TEACHING WITH PAPER-MAKING

The following exercise introduces the basic steps in paper-making, relating those steps to the chemical and physical properties of materials.

STEPS IN TRADITIONAL WESTERN PAPER-MAKING:

A. **Beating** fermented rags with stampers to make paper pulp of cotton and linen (flax) fibers.
B. **Casting** paper pulp by dipping a deckled paper mould frame into a vat of pulp slurry.
C. **Couching** the cast, wet paper sheet from the mould onto an absorbent stack.
D. **Loft or press drying** and flattening wet sheets.

STEPS IN PAPER-MAKING YOU CAN DO:

A. **Beating** torn up paper pieces with a blender to make paper pulp of recycled mixed fibers (cotton, bast, groundwood and chemical hard and softwood).
B. **Casting** paper pulp by dipping a two-piece deckled paper mould frame (with stainless steel screen) into a vat.
C. **Couching** the cast, wet paper sheet from the mould onto absorbent blotters.
D. **Air-drying**, stretch drying, heat drying or blotter-press drying and flattening wet sheets.

THINGS TO REMEMBER AND EXPERIMENT WITH:

**PAPER MAKING MATERIALS AND TECHNIQUES** AFFECT THE QUALITY, STABILITY, AND AGING OF PAPER PROPERTIES

NOTE: PAPER PROPERTIES INCLUDE CHEMICAL PROPERTIES (SUCH AS COLOR, pH, DEGREE OF POLYMERIZATION) & PHYSICAL PROPERTIES (SUCH AS OPACITY, DENSITY, POROSITY, TEXTURE, STRENGTH, DIMENSIONAL STABILITY, ETC.)
A. **Beating** affects the opacity, strength and dimensional stability of the paper you make.

- **Less rigorous beating** makes a less fibrillated pulp stock, and this makes an uneven, weak, opaque paper with little dimensional stability.
- **More beating** can make a more fibrillated pulp that creates a stronger, more transparent, and more dimensionally stable paper (unless you go too far, and **overbeat** the pulp, which could make a very weak paper!)

You can try different beating speeds and times to compare the effects.

The **type of fiber** pulped affects color and all the other properties listed above.

- **Cotton** makes a whiter, more opaque, stronger, and softer paper (because its long twisted fiber is high in stable alpha cellulose).
- **Bast fibers** like flax make a less opaque but very strong paper (because the long, straight fibers conform well to each other).
- **Groundwood fibers** make the weakest and darkest paper (since their short, splintery fibers don't interlock well, and contain acidic lignin which darkens as it ages, especially if exposed to sunlight - just like newsprint).
- **Chemical wood pulp fibers** are used for most papers today, like notebook paper, and they are bleached to make a white, but sometimes acidic paper, that may be strong for a while, but may become weaker as it ages over time.

You can try different types of plant fibers to see how they affect the color and strength of your paper.

Other things can be added to the pulp, like **sizes** to make the paper less absorbent.

- **Starch** and **gelatin** were used traditionally, but these can sometimes attract insects and mold.
- **Methylcellulose** is often used today to size **hand-made paper**.

Sizing can also be brushed or sprayed on the paper after it has dried.
B. **Casting** also affects all the paper properties listed above. If the paper mould is rotated laterally in all directions, the fibers will be deposited in a decorative strong, swirl pattern. If the mould is moved only back and forth, the fibers will be deposited primarily in one direction, resulting in a grain direction that will be very weak parallel to the grain, so that the paper will curl as it dries, and the dried paper may tear more easily in this direction (this is the problem with modern machine-made paper, which is cast on a moving belt going in one direction).

The type of screen on the paper mould frame affects the type of impressions found on the underside of the paper.

- "Laid and chain" screens make a pattern resembling a bamboo mat.
- "Wove" patterns result from woven fabric or metal.

These patterns, like those made by wire watermarks, can be seen in raking or transmitted light. Similar patterns can be impressed, after the paper has been made, by "dandy rolls," but these are made by compressing the fibers together, rather than preventing deposit of fibers, as in true screen or watermark impressions.

**You can look for these patterns, and test the dimensional strength and stability of your paper, by trying to tear it, or by watching it curl with changes in relative humidity.**

C. **Couching** wet paper sheets onto absorbent materials can also create an embossed pattern on the surface of papers, creating different surface textures.

**You can see how the texture changes if you substitute felt, woven fabric, wood, or polyester film for pressing surfaces.**

D. **Drying** paper also affects the surface texture and strength of the final paper sheet, depending on the method, speed, temperatures and pressures used.

- Air drying wet sheets allows them to shrink differentially, which causes them to curl and be less strong.
- Pressure drying, with many blotter changes, causes the paper to dry relatively evenly, flat, and strong.

Paper can be dried, rehumidified and flattened more than once.

**You can try this too!**

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