



Technique...

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## Determining Paper Grain Direction

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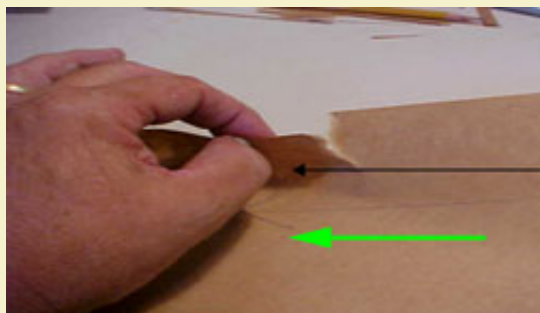


Figure 1: Jagged tear when tearing against the grain.

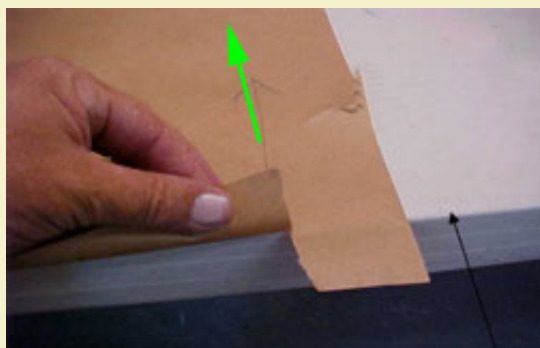


Figure 2: Straight tear when tearing with the grain.

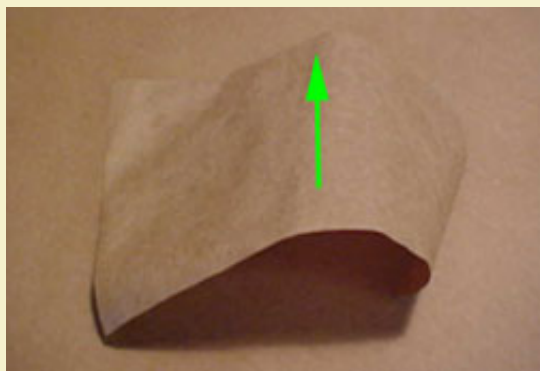


Figure 3: Wetting the paper to determine grain direction.

During the process of manufacturing paper, the fibers within the pulp become predominantly oriented in one direction. This results in a physical characteristic of the finished paper known as the "grain direction" of paper. In fireworks manufacture, it is often important to know what direction the grain is running when making casings. Rolling a shell casing with the grain running the wrong direction can cause heavier multi-break shells to flowerpot during lift, so grain direction is an important thing to be aware of.

This article describes several methods for determining grain direction for a given sample of paper. In all photographs, the green arrow represents the grain direction of the paper.

### Tear Method

This method relies on the characteristic of tearing to determine paper grain. Paper that is torn across the grain, as seen in Figure 1, tends to tear in an irregular fashion. However, if the same piece of paper is torn with the grain, as seen in Figure 2, then the tear is much straighter. Thus the direction in which the paper tears the straightest is the direction that the grain is running. This method does not work as well with recycled kraft, since the grain does not seem to be as strongly oriented in recycled paper. Recycled paper tends to tear irregularly in both directions.

### Wet Method

The wet method of grain detection operates on the fact that paper expands more across the grain than it does with the grain when wetted. Thus if a piece of paper is wetted on one side, the paper will curl such that the valley of the curl runs parallel with the grain direction, as seen in Figure 3.

### Folding Method

The fastest and most reliable way to determine grain direction is by simply folding a sample of paper in both directions, taking note of which axis folds with the least amount of resistance for a given amount of

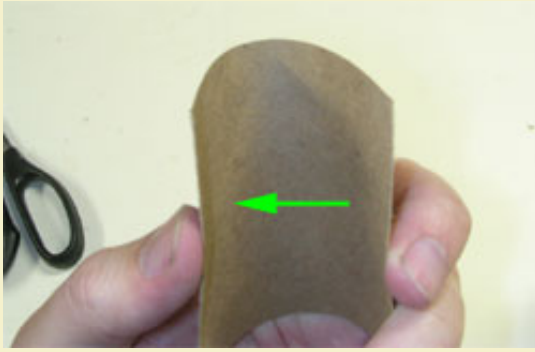


Figure 4: Folding against the grain.

pressure. Figures 4 and 5 show the same sample of paper receiving about the same amount of bending force in two different directions. Figure 5 shows the direction that yields the most to bending, thus revealing the grain direction as shown.

The folding method does not even require a small sample to be cut, you can simply make a small fold on the edge of a large sheet and still get a feel for which direction bends the easiest. This method works equally well for both virgin kraft and recycled kraft, with the example sheet in Figures 4 and 5 being 60 lb recycled kraft. 🔥



Figure 5: Folding with the grain.

