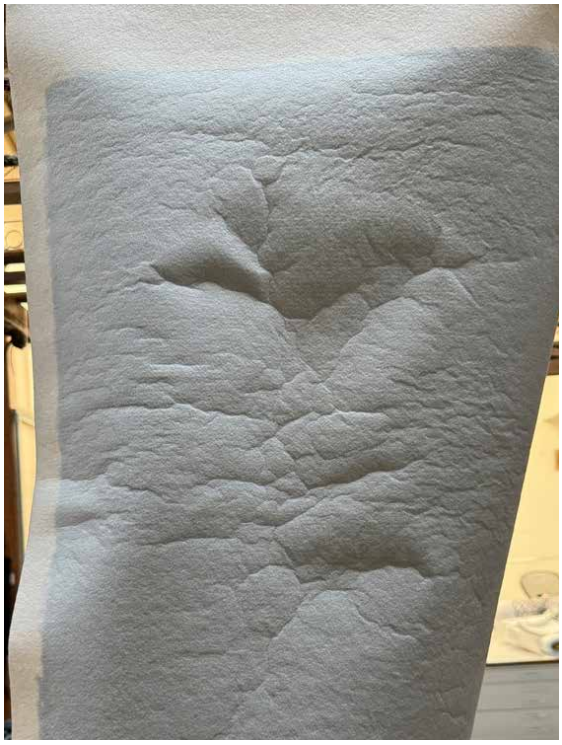
Beating blue shredded linen and checking fiber length

Heavyweight interfacing tents to develop a pebbly texture. When this texture become problematic, some brands of interfacing can me smoothed with a hand held steamer and a little pressure.

Interfacing that developed a pebbles surface texture

Interfacing steamed to revive a smoother surface texture

Do not use Ultra Heavy-Weight Pellon®
Pellon® reacts poorly to moisture and heat



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