

Drying and Flattening

干燥与平整

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Drying and flattening in paper conservation are typically carried out simultaneously after Washing or other aqueous treatments. Most drying techniques are also flattening techniques. Flattening, however, can constitute a treatment in its own right undertaken outside of the context of aqueous treatment, though it often involves wetting or Humidification.

在纸张保护中，平整和干燥通常是在清洗或其他水性处理后同时进行的。大多数干燥方法同时也是平整方法。但平整本身也可以作为水性处理之外的独立操作，虽然它常常涉及润湿或润潮。

This page only covers drying and flattening of paper. The drying and flattening of Parchment is covered in a separate wiki page devoted to that material.

以下内容仅涉及纸张的干燥与平整。羊皮纸的干燥与平整另在其专属页面中进行介绍。

1 Definitions 定义

- **Drying**—To bring wet or humid paper into equilibrium with ambient relative humidity (RH). When paper has reached equilibrium with the environment and is considered dry, the paper still retains water. At RH of 20% to 70%, water content will be about 4% to 8% (Banik and Brückle 2018, 91). This is a process that will occur naturally, but in a conservation context, it is important that this process be controlled in order to achieve specific treatment goals.

干燥 (drying) ——使湿纸 (wet paper) 或潮纸 (humid paper) 与周围环境的相对湿度达到平衡。纸张与周围环境湿度一致时, 被认为处于干燥状态, 这时纸张中仍含有水分。环境相对湿度在 20%~70%时, 纸张含水量约为 4%~8% (Banik and Brückle 2018, 91)。干燥是一个可以自然发生的过程, 但在纸张保护修复的语境中, “干燥” 强调的是对这一过程进行控制以达到特定处理目的。

- **Flattening**—Removing or preventing the formation of planar distortions in paper with the goal of maintaining or recreating as closely as possible the paper's original dimensionality. Unlike drying, this is not a naturally-occurring process and requires intervention, though it does not always require water.

平整 (flattening) ——消除或预防纸张的平面变形 (planar distortion), 尽可能维持或恢复其原始形貌。与干燥不同的是, 平整不会自然而然发生, 需要进行干预, 但此干预不是所有时候都需要用到水。

- **Humidification**—The exposure of paper to water vapor. This will plasticize the paper by breaking bonds within fibers, but will not result in the breakage of fiber to fiber bonds (Sugarman and Vitale 1992).

润潮 (humidification) ——令纸张接触水蒸气 (气态水)。通过打开纤维内部的键合对纸张进行重塑, 但不会造成纤维之间氢键的断裂 (Sugarman and Vitale 1992)。

- **Wetting**—The introduction of liquid water to paper. Methods of wetting can include misting, floating, blotting and immersion.

润湿 (wetting) ——向纸张中施加液态水。润湿方法包括喷洒水雾、漂浮浸润、吸水纸间接润湿以及浸泡法。

1.1 Forms of Planar Distortion Caused by Water 水造成的平面变形

The following forms of distortion can emerge during the drying process after paper has been wetted or humidified. A properly chosen drying technique can minimize them.

经过润湿或润潮的纸张在干燥过程中可能出现以下几种变形。选择合适的干燥方法可以减少变形的程度。

- **Curling**—A rolling distortion that affects the entire paper sheet. It is caused by the uneven expansion or contraction of the two sides of the sheet due to the physical differences built in during the manufacturing process. It can also be caused by moistening only one side of a sheet.

卷曲 (curling) ——纸张整体的卷翘变形。这是纸张正反两面伸缩率不同造成的, 其源于造纸过程中形成的纸张两面的物理差异。纸张单面受潮也会导致卷曲。

- **Cockling**—Distortions that affect sections of a paper sheet that has been moistened and subsequently air-dried without restraint. Sugarman and Vitale (1992) define cockles as being larger than 1 cm square and smaller than the whole sheet. It is caused by differences in evaporation rates across the sheet due to uneven

distribution of fiber ([Banik and Brückle 2018, 450](#)) and/or an uneven distribution of water ([Sugarman and Vitale 1992](#)).

起皱 (cockling) —— 纸张潮湿后在无外力约束下晾干时形成的局部变形。Sugarman 和 Vitale (1992) 将其定义为大于 1 平方厘米到小于纸张幅面的变形。纸张纤维分布不均匀 ([Banik and Brückle 2018, 450](#)) 以及/或者水分分布不均匀 ([Sugarman and Vitale 1992](#)) 使得纸张不同部位水分蒸发速率不同, 从而导致纸张发生起皱。

- Roughness—An overall increase in surface texture and loss of smoothness after a sheet has been wetted. It is caused by fiber swelling, uneven distribution of fiber and/or the release of dried in strain.

粗糙 (roughness) —— 指纸张润湿后表面整体纹理和粗糙度增加。这是由于纤维膨胀、纤维不均匀分布以及/或者内在应力释放造成的。

2 When to Dry and Flatten 什么时候进行干燥和平整

Anytime paper is wetted or humidified, it must be dried in a deliberately chosen, controlled way that will prevent the emergence of out-of-plane distortions.

每当纸张润湿或润潮后都须以经过谨慎选择且可控的方法进行干燥，避免发生平面变形。

Paper will need to be dried and flattened after:

- Aqueous treatments such as washing and deacidification
- Humidification
- Mending
- Local application of gels or other moisture
- Removal of adhesive residues

纸张进行如下处理后，需要进行平整和干燥：

清洗、脱酸等水性处理

润潮

嵌折（mending）¹

使用凝胶等进行局部潮湿

去除黏合剂残留

Paper may require flattening with or without the use of water when:

- It has been improperly stored i.e. paper tightly rolled in a tube or a book allowed to sag on a shelf
- It has been improperly handled i.e. folded or crushed
- A previous treatment was not well-executed i.e. paste and tissue mends not dried under weight

遇以下情形，需要对纸张进行平整（用水或不用水）：

存放不当，如纸张被紧紧卷成筒状，或书体中央下垂放置于架上

持拿不当，如发生折叠或挤压

前次修复不当，如使用浆糊和薄纸修补后未进行加压干燥

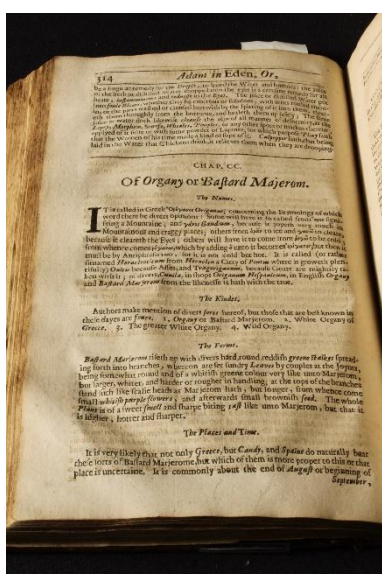
¹ 嵌折（mending）：指使用黏合剂和薄纸对纸张的裂缝、脆弱处进行局部加固。参考 <http://art.tnnua.edu.tw/ciococr/homepage.html?refresh=1>（2020-03-06）。

“Drying and Flattening”, *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

3 When Not to Flatten 什么时候不能进行平整



plate mark
版缘凹痕



normal undulation in hand-press era book paper

手工印刷时期书页的常见起伏

Paper must always be carefully dried after it has been wetted and humidified, but the extent to which it should subsequently be flattened is an important consideration. It is also important to decide what constitutes distortion in a paper leaf.

纸张经过润湿和润潮后，必须谨慎地进行干燥。但应当平整到什么程度是需要慎重考虑的问题。另外，确定纸张变形的种类也非常重要。

Paper is not a flat object. It is an object with three dimensions. Hand-made papers especially have an intrinsic undulating character that should be respected. There are other kinds of out-of-plane evidence that should be respected and retained. These forms of dimensionality are not distortions in need of correction, and every attempt should be made to protect them in the course of wet or humid treatments. They include:

- Surface texture
- Plate marks
- Impressions

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- Stretching in the center of leaves in books made during the hand press era
- Natural waviness of loft-dried sheets

纸张不是平面物体，它具有三维结构。尤其手工纸具有天然的起伏特征，应当予以尊重。纸张的其他立体信息也需要尊重和保留。这些形貌特征不是需要矫正的变形，而应当在润湿或润潮处理过程中尽量保留。这些特征包括：

表面纹理

版缘凹痕（plate mark）

印版压痕（impression）

手工印刷时期书页中央的伸胀

造纸时悬挂干燥²形成的自然起伏

There are other situations that require forbearance in the matter of flattening:

- Possible damage to media
- Possible damage to the substrate

平整时遇以下情况也需要保持克制：

可能对媒材（media）造成损伤

可能对纸张基底造成损伤

² 悬挂干燥（loft drying）：欧洲手工造纸时代使用的一种纸张干燥方法，湿纸压榨去除多余水分后，悬挂在建筑物上层空间进行通风干燥。详见 Hunter, Dard. 2014. *Papermaking: The History and Technique of an Ancient Craft*. New York: Dover Publications, 186-188.

"Drying and Flattening", *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

4 Factors to Consider 考虑因素

Paper that is wetted or humidified is changed in irreversible ways. The methods chosen to subsequently dry and flatten the paper will also alter the paper. Processes should be chosen deliberately and with care keeping in mind the following factors:

纸张润湿或润潮后发生不可逆的变化，随后所选择的干燥和平整方法也会改变纸张特性。因此选择处理方法时须小心慎重，谨记以下几项因素：

4.1 Materials of Manufacture 造纸原料

Fibers--The characteristics of native fibers can be lost during pulp processing, but they may be a factor in how a sheet responds to water. The presence of hemicellulose, for example, can make paper more absorbent, which means that paper made from pure forms of cellulose, such as cotton or chemical pulps, will hold less water at the same relative humidity (Uesaka 2002). Fiber length can also affect dimensional stability as longer fibers can minimize wet expansion (Lindner 2018). Of the traditional European paper plants, linen has the longest fiber, followed by cotton, cotton linter, Manila hemp, coniferous wood and finally deciduous wood (Grant 1962). Of the traditional Japanese fibers, *mitsumata* and *gampi* fibers are shorter than *kozo* fibers (Nielsen 1997).

纤维——纸浆处理过程中，原始纤维可能失去其特性，但仍会影响纸张与水的反应。例如，半纤维素可以增加纸张的吸水性，也就是说，在同样的湿度条件下，棉浆或化学浆等纯纤维素原料制成的纸张含水量较低（Uesaka 2002）。纤维长度也会影响纸张的尺寸稳定性，如长纤维纸的湿胀程度更小（Lindner 2018）。在欧洲传统造纸原料中，亚麻纤维最长，其次是棉、棉绒、马尼拉麻、针叶木，最后是阔叶木（Grant 1962）。日本传统造纸纤维中，三桠皮和雁皮纤维较楮皮纤维短（Nielsen 1997）。

Noncellulosic components--Lignin, traditional rosin/soap size, and mineral fillers can interfere with fiber bonding and retard shrinkage (Banik and Bruckle 2018, 190 and 193). Less restraint may be needed when drying to maintain close to original dimensions.

非纤维素成分——木质素、传统松香皂施胶剂及矿物填料会干扰纤维键合、减少收缩（Banik and Bruckle 2018, 190 and 193）。纸张中含有较多此类成分时，对其进行干燥并保持原始尺寸所需施加的外界约束力较小。

Chemical and mechanical pulps--Whether a paper is made of a chemical or mechanical pulp has no consistent effect on the degree of wet expansion, but mechanical pulp paper does tend to shrink less as it has less ability to retain water (Uesaka 2002).

化学浆和机械浆——不论化学浆或机械浆对于纸张的湿胀性能并无确定影响，但机械浆制成的纸张由于保水能力较差，往往收缩程度较小（Uesaka 2002）。

Recycled pulps--Papers made from recycled fibers expand and shrink less after exposure to moisture than papers made from virgin fibers (Caulfield 1988).

回收浆——与非回收浆相比，回收浆制成的纸张遇湿后伸缩程度较小（Caulfield 1988）。

4.2 Method of Formation 造纸方法

Machine—Machine-made papers have several characteristics that affect the way they respond to water. 1) They have a definite grain direction. Most of their fibers are oriented parallel to the belt on which the paper was formed, 2) these machine

direction fibers are dried under considerable restraint, and 3) these papers generally have dried-in strains as a result of the tensions placed on the sheet during manufacture. When exposed to water, these papers will expand little in the machine direction, but may expand considerably across the grain ([Lindner 2018, 13](#)). If dried without restraint, they will naturally cockle ([Smith 1950](#)), and if the paper is relatively new, there will likely be some irreversible, one-time shrinkage in the machine direction as tensions are released ([Uesaka, Moss and Nanri 1992](#)). If dried with restraint, some of the cross-grain expansion may be retained.

机制纸——机制纸具有以下几项特征，会影响其与水的反应。1) 机制纸具有明确的纤维方向性，多数纤维沿造纸机运行方向排列；2) 纸机方向（即纸张纵向）的纤维干燥时受到相当大的约束力；3) 造纸过程中受到的拉力使得机制纸通常具有内在应力。遇湿时，机制纸纵向伸胀很小，但横向伸胀较大（[Lindner 2018, 13](#)）。如果在没有外力约束下干燥时，很容易发生起皱（[Smith 1950](#)）；如果纸张较新，由于内在应力释放，纵向可能发生不可逆转的一次性收缩（[Uesaka, Moss and Nanri 1992](#)）。如果在干燥过程中施加约束，纸张横向可能保留一定程度的伸胀。

Hand—These papers have grain direction, but it is less pronounced than that of machine-made papers. At the time of their manufacture, they are dried under significantly less tension than machine-made paper and have significantly less dried-in strain. They will expand almost evenly in both directions when exposed to water. These sheets can usually be dried without much restraint.

手工纸——手工纸也具有纤维方向性，但不及机制纸那么明显。在造纸过程中，手工纸干燥时受到的拉力相比机制纸小很多，干燥应力也要小得多。手工纸遇湿时在两个方向上的伸胀程度大致相同。这类纸张干燥时通常不需要太多约束力。

Beating—The more heavily fibers in a paper had been beaten, the more that paper will expand when exposed to water and subsequently shrink when dried without restraint ([Munoz-Vinas 2009](#)). Western, machine-made papers tend to be more heavily beaten than hand-made papers and Asian papers.

打浆——纤维打浆度越大，纸张遇水后伸胀越多，随之无约束干燥时收缩越多（[Munoz-Vinas 2009](#)）。与手工纸和亚洲纸相比，西方机制纸往往打浆度更大。

4.3 Weight 重量

The heavier the paper, the less it will cockle when exposed to water ([Kajanto and Niskanen 1998](#)). Heavy papers will need less restraint when drying.

纸张越厚重，遇水后起皱程度越小（[Kajanto and Niskanen 1998](#)）。较厚重的纸干燥时所需约束力较小。

4.4 History 历史

Conditions of storage—Papers that are subjected to repeated temperature and humidity fluctuations lose their ability to absorb water, probably as a result of an increase in hydrogen bonding and density ([Knop 2007](#)). These papers will likely expand and shrink less when exposed to water and dried.

保存条件——保存环境温湿度反复波动会使纸张吸水性能下降，这可能是氢键增加、密度增大（[Knop 2007](#)）的结果。这类纸张湿胀干缩程度较小。

Age—As papers age they tend to lose dried-in strains and become less likely to shrink when exposed to water ([Munoz-Vinas 2009](#)).

老化——纸张老化后往往失去内在应力，遇水后不易收缩（[Munoz-Vinas 2009](#)）。

Previous treatment—As with aging and storage in fluctuating environmental conditions, previous aqueous treatment can leave paper more dense, less absorbent and less likely to have retained dried-in strains.

前人修复——与老化和环境波动的影响类似，进行过水性处理的纸张密度更大、吸水性更差、留存有内在应力的可能性更小。

4.5 How Much Water Needs to Be Removed 潮湿程度

Some drying and flattening techniques are obviously more appropriate for wet paper than for humid paper. Wet paper is more plastic and can change significantly in dimension and surface finish in the course of drying. In the case of wet paper, especially, decisions need to be made about desired outcomes and how to achieve them with appropriate processes.

有的干燥和平整方法显然更适用于湿纸而非潮纸。湿纸的可塑性更大，干燥过程中尺寸和表面加工可能发生显著变化。对于湿纸来说，尤其需要确定预期效果，并考虑如何通过合适的处理达到预期。

4.6 Overall Strength or Weakness 整体强度

Thin and/or brittle paper can be easily damaged by some drying and flattening processes. Lateral restraint techniques are not appropriate for brittle papers, for example, while thin papers respond well to friction drying and the use of soft materials such as polypropylene fleece.

有的干燥平整过程容易对较薄和/或脆化的纸张造成损伤。如边缘固定干燥法（lateral restraint）不适用于脆化纸张，而摩擦力辅助干燥法（friction drying）以及使用聚丙烯织物等柔软材料进行干燥的方法对于薄纸的效果较好。

4.7 Local Weakness and Damage 局部脆弱和破损

Local areas of damage and weakness (e.g., tears, cracks, mold damage, etc.) can be may worse in the course of treatment, especially if their presence is not known. Examine the paper closely, preferably on a light table, and identify damage and areas that are thinner than surrounding paper. Damaged sheets are best treated using drying processes that involve pressure being spread evenly over the entire sheet. Friction drying is a good option.

纸张的局部破损和脆弱（如撕裂、开裂、霉变等）在处理过程中可能变得更加严重，尤其在不知道其存在时。最好将纸张放在透光台上仔细检查，识别破损及薄弱区域。对破损纸张进行干燥时，最好使压力均匀分布在整个纸面。摩擦力辅助干燥法是个不错的选择。

4.8 Subsequent Use 后续使用

The level of acceptable changes to the paper that occur during aqueous treatments and subsequent drying and flattening needs to be determined and will inform treatment. For example, dimensional change may need to be minimized if the paper is to be bound back into the original book boards or the texture may be need to be retained as an important element in the aesthetic qualities of a print.

确定纸张在水性处理及随后的干燥平整过程中可以接受的改变程度，并以此考量修复处理步骤。例如，如果纸张需要重新装回原书封板，就要尽可能避免尺寸发生变化；而对版画作品来说，纸张纹理是一项重要的美学元素，应予以保留。

4.9 Texture and Surface Finish 表面纹理与加工

All aqueous processes will cause paper surfaces to roughen, but the effect is especially strong in wet treatments and in paper containing significant amounts of lignin, such as mechanical pulp paper (Forseth and Helle 1997). Roughening can be minimized by using humidification or dry processes to flatten, but if the paper has to be wetted out, there are some drying and flattening techniques that minimize changes in surface texture, including wet restraint and the use of smooth materials such as mylar and Gore-tex against the paper surface.

所有水性处理都会增加纸张表面的粗糙度，尤其是进行润湿处理以及纸张中木质素含量高（如机械浆纸）时，这种变化非常显著（Forseth and Helle 1997）。以润潮代替润湿，或者进行干式平整可以减少这一变化，但如果必须对纸张进行润湿，有一些干燥平整方法可以减少表面纹理的变化，如趁湿施压干燥（wet restraint），以及使用麦拉膜³、Gore-Tex 等光滑材料与纸张表面接触等。

4.10 Treatment Processes 其他修复处理

In the process of treatment, a sheet may be changed in ways that will affect how it responds to moistening and subsequent drying. If the paper has been lined, for example, the expansion and shrinkage of the lining paper need to be considered in addition to the characteristics of the paper being stabilized (Nielsen 1997). Repairs such as mending or filling can also locally change how paper responds to drying and flattening processes.

纸张可能在修复处理过程中发生改变，导致其对于潮湿及后续干燥的反应也随之变化。例如，如果纸张经过小托，除该纸张的特性外，还需要考虑托纸的伸缩性能（Nielsen 1997）。嵌折或缺等处理也会改变纸张局部对于干燥和平整的反应。

4.11 Media 媒材

The stability of media must be considered when choosing a drying and flattening method. Some media can be softened by aqueous treatment and should not be placed under weights. Brittle media may not respond well to processes that result in changes of paper dimension.

See also: [Media Problems](#).

选择干燥和平整方法时，必须考虑媒材的稳定性。经过水性处理后，有的媒材会被软化，不能进行加压；处理方法如果会导致纸张尺寸改变，则不宜用于脆化易碎的媒材。

参考：媒材问题

³ 麦拉膜（mylar）：一种聚酯薄膜。Mylar 为商品名，也常用 mylar 泛指这类产品，其化学成分为双向拉伸聚酯薄膜（BoPET）。

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5 Equipment 设备

5.1 Tools to Apply Restraint 施压工具

- Hand presses—Many conservation facilities have presses of various kinds, such as standing and nipping presses. They can be used to dry paper under restraint while saving table space. The pressure applied by hand press platens can be significant and adjustable, but it is hard to know exactly how much pressure is being applied.

手动压力机——很多修复机构有各种不同的压力机，如立式压力机（standing press）和小型压书机（nipping press）。压力机可以对纸张进行加压干燥，同时节省桌面空间。手动压力机施加的压力较大而且可以调节，但很难精确地得知到底施加了多大压力。

- Glass or other stiff material such as wood or thick Plexiglas, with or without added weight on top--These arrangements take up more table space. The weight that can be applied is limited, but at least it can be known.

玻璃板或木板、厚亚克力板等硬质材料（加或不加重物）——这种方法比较占据桌面空间，可施加的重量有限，但可知具体数值。

- Pneumatic press—Expensive, but allows for a greater range of known weights to be applied.

气动压力机——昂贵，但可以施加较大范围且具体可知的压力。

- Weights--These can be added on top of glass, wood or Plexiglas or used on their own in lateral restraint drying. Weights come in many forms, including lead shot in Nalgene bottles, old irons, bricks, etc. Weights that are not themselves made of clean, inert materials should be contained in clean, inert materials, such as Tyvek or polypropylene bottles. Look out for crumbs and rust. Iron objects may need to be cleaned and sealed before use.

重物——可以放在玻璃板、木板或亚克力板上，也可以在边缘固定干燥中单独使用。重物有多种形式，包括装在瓶子里的铅丸、旧熨斗、砖块等等。重物材料本身不够洁净、稳定时，应用干净的惰性材料，如特卫强布（Tyvek）或聚丙烯瓶进行包裹。当心碎屑和锈蚀。铁质重物使用前需要进行清洁和密封。

5.2 Rigid Supports 刚性支撑材料



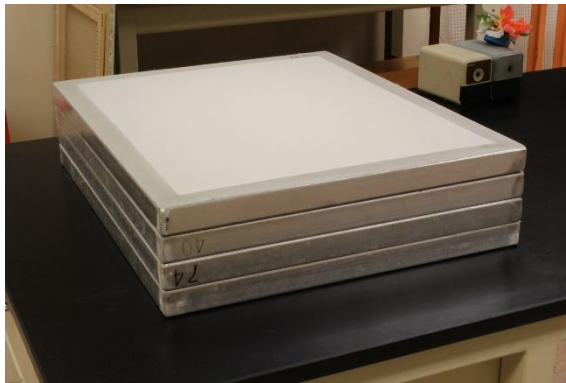
custom made drying rack at the Penn State University Libraries' conservation lab designed by Bill Minter

宾夕法尼亚州立大学图书馆修复室定制的干燥架，由 Bill Minter 设计

"Drying and Flattening", *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

- **Drying racks**—These can be purchased from conservation, art or baking suppliers. Conservation drying racks have moveable screens that can slide out of a support structure. Art drying racks designed for use in print shops have metal wire shelves hinged at the back. They can't be removed, but they can be flipped open. Bakery racks can be used, but they are designed to hold baking sheets, not screens. You will need to fabricate/purchase appropriate screens. Custom made drying racks are also an option.

干燥架——可以从修复、艺术或者烘焙类产品供货商处购买。修复用干燥架上的网格层可以从主体结构中抽出。艺术行业使用的干燥架是为丝网印刷设计的，金属网架背后以铰链固定，不能抽出，但可以向上翻起。也可以使用烘焙架，但烘焙架用于放置烤盘而非网格，需要再配置或购买合适的网格层。也可以根据需要自己定制干燥架。



drying rack made of stacked screens

网框叠放形成的干燥架

- **Screens**—aluminum or wooden frames stretched with woven polyester fabric can be stacked to form an enclosed drying rack or used on their own to support fragile wet paper. Screens can be purchased from silkscreen suppliers.

网框——即绷有聚酯布的铝制或木质框架，叠放在一起可以形成四周封闭的干燥架，也可以单独使用作为脆弱湿纸的支撑。网框可以从丝网印刷供货商处购买。

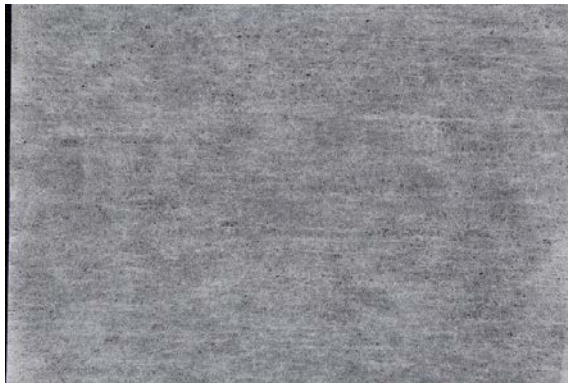
5.3 Flexible Supports 柔性支撑材料



Reemay



Hollytex



Bondina

It is usually best to leave papers sandwiched between polyester, non-woven, permeable supports throughout treatment as long as the papers are wet or humid. These polyester webs include:

在整个修复处理过程中，只要纸张为潮湿状态，最好将其夹入可透水的聚酯无纺支撑材料之间，这类材料包括：

- Reemay—The option with the most surface texture. Provides a good grip on wet paper in the washing process.

Reemay——表面纹理最多，在清洗过程中可以很好地“抓牢”湿纸。

- Hollytex—Smoother than Reemay. Made using a calendaring process. Use if there are any concerns about texture transfer to soft media or paper

Hollytex——较 Reemay 光滑，制造时经过压光处理。如果担心材料表面纹理转印在软质媒材或纸张上，可以选择 Hollytex。

- Bondina—Smoother than Hollytex with a more ordered and dense fiber arrangement. Another option if texture transfer is a concern.

Bondina——较 Hollytex 更为光滑，纤维排列更加有序、致密，是担心发生纹理转印时的另一个选择。

5.4 Absorbent Materials 吸水材料

Absorbent materials are often used in drying and flattening to accelerate the removal of water from paper. These materials include:

干燥和平整时常使用吸水材料，加快纸张中水分的移除，这类材料包括：

- Blotter—Unsize, thick, lightly-beaten papers made of cotton or chemical pulp. 100% cotton is preferred. Blotters become stained and warped with use and must

eventually be replaced. Comes in different weights. Best used in combination with some cushioning material, such as foam or felt, since the stiff blotter sheet can't conform well to a paper's variable thickness.

吸水纸——以棉浆或化学浆为原料、无施胶、轻度打浆的厚纸。首选 100%棉浆。使用过程中吸水纸会变脏、变形，最后必须撤换。吸水纸有不同的重量。当较硬挺的吸水纸无法贴合厚薄不匀的纸张时，最好与泡沫塑料、毛毡等缓冲材料配合使用。

- Felt, wool and synthetic—Absorbent, durable, washable and reusable. Felt is available in a variety of densities and thicknesses. Softer, less dense felt has the ability to conform to the variable thickness found within every paper sheet, even machine-made sheets. Softer felts can also minimize damage to plate marks, type impressions and other dimensional evidence while still being part of a light restraint drying system. Bear in mind that wool contains sulfur and can adversely affect some pigments.

毛毡（羊毛或合成材料）——毛毡吸水、耐用、可以清洗和重复使用，有不同的密度和厚度。纸张本身厚度分布不均匀（即使是机制纸），相对松软的毛毡可以与之很好地贴合。使用较柔软的毛毡进行轻压干燥也可以最大程度地保留版缘凹痕、铅字压痕（**type impression**）和其他立体信息。需要注意的是，羊毛中含有硫，对一些颜料有负面影响。

- Tek-Wipe—a non-woven material made of polyester and cellulose. Washable and reusable.

Tek-Wipe——一种由聚酯纤维和纤维素制成的无纺布。可以清洗和重复使用。

6 Drying and Flattening Methods 干燥平整方法

Keep the following in mind before you start a drying and/or flattening process:

进行干燥和/或平整前请谨记以下几点:

- Every time a paper sheet is exposed to water, vapor or liquid, it changes permanently as bonds shift. The original size, density, strength and surface texture are all lost. Drying and flattening processes can be chosen to minimize changes but cannot prevent them.

由于键合转移, 纸张每次遇水(无论气态水或液态水)后都会发生永久性的变化。其原始尺寸、密度、强度和表面纹理都会改变。选择合适的干燥平整方法可以降低变化的程度, 但不能阻止变化的发生。

- The fewer times a sheet is wetted/ humidified and then dried, the better.
对纸张进行润湿/润潮再干燥的次数越少越好。
- It is generally better to wet/humidify whole sheets than parts of sheets because the fibers in the interface between dry and wet/humid areas can be damaged.
一般来说, 对纸张进行整体润湿/润潮要好于局部润湿/润潮, 因为局部润湿/润潮会对处于干湿/潮界面的纤维造成损伤。
- Leave wet or humid sheets sandwiched in polyester web during treatment.
处理过程中要将湿纸或潮纸夹放在聚酯无纺布之间。
- Drying should ideally be done slowly and evenly.
理想的干燥过程应是缓慢、均匀的。
- Avoid the introduction of heat in the drying process, especially heat applied to only part of the paper sheet. Heat can accelerate drying and cause unwanted distortion and stress.
干燥过程中避免加热, 尤其只在纸张局部加热。加热会加快干燥速度, 造成不必要的变形和应力。
- Most drying processes should be started after the free water gloss is off of your object, and it has a matte surface ([Sugarman and Vitale 1992](#)). Free water can be removed by:
 - Evaporation
 - Blotting
 - Draining at an angle
多数情况下, 需要先去i除纸张中的游离水, 待纸张表面失去水的光泽后再进行干燥 ([Sugarman and Vitale 1992](#))。去除游离水的方法包括:
令水分蒸发
吸去多余水分
将纸张倾斜排走水分
- The amount of weight put on humid or wet paper, especially wet paper, does make a difference in outcomes. The greater the weight, the more likely wet expansion will be dried in; the lesser the weight, the more likely shrinkage will take place ([Munoz-Vinas 2009](#)).

在潮纸或湿纸(尤其湿纸)上施加的压力大小会影响最终效果。压力越大, 湿纸/潮纸的伸胀在干燥后被保留的越多; 压力越小, 则越可能发生收缩 ([Munoz-Vinas 2009](#))。

- The amount of time required for each process varies and is difficult to predict, but when in doubt, give paper a generous amount of time to dry. As a rule, the more restraint applied, the longer the drying/flattening will take. Machine-made papers will need more time than hand-made papers. Restraint drying machine-made papers can take weeks.

每个干燥平整过程所需要的时间各不相同，也不太容易预测。如果不太确定，尽量给予足够的时间。通常来说，施加压力越大，所需要的干燥或平整时间越长；而机制纸相比手工纸需要更多的时间，对机制纸进行施压干燥可能要花费数周。

6.1 To Restrain or Not to Restrain 是否施加约束

The extent to which paper is restrained when drying can affect planarity, texture, strength and dimension. As a general rule, consider drying machine-made paper with more restraint than hand-made paper. Restraint can be created by either placing weight on a sheet or securing its edges.

干燥过程中对纸张施加的约束程度会影响纸张的平整度、表面纹理、强度和尺寸。通常来说，对机制纸进行干燥时比手工纸施加更多的约束。施加约束的方法包括在纸上放置重物或对纸张边缘进行固定。

Restraint 施加约束

Pros—

- Prevents planar distortions and the loss of strength that results if the sheet is dried without restraint. Evidence for the loss of strength in sheets dried without restraint can be found in Vitale (1992) as well as MacKay and Smith (1994). In contrast, Smith (1997) found little change in strength when sheets were dried under light restraint. Some sources suggest that drying under pressure increases interfiber bonding (Banik and Brückle 2018, 455) and helps to retain the paper's original texture (Sugarman and Vitale 1992). Significant pressure can minimize changes to even calendared or burnished surfaces and prevent vertical expansion.

优点——

避免纸张由于无约束干燥出现的平面变形和强度下降。Vitale (1992) 以及 MacKay 和 Smith (1994) 研究表明，无约束干燥会导致纸张强度下降。但 Smith (1997) 研究发现，纸张在轻微约束下干燥时强度几乎没有变化。有文献指出，加压干燥有助于增加纤维间键合力 (Banik and Brückle 2018, 455)、保持纸张原本纹理 (Sugarman and Vitale 1992)。足够的压力甚至能最大程度地保持压光或研光表面，减少厚度的增加。

Cons—

- Can remove important evidence of paper manufacture and history by obscuring plate marks, type impressions, paper dimensionality, etc. Can also result in dried-in wet expansion, leaving the sheet with larger dimensions than it had before treatment.

缺点——

可能使版缘凹痕、铅字压痕、纸张形貌等信息模糊，丢失纸张制造和历史的重要证据。也可能使纸张停留在湿胀的尺寸，导致尺寸较处理前增加。

Little/no restraint 轻微约束/无约束

Pros—

- Preserves the natural undulations of hand-made sheets and other out-of-plane evidence. Older and hand-made papers dry to something close to their original dimensions, though often with small amounts of shrinkage.

优点——

保留手工纸的自然起伏和其他立体特征。老纸和手工纸干燥后与原尺寸接近，尽管通常伴随着轻微收缩。

Cons—

- Some loss of paper strength, surface roughening and planar distortions. Significant shrinkage in new heavily-beaten, machine-made papers, especially in the machine direction (Uesaka, Moss and Nanri 1992).

缺点——

导致纸张强度一定程度下降、表面粗糙度增加、发生平面变形。较新的、重度打浆的机制纸会发生明显收缩，尤其在纸张纵向（Uesaka, Moss and Nanri 1992）。

6.2 Unrestrained 无约束干燥

Air drying paper in the absence of weights, lateral restraint or absorbent material. To minimize out-of-plane distortions, unrestrained drying should be done slowly and evenly. Thin strips of paper (such as newsprint) can be laid along paper edges that are perpendicular to the grain. This moves the edge of evaporation away from the sheet and prevents edge cockling. Paper being air dried needs a flat support, preferably one that allows air to circulate above and below the sheet. For free water evaporation or no restraint drying, drying racks and screens offer support, air circulation and a microclimate that allows evaporation and drying to proceed slowly and evenly.

无约束干燥是指不进行加压、边缘固定或使用吸水材料，令纸张自然晾干。为了尽可能减少平面变形，无约束干燥过程应缓慢、均匀。可以在纸张边缘覆盖新闻纸等薄纸条（垂直于纤维方向），减少边缘水分蒸发，预防纸张边缘起皱。纸张晾干时需要一个支撑平面，最好能使纸张上下两面空气流通。蒸发去除纸张中的游离水或者进行无约束干燥时，可以使用干燥架或网框，为纸张提供支撑、保证空气流通、构成微环境，使蒸发和干燥过程缓慢、均匀。

6.2.1 Microclimate 微环境干燥法

Creating a microclimate is conducive to slow, even drying. Can be used on wet or humid paper.

制造一个有助于缓慢、均匀干燥的微环境。适用于湿纸或潮纸。

Equipment

- Drying rack or taut screens
- A cover for taut screens, such as Plexiglass

设备

干燥架或网框

可以遮盖网框的亚克力盖子等

Place wet or humid paper protected in a polyester web on a drying rack, in a stack of taut screens or on a taut screen under a cover. These arrangements all create semi-enclosed microclimates conducive to slow, even drying that minimizes distortions.

将湿纸或潮纸上下垫聚酯无纺布，放入干燥架、一沓网框内或一个带盖的网框上。这些方法都可以形成半封闭的微环境，使得干燥过程缓慢、均匀，尽可能减少变形。

Variations

- A microclimate can also be made by placing the paper on blotter, in a tray. The tray can then be covered with a piece of Plexiglass, with a slight opening to allow for air exchange.

变通方法

微环境还可以通过以下方法实现：将待处理纸张放在吸水纸上，一同放入托盘。托盘上方加盖亚克力板，留一小缝便于内外气体交换。

Pros—

- A good drying method for older, hand-made papers that tend not to shrink, cockle or curl much when wetted or humidified. It allows these papers to maintain something close to their original dimensions, as well as plate marks, impressions, undulations, etc.

优点——

对于润湿或润潮后不易收缩、起皱、卷曲的早期手工纸是一种比较好的干燥方法。有助于保留纸张原始尺寸以及版缘凹痕、印版压痕、自然起伏等。

Cons—

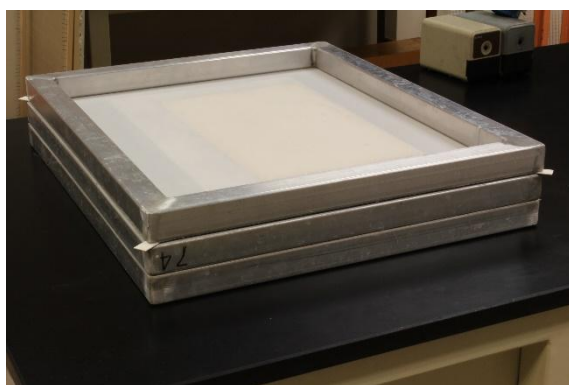
- Not a good drying method for newer, machine-made papers due to cockling and shrinkage.
- According to some sources, all papers lose strength when air-dried, while their textures change and become more pronounced ([Vitale 1992](#), [Sugarman and Vitale 1992](#)).

缺点——

不适用于较新的机制纸，因其容易起皱、收缩。

有文献（[Vitale 1992](#), [Sugarman and Vitale 1992](#)）指出，所有纸张晾干后强度都会下降，表面纹理则会更加明显。

6.2.2 Face-to-face Taut Screens “面对面”网框干燥法



face-to-face screens

“面对面”网框干燥法

The Face-to-face taut screen method can be used on wet or humid paper.

“面对面”网框干燥法可以用于湿纸或潮纸。

Equipment

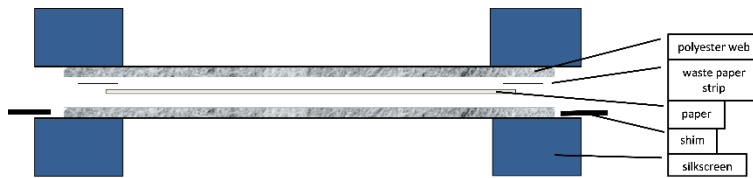
“Drying and Flattening”, Book and Paper Group Wiki, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

- Polyester web
- Taut screens

设备

聚酯无纺布

网框



face to face screen schematic

“面对面”网框干燥法结构示意图

The paper is placed in a polyester web sandwich, placed on a screen, and then a second screen can be placed face down on top of the paper but with shims in place to keep the second screen from actually touching the paper. The paper is not restrained, but the second screen will prevent significant planar distortions from forming.

将待处理纸张夹入聚酯无纺布之间，放在网框上，另一个网框网面朝下放在纸上，并在适当位置塞入垫片，避免上层网面与纸张直接接触。纸张本身没有受到约束，但上层网面可以避免纸张发生明显的平面变形。

Pros—

- Also good for keeping the out-of-plane evidence in older, hand-made sheets. Minimizes any distortions that may arise.
- Makes it more workable to air dry machine-made papers and subject them to subsequent flattening since there are fewer significant distortions.

优点——

同样有助于早期手工纸保留其立体特征，最大程度地减少可能发生的变形。

使得对机制纸先晾干再平整更为可行，引起的变形更少。

Cons—

- While it may minimize cockling in machine-made papers, some cockling is still present.
- As with other air-dry methods, strength may be lost and texture may coarsen.

缺点——

机制纸的起皱程度虽然降低，但起皱仍然存在。

与其他晾干方法一样，可能使纸张强度降低、表面粗糙度增加。

6.2.3 Subsequent Flattening 后续平整法

After paper has been air dried, it can be humidified and flattened or dry flattened via the semi-restrained, restrained, or dry methods below.

纸张晾干后，可以通过后文所述各种半约束干燥、约束干燥方法进行润潮平整或者干式平整。

Pros—

- According to Sugarman and Vitale (1992), the air dry/humidify/dry under weight method is as good as early wet restraint in maintaining the sheet's original texture.
优点——

Sugarman 和 Vitale (1992) 指出，在保持纸张原始纹理特征方面，先晾干/再润潮/加压干燥这一方法与趁湿施压干燥法具有同样好的效果。

- Allowing papers to air dry before flattening may also allow them to maintain something close to their original dimensions as the sheets are humid, not wet, when dried under weight. This is an effective method to use with machine-made book paper that needs to be bound back into original covers more or less unchanged in dimension.

将纸张晾干后再进行平整也有助于保持其原始尺寸，因为加压干燥前，只对纸张进行了润潮而非润湿。对于需要装回原封面（尺寸几乎未变）的机制书芯纸来说，是一种有效的方法。

Cons—

- Unlike the wet restraint method, the air dry/humidify/dry under weight method does not help maintain the sheet's strength (Vitale 1992).

缺点——

与趁湿施压干燥法不同，先晾干/再润潮/加压干燥的方法无助于保持纸张的强度（Vitale 1992）。

6.3 Semi-restrained 半约束干燥

6.3.1 Light Weight 轻压干燥法

Light weight can be used with humid or wet paper.

轻压干燥法可以用于潮纸或湿纸。

Equipment

- Soft felts, wool or synthetic
- Flat, dimensionally stable surface such as a clean table top, silicone mat, taut screen or a stiff but absorbent material such as honeycomb board with or without blotter or mat board

设备

软毛毡（羊毛或合成材料）

平整、尺寸稳定的平台，如干净的桌面、硅胶垫、网框，或者具有吸水性的硬质材料，如蜂窝纸板或无酸卡纸

The paper in its polyester web sandwich is placed on a flat, dimensionally stable surface. A taut screen has the advantage of allowing evaporation from the bottom of the sandwich. Absorbent surfaces can also be used as long as they remain dimensionally stable. A thick but soft felt is laid over the paper. No other weight is needed. Several layers of thinner felt can also be used. Leave the stack overnight and remove the felt in the morning. The felt should not need changing as it can evaporate out much of the water it is wicking. It is important that the felt be soft so that it can keep in contact with the paper if/when it goes slightly out of plane.

将待处理纸张上下垫聚酯无纺布，放在平整、尺寸稳定的平台上。使用网框作为平台的好处是水分可以同时从底部蒸发；也可以使用具有吸水性的平台，只要尺寸稳定即可。再将一层柔软的厚毛毡或几层薄毛毡盖在纸上，无需额外加压。放置一晚上第二天早上去除毛

毡。毛毡吸收的水分大部分被蒸发掉，因此不需要更换。重要的是毛毡的柔软性，它可以保证纸张出现轻微平面变形时，毛毡仍与之保持贴合。

Variations

- An additional light weight such as a taut screen turned over on its face can also be added to the stack.

变通方法

也可以在纸上轻微加压，如放一块网面朝下的网框。

Pros--

- Prevents significant planar distortions while preventing over-flattening. Papers retain plate marks, type impressions, etc. Another good option for hand-made papers in addition to air-drying if a light restraint seems safer. Could also be an option in some cases of fragile media.

优点——

既能避免明显的平面变形，也能避免过度平整。可以保留纸上的版缘凹痕、铅字压痕等。对于允许施加轻微约束的手工纸来说，是在晾干以外的另一个好方法。对于媒材脆弱的纸张来说也是一个可供选择的方案。

Cons--

- Has some of the same drawbacks as air drying.
- Not a good option for newer, machine-made papers, which will be left with planar distortions and probable shrinkage.
- Surface texture will roughen.
- According to Vitale, paper dried under light weight, like air-dried paper, will lose strength (Vitale 1992).

缺点——

具有一些与晾干法相同的弊端。

对于较新的机制纸不太适用，会造成平面变形，也可能导致收缩。

表面纹理变得粗糙。

与晾干法类似，轻压干燥会降低纸张强度（Vitale1992）。

6.3.2 *Karibari* Method 上板绷平法

The *karibari* can be used on wet or humidified paper (Webber 2017). If humidified, the paper must be fully relaxed.

上板绷平法可以用于湿纸或潮纸（Webber 2017）。如果是潮纸，必须令纸张完全舒展。

Equipment

- *Karibari* board
- Asian style paper
- Smoothing brush such as *nadebake*
- Starch paste

设备

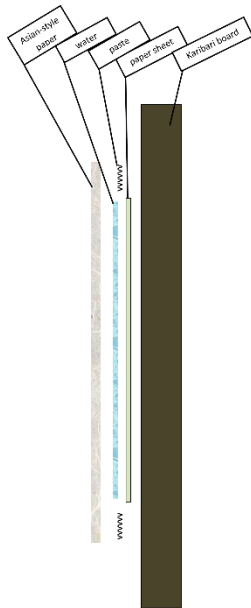
张贴板 (*karibari*)⁴

⁴ 张贴板 (*karibari*)：日本书画装裱与修复中使用的活动式纸壁。

亚洲纸

用于抚平纸张的棕刷，如日本抚刷（*nadebake*）

淀粉浆糊



karibari schematic

上板绷平法结构示意图

If it is to be used for drying and flattening without lining, then a false liner is used. The paper to be treated needs to be wet rather than humid. It is laid face down on a protective surface, such as a polyester web. If it is not already wet, it may be humidified and then misted with water. A larger, medium weight sheet of moist Asian style paper is laid on the back of the paper to be treated and the two sheets are brushed or pressed into close contact, the water holding them together. A brush, such as a *nadebake*, can be used but so can a bone folder, though in that case place a polyester web over the papers before applying the folder. Make sure that the false liner extends about an inch beyond all four edges of the paper being treated, and it is usually best that the grain directions of the two sheets match. After the false liner is in place, turn the two sheets over and apply paste to the edges of the false liner. Take the two sheets to the *karibari* board and use a brush or bone folder to adhere the package to the board surface, the face of the paper being treated against the board. Place the board upright against a support (e.g., wall or table) to save space and allow for air flow across the back. The papers will dry quite quickly (in less than a day), but in Japan, papers could be left on the board for extended periods of time in order to pass through seasonal cycles of high and low humidity.

如果纸张背后没有托纸，使用此法进行干燥平整时需要一层“假托纸”，且纸张需要进行完全润湿，而不只是润潮。将待处理纸张正面朝下放在聚酯无纺布等材料之上作为保护，先润潮再喷水令其完全润湿（如果此时纸张不是湿的）。将一张稍大的、中等厚度的亚洲纸喷湿后放在待处理纸张之上，可以用棕刷（如日本抚刷）刷合，也可以在纸上垫一层聚酯无纺布用骨刀压实，使两层纸紧密接触并在水分的作用下完全贴合。确保“假托纸”四周多出待处理纸张约1英寸，两层纸最好纤维方向一致。“假托纸”放好后，将两层纸一起翻面，在“假托纸”边缘刷浆。将两层纸移至张贴板前（待处理纸张正面朝向张贴

板），用棕刷或骨刀将边缘固定在板上。可将板子竖立靠在墙上或桌边，以节省空间并使背面空气流通。贴在张贴板上的纸会干得非常快（一天之内），但在日本一般将纸在板上保留较长时间，以使其经历不同季节的湿度循环。

Variations

- The process of drying can be slowed down by adding layers of moist paper over the false liner.
- Substitutes for a traditional *karibari* board include a painting canvas on a stretcher that is covered with machine-made Japanese tissue or wove paper (Webber 2017).
- In China a similar method is used by drying on walls (Kato and Kimishima 2017).
- Other kinds of boards, such as wood, glass or Plexiglas can also be used though they are not as gentle as the traditional *karibari*.

变通方法

可以在“假托纸”上增加几层湿纸，减缓干燥过程。

利用绷好框的油画画布，贴上日本纸或布纹纸（wove paper），可以代替日本张贴板（Webber 2017）。

中国使用类似的方法，在大墙上进行干燥（Kato and Kimishima 2017）。

也可以使用木板、玻璃板、亚克力板等，但不及日本传统张贴板温和。

Pros--

- The traditional *karibari* board allows for evaporation from both sides and gives slightly as the papers dry, so it is a rather gentle form of restraint.
- Well-suited to Asian style papers.
- Ideally suited to Japan's climate.

优点——

日本传统张贴板使水分可以同时从正反两面蒸发，当纸张干燥时又给予些微湿气，因此这种方法所施加的约束力比较温和。

非常适用于亚洲纸。

与日本气候完美适应。

Cons--

- Fast drying could damage weak papers, especially short-fibered Western style papers.

缺点——

干燥速度较快，可能对脆弱纸张造成损伤，尤其短纤维西方纸。

6.4 Restrained 约束干燥

6.4.1 Standard Method 标准加压干燥法

This commonly-used method is described by Vitale (1992), Sugarman and Vitale (1992) and Watkins (2002). It can be used for both wet and humidified papers. If the paper has been wetted, then free water should first be blotted, drained or allowed to evaporate off the paper before it is restrained. Once free water is gone, the paper should have a matte but still wet appearance. If the paper is allowed to dry past this point, distortion and bonding will have already started to take place, resulting in the more pronounced loss of original surface texture (Sugarman and Vitale 1992).

Vitale (1992)、Sugarman 和 Vitale (1992) 以及 Watkins (2002) 都对这一常用干燥方法进行过阐述。此法既可以用于湿纸也可以用于潮纸。如果用于湿纸，对其施加约束前，需要先通过吸、排、晾等方法去除其中的游离水。待游离水去掉后，纸张表面不再有水的光泽，但仍呈现湿润状态。此时如果任其继续干燥，纸张开始发生变形、氢键再度键合，会使得纸张的表面纹理变化更为显著 (Sugarman and Vitale 1992)。

Equipment

- Flat, dimensionally stable surface, such as a table top, heavy glass, plexiglass, or a wooden platen
- Absorbent material, such as blotter, felt, capillary matting, or Tek-wipe
- Heavy solid surface such as glass, Plexiglas, wooden platen
- Weights or press, such as a nipping press or standing press

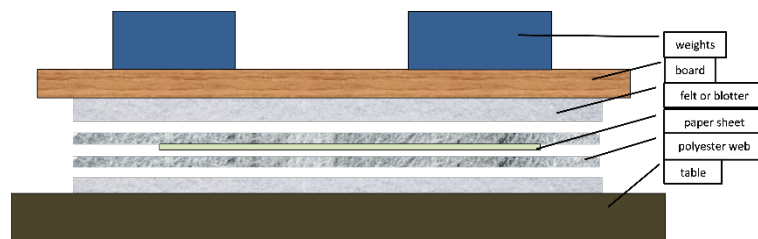
设备

平整、尺寸稳定的平台，如桌面、厚玻璃板、亚克力板或木板

吸水材料，如吸水纸、毛毡、毛细垫或 Tek-wipe

具有一定重量的硬质压板，如玻璃板、亚克力板、木质压板

重物或压力机，如小型压书机或立式压力机



standard schematic

标准加压干燥法结构示意图

The humid or wet paper is placed between absorbent layers in the following sandwich described from bottom to top: flat surface/absorbent material/ polyester web/paper/polyester web/absorbent material/platen/weights. If blotters are used, it may be helpful to back at least the top blotter with a softer material such as felt, capillary matting, Tek-wipes or foam in order to conform to the paper's natural variations in thickness. The sandwich is then placed in a press or under weights.

将湿纸或潮纸放入如下“三明治”结构，从下到上依次为：平台/吸水材料/聚酯无纺布/待处理纸张/聚酯无纺布/吸水材料/压板/重物。如果使用吸水纸作为吸水材料，至少在上层吸水纸下加入一层柔软材料，如毛毡、毛细垫、Tek-wipe 或泡沫塑料等，以确保其与厚薄不均的纸张贴合良好。然后将上述“三明治”结构放入压力机或置于重物下。

The absorbent material should be changed out with dry material about 4 times at increasingly long intervals, such as ten minutes, thirty minutes, two hours, etc. The amount of weight placed on the stack should vary with the absorbent material used and the nature of the paper. Heavy weight (e.g., 200 g/cm²) [Munoz-Vinas 2009](#) combined with blotters will result in flatter paper and dried-in wet expansion. This combination may not be appropriate for hand-made paper or paper with plate marks, type impressions or other dimensional evidence. These papers may best be dried under lighter weight using softer absorbent materials, such as felts.

干燥过程中需要更换吸水材料，大约 4 次，每次间隔时间逐渐延长，如 10 分钟、30 分钟、2 小时等。根据所使用的吸水材料以及待处理纸张的性质，施加的压力各不相同。施
 “Drying and Flattening”, *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

加较大压力（如 200 g/cm²）（Munoz-Vinas 2009）并以吸水纸作为吸水材料时，纸张干燥后更为平整并且停留在湿胀时的尺寸。手工纸以及带有版缘凹痕、铅字压痕和其他立体信息的纸张不宜采用这种组合，最好是施加较小的压力，并使用毛毡等更为柔软的吸水材料。

The amount of time that papers need to spend in the stack can vary, but when in doubt be generous with time. Hand-made papers may be stable after drying overnight. Machine-made papers may need several days or longer. It is common to remove machine-made papers from the drying stack after several days, take them out of their polyester web supports and then place them in a press for several weeks.

纸张在叠压结构中的时间也各不相同，不太确定时尽量给予充足的时间。手工纸干燥一晚可能就已稳定，机制纸则可能需要几天或者更长时间。通常做法是，几天之后将机制纸从叠压结构中取出，去除聚酯无纺布后放入压力机再加压数周。

Pros--

- Well-suited to machine-made papers as it mimics some the pressures they were subject to during manufacture.
- Some research indicates that drying under weight prevents the loss of paper strength and may increase interfiber bonding (Vitale 1992, Banik and Bruckle 2018).
- Prevents out-of-plane distortions, especially in machine-made papers with dried-in stresses.
- Because weight is evenly-distributed over the sheet, localized stresses are less likely to result in ripping, as may happen in lateral restraint, making this method appropriate for more brittle papers.

优点——

适用于机制纸，某种程度上模拟了机制纸在生产过程中受到的压力。

有研究表明，加压干燥可以避免纸张强度下降，增加纤维间键合力（Vitale 1992, Banik and Bruckle 2018）。

避免出现平面变形，尤其是具有内在应力的机制纸。

压力分布均匀，不容易像边缘固定干燥法一样由于局部应力导致纸张撕扯，因此更适用于脆弱纸张。

Cons--

- Not good for paper holding fragile media.
- Heavy weight may result in the loss of a paper's dimensional evidence, such as plate marks and impressions.
- Not a good or necessary choice for loft-dried, hand-made papers that need to retain their natural undulations.
- Can result in dried-in wet expansion, especially in newer, heavily-beaten, chemically-pulped, machine-made papers.

缺点——

不适用于带有脆弱媒材的纸张。

重压可能导致纸张中版缘凹痕、印版压痕等立体信息的丢失。

造纸时悬挂晾干的手工纸需要保留其自然起伏特征，不适合采用也没有必要采用这种方法。

纸张干燥后会停留在湿胀时的尺寸，尤其是较新的、重度打浆的化学浆机制纸。

"Drying and Flattening", *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

6.4.2 Forced Air 强制通风干燥法

This drying process mimics the methods used in hand paper mills. It has been described by Minter (2002) and is especially useful when processing many sheets at once.

这种方法模拟了手工造纸厂的干燥方法。Minter (2002) 对这种方法进行了描述，尤其适用于纸张的批量干燥。

Equipment

- fan
- corrugated boards, preferably 2 or 3 ply, preferably archival
- Flat, dimensionally stable surface
- Absorbent material, such as blotter, felt or Tek-wipe
- Heavy glass, Plexiglas, or wooden platen
- Weights or press

设备

风扇

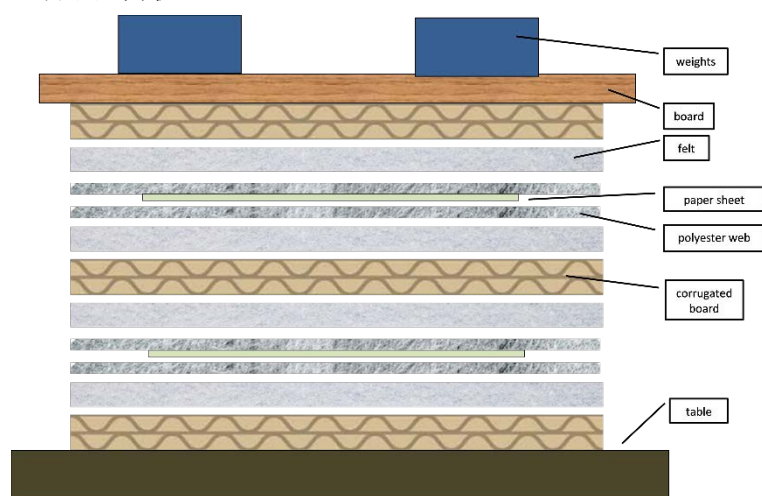
瓦楞纸板，2层或3层最佳，首选档案级别

平整、尺寸稳定的平台

吸水材料，如吸水纸、毛毡或 Tek-wipe

厚玻璃板、亚克力板或木质压板

重物或压力机



forced air schematic

强制通风干燥法结构示意图

Follow the [standard method](#) until the drying sandwich needs to be made. Place corrugated boards between each sheet: flat surface/corrugated board/absorbent material/ polyester web/paper/polyester web/absorbent material/corrugated board/absorbent material/ polyester web/paper/polyester web/absorbent material/corrugated board/*repeat*/platen/weights. The stack can be made as tall as needed. Make sure the flutes in the corrugated board all face the same direction. When the stack is finished, set the fan to blow through the flutes. The stack can be

placed on a table under weights, or it can be placed in a large press, which is a great way to save space.

叠压之前的处理与标准加压干燥法相同。在每一叠压单元之间放置瓦楞纸板，从下到上依次为：平台/瓦楞纸板/吸水材料/聚酯无纺布/待干燥纸张/聚酯无纺布/吸水材料/瓦楞纸板/吸水材料/聚酯无纺布/待干燥纸张/聚酯无纺布/吸水材料/瓦楞纸板/（重复前述叠压单元）/压板/重物。叠压高度根据需要而定，确保瓦楞纸板的波纹都朝向同一个方向；叠压完成后，将风扇对着瓦楞纸板的波纹方向送风。叠压结构可以放在桌上用重物加压，也可以放入大型压力机以节省空间。



forced air set-up using a standing press

使用立式压力机进行强制通风干燥

Run the fan all day or overnight. After turning off the fan, the papers can be checked for dryness. They may need to be left in the stack for another day or two, with or without the fan. Machine-made papers may need several days or longer. It is often best to remove machine-made papers from the drying stack after several days, take them out of their polyester web supports and then place them in a press for several weeks.

令风扇运行一天或一夜，关闭风扇后检查纸张的干燥程度。视情况可能需要将其再留在叠压结构中一两天，开不开风扇均可；机制纸也许需要几天或者更长时间。几天后将机制纸从叠压结构中取出后，去除聚酯无纺布，最好在压力机中再加压数周。

Variations

- A stack with corrugated boards can be used without the fan if the stack is not too high or the sheets inside not too moist.

变通方法

如果叠压结构不是很高，或者待干燥纸张不是特别湿，也可以不用风扇。

Pros--

- Alleviates the need to change out absorbent materials.
- Saves space and time by making it easy to process large numbers of sheets in tall drying stacks.
- As with the "Standard" method, this drying process works best for machine-made papers.

优点——

省去了吸水材料的更换。

节省空间和时间，便于批量处理。

同标准加压干燥法一样，此法对于机制纸效果最佳。

Cons--

- Can't be precise as to the amount of pressure each sheet is under.
- Sheets at the bottom of the stack are under slightly more pressure than those near the top.
- Not a good choice for hand-made papers that need to maintain their natural waviness.

缺点——

无法精确得知每张纸承受的压力。

处于底部的纸张承受的压力稍大。

不适用于需要保留自然起伏特征的手工纸。

6.4.3 Friction Drying 摩擦力辅助干燥法

This method can be used to dry and flatten both wet and humid papers.

这种方法既可以用于湿纸，也可以用于潮纸的干燥平整。

Equipment

- Asian-style paper
- Smoothing brush such as *nadebake*
- Flat, dimensionally stable surface, such as a clean table top or silicone mat
- Absorbent material, such as blotter, felt or Tek-wipe
- Heavy glass, Plexiglas, wooden platen or press
- Weights or press
- Support material, such as mylar or polyester web

设备

亚洲纸

用于抚平纸张的棕刷，如日本抚刷

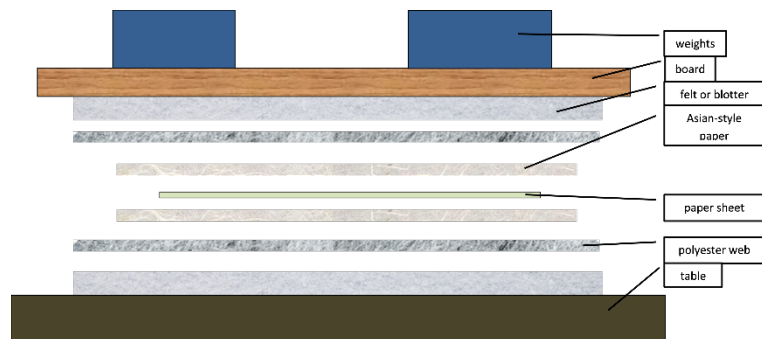
平整、尺寸稳定的平台，如干净的桌面或硅胶垫

吸水材料，如吸水纸、毛毡或 Tek-wipe

厚玻璃板、亚克力板、木质压板或压力机

重物或压力机

支撑材料，如麦拉膜或聚酯无纺布



friction schematic

摩擦力辅助干燥法结构示意图

Begin by choosing a medium weight, Asian-style paper that will expand and contract in the same way as the paper being treated. If you are treating another Asian-style paper, try to match the fiber ie *gampi* or *kozo* (Fletcher and Walsh 1979). Cut two pieces of this paper about four inches larger than the paper being treated (two inches around all sides). These will be the friction sheets. Wet out one friction sheet and place on a flat, dimensionally stable surface. Wet out the paper being treated and place face down in the middle of the friction sheet, using the smoothing brush to make good contact. Wet out the other friction sheet and place on top of the paper being treated. Use the brush again to make good contact. It is generally a good idea to match grains in all the sheets. Wetting out the papers can be done with a sprayer in place (Keyes 1984) or by dipping the sheets in water and bringing them out on support material. The wet three-sheet sandwich can then be dried under pressure using the standard method or the forced air method.

首先挑选中等厚度的亚洲纸，其伸缩性能应与待处理纸张相同；如果待处理纸张也是亚洲纸，尽量选择与其纤维匹配的纸张，如雁皮、楮皮等（Fletcher and Walsh 1979）。裁出两张亚洲纸，使其较待处理纸张长宽各大出 4 英寸，即四周各大出 2 英寸，作为“摩擦纸”。将其中一块润湿，放在平整、尺寸稳定的平台上，再将待处理纸张润湿，正面朝下放在“摩擦纸”中央，用棕刷使两者完全贴合；将另一张“摩擦纸”润湿，放在待处理纸张上再次刷合，三层纸最好纤维方向一致。润湿时可以用喷壶喷水（Keyes 1984），也可以放在支撑材料上浸入水中再取出。三层纸紧密刷合后使用标准干燥法或强制通风干燥法进行加压干燥。

Variations

- For humid papers, the method needs to be slightly modified. Since no liquid water is present, smoothing the sheets together with a brush is not necessary, but extra pressure needs to be placed on the sandwich as it dries, making a press a better option than a platen with weights (Keyes 1984).

变通方法

此法用于潮纸时需要稍加改动。潮纸中没有液态水，因此不需要将纸层刷合，但干燥过程中需要施加更大压力，因此相比压板和重物，压力机的效果更好（Keyes 1984）。

Pros--

- Can effectively flatten thin, fragile, damaged or creased papers.
- A good method for thin Asian-style papers.

优点——

可以有效地对薄纸或脆化、破损、折皱的纸张进行平整。

适用于较薄的亚洲纸。

Cons--

- The friction paper may impart texture to the sheet being treated, so this process may not be appropriate for calendared papers (Neufeld 2014).

缺点——

“摩擦纸”本身的纹理可能印在待处理纸张上，因此不适用于压光纸（Neufeld 2014）。

6.4.4 Mylar/Teflon/Gore-Tex 麦拉膜/特氟龙膜/Gore-Tex 辅助干燥法

Aqueous treatment and to a lesser extent humidification tend to roughen paper surfaces, and while this effect can be minimized through early wet restraint drying (see Standard Method), it can not be eliminated by these means. If a calendared

surface is an important part of a paper's character, then special efforts need to be made to retain it in the course of drying, and this can be done by placing a smooth material against the paper in the drying stack in a variation of friction drying. This method works best with wet papers, but can also be used with humidified papers.

水性处理和润潮常常使纸张表面变得粗糙，趁湿施压干燥（见标准加压干燥法）可以减少这种效应，但无法完全避免。如果表面压光是纸张的一项重要特征，就需要在干燥叠压结构中待处理纸张接触处加入一层光滑材料，这种方法可以视作摩擦力辅助干燥法的一种变通方法。这种方法对于湿纸效果最好，但也可以用于潮纸。

Equipment

- Smooth membrane like Gore-Tex, Sympatex or Hydra Air
- Smooth nonstick material such as Mylar, Teflon, silicone or Parafilm M
- Flat, dimensionally stable surface
- Absorbent material, such as blotter, felt or Tek-wipe
- Heavy glass, Plexiglas, wooden platen or press
- Weights or press

设备

光滑的隔膜材料，如 Gore-Tex，Sympatex 或 Hydra Air⁵

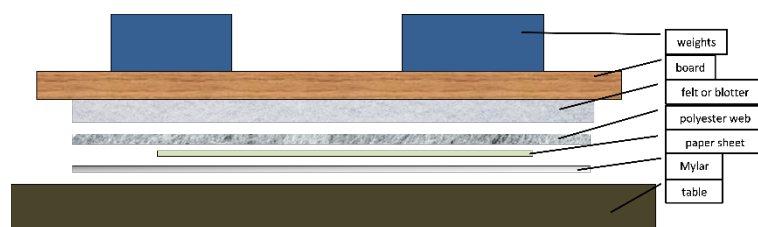
光滑的不粘材料，如麦拉膜、特氟龙膜、硅胶膜或 Parafilm M⁶

平整、尺寸稳定的平台

吸水材料，如吸水纸、毛毡或 Tek-wipe

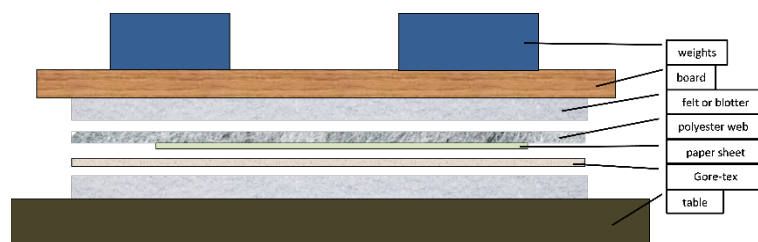
厚玻璃板、亚克力板、木质压板或压力机

重物或压力机



Mylar schematic

麦拉膜辅助干燥结构示意图



Gore-Tex schematic

Gore-Tex 辅助干燥结构示意图

⁵ Hydra Air: 即 Hydra Air PTFE，与 Gore-Tex 功能类似，详见 <http://www.cxdinternational.com/category.aspx?id=809>（2020-02-01）。

⁶ Parafilm M：商品名，一种实验室常用封口膜。

“Drying and Flattening”, *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

Mylar--This material can be used to bring the wet paper face down out of a water bath and can then be left in place throughout the drying process. Paper can also be wetted out with a sprayer while lying face down on the Mylar, using brush such as a *nadebake* to make good contact. Let the Mylar/paper drain at an angle until free water is gone and then place in a drying sandwich: flat surface/Mylar/paper/polyester web/absorbent material/platen/weights (Nicholson 1988). The sandwich can then be dried under pressure using the "standard" method or the forced air method.

麦拉膜——将待处理纸张正面朝下放在麦拉膜上，放入水中浸泡并取出，在随后的干燥过程中不需要移除麦拉膜。也可以将纸张正面朝下放在麦拉膜上，喷湿后用日本抚刷等将其与麦拉膜刷合。将麦拉膜和纸张倾斜，使游离水排出，然后放入以下“三明治”结构中：平台/麦拉膜/待处理纸张/聚酯无纺布/吸水材料/压板/重物（Nicholson 1988）。然后使用标准加压干燥法或者强制通风法进行加压干燥。

Teflon, silicon or Parafilm M--Use the same method as with Mylar. These non-stick materials are best used if there are any concerns about adhesive residues.

特氟龙、硅胶或 Parafilm M——与麦拉膜使用方法相同。这类不粘材料最适用于纸张表面有黏合剂残留的情况。

Gore-Tex and substitutes--Support the paper on a polyester web. It can be wetted out in place with a sprayer or pulled out of a water bath. Allow the free water to evaporate or drain off as described in the Standard Method. Place in a drying sandwich: flat surface/absorbent material/ Gore-Tex/paper/polyester web/absorbent material/platen/weights. The smooth side of the Gore-Tex should always face the paper. The sandwich can then be dried under pressure using the standard or forced air method. As a variation, Gore-Tex can be used on both sides of the paper. It can also be cut to size to fit inside plate marks (Dwan 1992). Gore-Tex and its substitutes have the advantage of allowing evaporation from both sides of the paper.

Gore-Tex 及其替代产品——将待处理纸张放在聚酯无纺布上作为支撑，用喷壶喷湿，或放入水中浸湿后再取出。同标准加压干燥法一样，令纸张中的游离水蒸发或排出后，放入以下“三明治”结构中：平台/吸水材料/Gore-Tex/待处理纸张/聚酯无纺布/吸水材料/压板/重物。特别注意要令 Gore-Tex 的光滑面与纸张接触，然后使用标准加压干燥法或强制通风法进行干燥。以下提供几种变通方式：可以在待处理纸张两面都使用 Gore-Tex，也可以根据需要按照纸内的版缘凹痕将 Gore-Tex 裁切修整成稍小于印版的尺寸（Dwan 1992）。相较于其他几种材料，Gore-Tex 及其替代产品的好处在于可以使水分同时从纸张两面蒸发。

Pros--

- Retains calendared surfaces on papers. Mylar/Gore-tex/Teflon/silicone/Parafilm act as supports for thin and fragile papers.

优点——

保留压光纸的表面特征。麦拉膜、Gore-Tex、特氟龙膜、硅胶、Parafilm 同时也对薄纸和脆弱纸张起到支撑作用。

Cons--

- If using Mylar, Teflon, silicone or Parafilm M, evaporation is only on one side. This could cause curling after drying.

缺点——

使用麦拉膜、特氟龙膜、硅胶或 Parafilm M 时，水分只能从纸张一面蒸发，可能导致干燥后发生卷曲。

"Drying and Flattening", *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

6.4.5 Hard/Soft Sandwich 硬/软“三明治”干燥法

The hard/soft sandwich is best used to dry and flatten humidified, not wet, paper. Fragile, thin, badly creased and transparent papers may need special, gentle handling. For these sensitive papers, pressing under layers of soft polypropylene may be safer and more effective than blotters or dense felts. These papers need to dry under very uniform pressure, and only a soft material can provide it; blotter and dense felt both have surfaces with enough texture to prevent the pressure from being as uniform as that of layered polypropylene. Homburger and Korbel (1999) first developed this hard/soft sandwich to flatten architectural drawings.

硬/软“三明治”干燥法适用于潮纸的干燥平整，不适用于湿纸。脆化的、较薄的、褶皱严重的纸张以及透明纸在持拿时需要特别小心。对于这类较脆弱纸张，放在柔软的聚丙烯材料下加压，比在吸水纸或致密的毛毡下更为安全和有效。这类纸张干燥时对压力的均匀度要求较高，只有柔软的材料才能够提供较好的均匀度；吸水纸和致密毛毡表面的纹理使得压力分布不及堆叠成层的聚丙烯材料均匀。Homburger 和 Korbel (1999) 首次使用这种硬/软“三明治”结构对建筑图纸进行平整。

Equipment

- polypropylene fleece or felts
- Flat, dimensionally stable surface or stiff but absorbent material such as honeycomb board with or without blotter or mat board
- Heavy glass, Plexiglas, or wooden platen
- Weights or press

设备

聚丙烯织物或毛毡

平整、尺寸稳定的平台，或者蜂窝纸板、无酸卡纸等具有吸水性的硬质材料

厚玻璃板、亚克力板或木质压板

重物或压力机



hard/soft sandwich schematic

硬/软“三明治”干燥法结构示意图

The humid paper is placed in the following sandwich described from bottom to top: flat surface/polyester web/paper/polypropylene fleece/platen/weights. The flat surface can be a clean table top or silicone mat. Absorbent surfaces can also be used as long as they are smooth and remain dimensionally stable. When the first or only layer of fleece is put on the paper, a brush, such as a *nadebake*, or a bone folder should be used to smooth the fleece unto the paper. The more distorted the paper is, the more layers of polypropylene fleece will be needed, up to about four layers. Leave the sandwich to dry overnight and repeat if necessary.

将润潮的纸张放入如下“三明治”结构中，从下到上依次为：平台/聚酯无纺布/待处理纸张/聚丙烯织物/压板/重物。平台可以是干净的桌面或者硅胶垫，也可以是具有吸水性的表
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面，只要表面光滑、尺寸稳定即可。聚丙烯织物（如果使用多层，这里指第一层）放在纸上后，用棕刷（如日本抚刷）或骨刀使其与纸张贴合。纸张变形程度越大，需要的聚丙烯织物层数越多，最多可用四层。将“三明治”结构加压干燥一夜，根据需要可以重复此操作。

Variations

- Soft felts can be used for a comparable effect.

变通方法

柔软的毛毡也可以取得类似的效果。

Pros--

- Good for problematic papers liable to damage or distortion when air-dried or dried under blotters or dense felts. These problematic papers include fragile, thin, badly creased and transparent papers.

优点——

适用于晾干或使用吸水纸或致密的毛毡进行干燥时容易受损或变形的“问题”纸张，包括脆化纸张、薄纸、严重褶皱的纸张以及透明纸。

Cons--

- Doesn't work well with wet papers.
- Method provides no benefit for papers other than the sensitive ones described above.

缺点——

用于湿纸效果不佳。

除上述几种较敏感的纸张外，这种方法对于其他纸张并无优势。

6.4.6 Lateral Restraint 边缘固定干燥法

This technique is especially useful for thin papers or papers that hold media that cannot be pressed. It is more effective for wet than humid paper.

这种方法尤其适用于薄纸或者媒材不宜施压的情况。用于湿纸的效果比潮纸更好。

Equipment

- Flat, dimensionally stable surface or absorbent material such as honeycomb board with or without blotter or mat board
- non-woven polyester
- strips of blotter
- pieces of glass or other stiff material such as book board
- weights

设备

平整、尺寸稳定的平台，或蜂窝纸板、无酸卡纸等吸水材料

聚酯无纺布

吸水纸纸条

条状的玻璃或封面纸板等硬质材料

重物



lateral restraint schematic

边缘固定干燥法结构示意图

The paper on a non-woven polyester support is placed on a flat, dimensionally stable surface, such as a clean table top or silicone mat. Absorbent surfaces can also be used as long as they remain dimensionally stable. The edges of the paper (about 0.5-1 cm) are covered by strips of blotter, which are in turn covered by strips of book board or glass held down by weights. As the paper dries, it will become taut and flat.

待处理纸张下垫聚酯无纺布作为支撑，放在桌面、硅胶垫等平整、尺寸稳定的平台上。也可以放在具有吸水性的材料上，只要其尺寸稳定即可。纸张边缘约 0.5~1 厘米处用吸水纸纸条覆盖，纸条上放置条状的封面纸板或玻璃，压上重物。纸张干后即被拉紧、变平。

Variations

- Place a cover over the paper as it dries to slow the process down and make drying more even.

变通方法

在纸张上方进行遮盖，使干燥过程更为缓慢、均匀。

Pros--

- Good for thin sheets and paper that holds fragile media.

优点——

适用于薄纸和带有脆弱媒材的纸张。

Cons--

- Paper may be left with larger dimensions.
- Brittle paper may rip as uneven drying stresses the sheet.
- Not good for paper whose edges are weak.

缺点——

纸张尺寸可能增加。

干燥不均匀，对纸张形成应力，脆弱纸张可能发生开裂。

不适用于边缘脆弱的纸张。

6.4.7 Suction Table 真空吸附台辅助干燥法

Suction table drying and flattening is a method that allows some control over dimensional changes in paper. It is a treatment option for papers with sensitive media that may offset onto interleaving materials and works that cannot be flattened inside a drying stack. It can be done with a basic suction table, or with a suction table equipped with a humidification dome. It is sometimes used to finish off treatments that were already being carried out on the suction table. This method can be used on wet or humidified supports.

使用真空吸附台进行干燥和平整可以对纸张的尺寸变化进行一定程度的控制。当纸张上的敏感媒材可能沾染至相邻材料，或作品不宜使用叠压方式进行平整时，可以选择这一方

法。可以使用基础款吸附台，或带润潮功能的吸附台。使用吸附台对纸张进行其他处理时，有时也以这种干燥平整方法来结束整个处理过程。这种方法既可以用于湿纸，也可以用于潮纸。

While works can be dried completely on the suction table, suction table drying is also done in a two-step process, with initial drying done on the table and then transferring the work to dry between polyester web, blotters and/or felts under weight.

可以令纸张在吸附台上完全干燥，也可以分作两个阶段，即先在吸附台上初步干燥，再将其移至聚酯无纺布、吸水纸和/或毛毡之间进行加压干燥。

The suction table can also be used to treat parchment.

吸附台也可以用于处理羊皮纸。

Equipment

- Suction table with or without dome
- Polyester web
- Blotter paper or other barrier material

设备

真空吸附台，有无穹盖均可

聚酯无纺布

吸水纸或其他隔垫材料

Transfer paper to be dried and flattened to the suction table. A polyester web should be used as support. If the paper is already on the table after treatment, leave in place. A barrier material such as blotter or polyester web can be used between the table and the work. Curling can occur if the object is dried fully on the suction table. Place weights along the edges of the paper to prevent this. Polyester strips can also be placed over the edges to prevent them from drying out faster than the rest of the sheet. Start with low suction to ease out creases and undulations, and increase suction as the object flattens out. After the work has been flattened, and the media of the object appears to be dry to the touch, the suction can be turned off, and the object allowed to dry with the edges weighted (Weidner 1993). At this point, the object can also be transferred to a traditional blotter drying stack if desired.

将待处理纸张放在吸附台上，下垫聚酯无纺布作为支撑。如果纸张已经在吸附台上（之前进行了其他处理），留在原位即可。吸附台和纸张之间加入吸水纸或聚酯无纺布作为隔垫。纸张在吸附台上完全干燥可能发生卷曲。为避免这种情况，可以在纸张边缘放置重物，也可以用聚酯条覆盖纸张边缘，避免边缘较其余部位过快干燥。开始时先用较小的吸力撑平纸张的折痕和起伏，随着纸张的平整逐渐加大吸力。纸张平整且媒材触摸起来已干时，关闭吸附台，保持边缘加压至完全干燥（Weidner 1993）。这时如果需要也可以将纸张移至传统吸水纸叠压结构中进行加压干燥。

If the paper has undergone severe expansion, splitting of the paper could occur. To prevent this, the weighted edges can be released and the suction turned off to allow the paper to contract briefly. Replace the weights along the edges. Once the object is flat, the suction can be turned off and the object allowed to dry in place (Weidner 1993).

如果纸张潮湿时润胀明显，使用上述方法可能导致开裂。为避免开裂，先去除边缘重物，关闭吸附台，令纸张初步收缩。然后在纸张边缘压上重物。纸张平整后马上关闭吸附台，令纸张在原位干燥（Weidner 1993）。

Variations

- The rate of drying can be slowed down by working under a dome with an ultrasonic humidifier.
- The suction table can cause airborne pollutants and surrounding dust and dirt to embed itself into the paper fibers, a Gore-tex barrier has often been recommended as a filter. Gore-tex can also be used to slow down drying ([Mowery 1991](#)).

变通方法

配合使用穹盖和超声波加湿器可以降低干燥速率。

吸附台会将空气污染物及周围灰尘吸附并嵌入纸张纤维中，一般建议使用 Gore-Tex 作为过滤。Gore-Tex 也可以用于降低干燥速度（[Mowery 1991](#)）。

Pros--

- A treatment option for works with creases and cockling that require manipulation during flattening, and works that cannot be covered while wet (unfixed pastels, gouache, impasto, textured paper etc.) ([Weidner 1984](#)).

优点——

作品上有折痕和起皱需要展平，以及作品（未加固的色粉画、水粉画、使用厚涂法的绘画、带纹理的纸张等）在潮湿状态下不宜覆盖时，可以选择这种方法（[Weidner 1984](#)）。

Cons--

- Not an ideal method for objects with sensitive media on both sides
- The use of the suction table can lead to changes in the texture and characteristics of the paper
- Not ideal for Asian papers
- Suction table drying dries works in an expanded state which can lead to curling, formation of creases and distortions, and sometimes tearing or splitting ([Watkins 2002](#)).
- Suction table flattening and drying can cause severe distortions on tracing papers compared to using a traditional blotter press ([Reyden, Hofmann, and Baker 1993](#)).
- Pastel pigments can sink into the support or condense or clump on the paper surface resulting in visible changes in the texture of the medium ([Kosek 1990](#), [Weidner and Zachary 1994](#), [Daniels 1998](#)).

缺点——

不适用于两面都有脆弱媒材的纸张。

吸附台可能导致纸张纹理或特性发生变化。

不适用于亚洲纸。

使用这种方法时，纸张在伸胀状态下干燥，可能导致卷曲、折痕、变形，有时还可能出现撕裂、开裂等（[Watkins 2002](#)）。

相比传统吸水纸加压干燥法，此方法可能造成描图纸发生严重变形（[Reyden, Hofmann, and Baker 1993](#)）。

色粉画颜料可能渗入纸张内部，或在纸张表面浓缩、结块，造成颜料表面肉眼可见的变化（[Kosek 1990](#), [Weidner and Zachary 1994](#), [Daniels 1998](#)）。

6.5 Dry Flattening 干式平整法

Sometimes water needs to be introduced in order to flatten paper. In less extreme cases, water speeds up the flattening process and usually makes it more effective. There are times, however, when paper needs to be flattened but the introduction of water is not an option such as when:

- Paper holds iron gall ink.
- Paper holds water-sensitive media.
- The texture of the paper is considered an important feature.
- The dimensions of the paper cannot change.

为了对纸张进行平整，有时需要向其中引入水分。通常情况下水可以加速平整过程，并使之更加有效。但有些时候，纸张需要进行平整，但又不能向其引入水分，如：

纸张上有鞣酸铁墨水。

纸张上有对水敏感的媒材。

表面纹理是纸张的重要特征。

纸张尺寸不能改变。

In these cases, paper can be placed under weights or in a press and, given enough time, will eventually flatten out. This process can take weeks or months. To avoid cracks in severely curled paper, and in fragile paper or media, work slowly to reshape the paper. Weight can be added slowly over several days or weeks or if using a press, the platen can be brought down as gradually as necessary ie. a quarter turn every day, every week, etc. The sheets should be placed between stiff, protective, inert materials such as book board. Add a polyester web barrier around the sheet if there are any concerns about sticking. Be conscious of the pressure or weight applied and add soft materials such as felt or polypropylene fleece if there are dimensional features that need to be saved.

遇上述情况，可以将纸张放在重物下或压力机中，给予足够的时间令其平整，这个过程可能需要几周甚至几个月。为了避免卷曲严重的纸张或者脆弱的纸张、媒材发生开裂，加压重塑过程应缓慢进行，在几天或几周时间里缓慢增加重物；如果使用压力机，则要根据具体情况逐渐放低压盘，如每天或每周放低四分之一圈等。纸张应当夹入封面纸板等硬质、惰性材料之间进行保护；如果纸张可能发生粘连，可加入聚酯无纺布作为隔垫。一定要密切注意所施加的压力或重量，如果纸上有需要保留的立体信息，加入毛毡或聚丙烯织物等柔软材料。

Paper that has been stored rolled in a tube can be uncurled by securing it to a wall with paper-lined clips and allowed to slowly unroll ([Watkins 2002](#)). Since this process can take weeks a cover should be put over the paper to protect it from dust.

对卷成筒状的纸张进行展平时，用夹子（内侧衬纸）固定在墙上令其慢慢打开（Watkins 2002）。这个过程可能需要几周时间，纸张表面做好遮盖，避免灰尘附着。

Pros--

- Avoids the problems associated with the introduction of moisture, such as changes in dimension, increased roughness and loss of surface finish.

优点——

可以避免由于引入水分带来的各种问题，如尺寸变化、表面粗糙度增加、失去表面纹理等。

Cons--

- Generally less effective and takes longer than other methods.

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- Flattening brittle or fragile paper in this way can cause cracks.
- Media may also flake off of the paper.

缺点——

相比其他方法效果较差、用时较长。

对脆化或易碎纸张进行平整时可能造成开裂。

媒材可能发生剥落。

6.6 Special Cases 特殊案例

6.6.1 Books 书籍

Books are complex hybrid objects that often require special methods to treat their paper components. Whenever possible, avoid pulling the book and treat its components in situ.

书籍是综合不同材质的复合体，对其中的纸张进行处理常常需要一些特殊方法。只要有可能，尽量对纸张进行原位处理，不要分拆书体结构。

- Distorted textblock paper--Leaves in books may be folded, crumpled or cockled due to water damage. To flatten these leaves, isolate them from the rest of the textblock by placing mylar sheets on either side of the damaged section. Insert a piece of slightly moist or humid blotter between the mylar and the damaged leaves, protecting the leaves from the blotter with a piece of polyester web. If the damaged section is thick enough, place a second piece of moist blotter on the other side of the section, again with a piece of polyester web protecting the leaves direct contact with the blotter. Leave in place for about twenty minutes. The volume can be closed or open during this humidification process. Remove the blotter and polyester web and close the book. The book may be weighted down under a board or placed in a press. Observe the book's natural paper density and apply more weight for a dense book and less or no weight for a book whose textblock contains a significant amount of air. As a general rule of thumb, books produced before the 18th century are less dense. Thin sheets of waste paper may be added to the humidified section to adsorb moisture. These should be removed or changed out as needed. Leave the book to dry closed overnight.

书芯纸变形——由于水分入侵，书页可能出现折痕或褶皱。对其进行平整时，在书芯受损部分前后各插入一张麦拉膜，使其与其余部分隔绝。在麦拉膜和受损书页之间放入一张轻微润湿或润潮的吸水纸，书页与吸水纸之间再用一层聚酯无纺布隔离。如果受损部分较厚，在另一侧再放入一张潮湿的吸水纸，同样用聚酯无纺布隔离，避免书页直接与吸水纸接触，等待约 20 分钟；在润潮过程中将书合上或打开均可。润潮后撤除吸水纸和聚酯无纺布，将书合上，压入板下或放入压力机中。观察书芯纸页的紧密程度，书芯较紧密时施加较大压力，反之书页之间空隙较大时施加较小压力或不施加压力。一般来说，18 世纪以前制作的书籍书页之间较疏松，因此可以在书芯润潮部分夹入薄纸以吸收潮气，并根据具体情况去除或更换薄纸。将书保持合上，放置一夜干燥。

- Warped boards--Warped book boards can place stress on sewing structures and damage textblocks, so treating them to bring them back into plain may be necessary. When the boards are made of cellulose (paste, mill and pulp boards) they can be flattened through humidification. Open the book so the board lays flat on a surface, leaving the pastedown exposed. Support the rest of the book with a weight, polyurethane wedge, etc., holding it almost upright. Cut a piece of blotter a little smaller than the paste down, moisten it slightly, and then place it in the following

sandwich: board/polyester web/moist blotter/mylar. If the board is part of a leather bound book, cut the blotter so that it is slightly smaller than the turn-ins. This will protect the leather under the pastedown from being adversely affected by moisture. Leave the humidifying sandwich in place for about twenty minutes and then remove the blotter and polyester web, leaving the mylar in place. Put the book in a press between two pieces of clean book board and leave it there for several weeks. It may be necessary to repeat the process. If the boards are detached from the textblock, follow the same procedure for flattening them and treat them before reattaching them.

封板起瓦——书籍封板起瓦会对缝线结构形成应力，损伤书芯，因此对其进行平整是非常必要的。如果封板为硬纸板、层压板、纸浆板⁷等纤维素板，则可以通过润潮进行平整。打开封面，将封板放在一个平面上，露出环衬，用重物或聚氨酯书楔等支撑书体其余部位，使其基本呈竖直状态。裁一块稍小于环衬贴页（pastedown）的吸水纸，稍微润潮，放入如下“三明治”结构中：封板/聚酯无纺布/潮湿吸水纸/麦拉膜。如果书籍为皮革装帧，则吸水纸应稍小于封面皮革折回的部分，避免环衬下封面皮革折回的部分受到潮气影响。将此润潮结构放置约 20 分钟后，撤除吸水纸和聚酯无纺布，麦拉膜保留不动。将书夹在两块干净的封面纸板之间，放入压力机加压几周。必要时可以重复此过程。如果封板已经与书芯分离，按同样的步骤平整后再重新连接封板和书芯。

- **Drying and flattening bifolia**--If the book has been pulled in order to treat the paper of the textblock, try to keep the bifolia folded throughout treatment. This will relieve stress on the weakened paper on the fold. Each bifolium can be placed in a folded sheet of polyester web with an additional polyester web insert placed between the leaves. The additional polyester web insert should be pulled snug into the paper fold, holding it against the polyester web fold. Sew threads through all three layers of web on either side of the bifolium and tie loosely. This sewing will hold the bifolium in place throughout treatment. Once the bifolium has been treated (e.g., washed, deacidified, etc.), it is left in the same polyester web for resizing and then drying. As a general rule, paper for books is best dried using a no or low restraint method. Since the paper needs to return to wrappers or covers, it is important that its original dimensions be retained as much as possible. In the case of hand made paper from the hand press era, there is also important dimensional evidence (type impressions, natural undulations, etc.) that may be lost if the paper is dried under pressure. Dry the bifolia overnight and then remove from the polyester web. Place them in a stack, rotating each bifolium 180 degrees in relation to the bifolium below it, so that each fold is cover by a fore edge and so forth. For hand made paper, place a light weight on top of the stack and leave overnight. For machine made paper (which will likely be much more cockled) place the stack in a press between two pieces of clean book board, apply pressure and leave in place for at least 48 hours but longer if possible. It is usually not necessary to rehumidify bifolia to help them dry flat, but it is an option if dry pressing for several weeks doesn't work.

⁷ 硬纸板（paste board）：将多层纸用胶黏合形成的纸板，多用于书籍装订，也称 paste-laminate board。详见 <https://www.ligatus.org.uk/lob/concept/1492>（2020-01-29）。

层压板（mill board）：指在造纸厂用多层湿纸直接形成的纸板，也称 couched-laminate board。详见 <https://www.ligatus.org.uk/lob/concept/1264>（2020-01-29）。

纸浆板（pulp board）：一种用粗制纸浆制成的厚板，原料通常来自回收纸。详见 <https://www.ligatus.org.uk/lob/concept/1528>（2020-01-29）。

“Drying and Flattening”, *Book and Paper Group Wiki*, published by the American Institute for Conservation. Translated in March 2020 by Lydia Lyu. Reviewed by Hsin-Chen Tsai.

折页的干燥平整——如果为了处理书芯纸已经将书体拆解，在处理过程中尽量保持折页对折不要打开，以减少脆弱纸张折缝处的应力。将每张折页放在一张对折的聚酯无纺布内，并在折页之间插入另外一张聚酯无纺布。中间这张聚酯无纺布应紧贴折页折缝，使其紧靠外层的聚酯无纺布折缝。在折页以外上下处，将三层聚酯无纺布用线缝合并打松结固定，这样可以保证折页在处理过程中不会移动。折页经过清洗、脱酸等处理后，留在上述聚酯无纺布结构中继续进行重新施胶和干燥。一般来说，书芯纸最好在无约束或轻微约束下干燥，因为书芯纸需要重新装回封皮或封板，需尽可能保证其尺寸不变。对于手工印刷时期的人工纸来说，如果对其进行加压干燥，可能造成铅字压痕、自然起伏等重要立体信息的丢失。将折页干燥一夜后从聚酯无纺布中取出，将所有折页叠放，相邻折页翻转 180 度，即折页的折缝与相邻折页的书口对应。如果是手工纸，在纸沓上轻轻施压放置一晚；如果是机制纸（起皱可能严重得多），将纸沓放在两块干净的封面纸板之间，放入压力机，加压至少 48 小时，条件允许的话时间可以延长。一般不需要将折页再次润潮使其平整，但如果几周后效果不理想也可以进行重新润潮平整。



bifolium being placed in a folded polyester web

将折页放入对折的聚酯无纺布内



bifolium secured in polyester web

折页被固定在聚酯无纺布结构中

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