Exploratorium Cookbook I

A Construction Manual for Exploratorium Exhibits
Revised Edition

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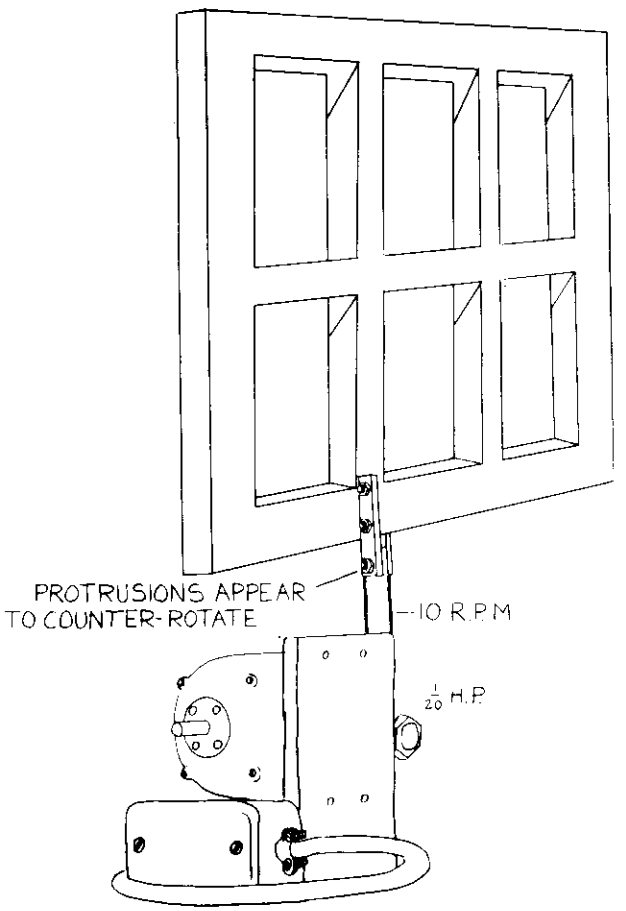
by Raymond Bruman and the Exploratorium Staff

Trapezoidal Window



Description

In our civilization we are surrounded by geometrical forms consisting almost entirely of orthogonal lines and circular arcs. As a result, we have become thoroughly accustomed to the convergence of parallel lines and the elliptical shape of circles when either is viewed in perspective. When we look at a rotating trapezoidal object that has all the usual features of a common rectangular object, we are strongly inclined to see its smaller end as being further away. When stereoscopic information is removed, by closing one eye or by moving away to a distance of ten yards, it is easier to believe that the rotation is reversing than to believe that the smaller end is actually getting closer.

This effect can even be seen to some extent in the motionless picture of the trapezoidal window. There is a paradoxical wrongness about the orientation of the bracket that holds the window, because all the cues from the window itself imply a different orientation. When the window rotates, mounting bolts and other protuberances on the shaft will seem to rotate independently of the window's apparent oscillation.

It is interesting to note that not everyone is subject to this illusion. Dr. Eugene Rebstock of San Francisco State University showed a trapezoidal window to some African villagers whose homes are circular and who are exposed to rectangular objects much less frequently than we are. They were only able to see the object as an ordinary trapezoid, not as an optical illusion.

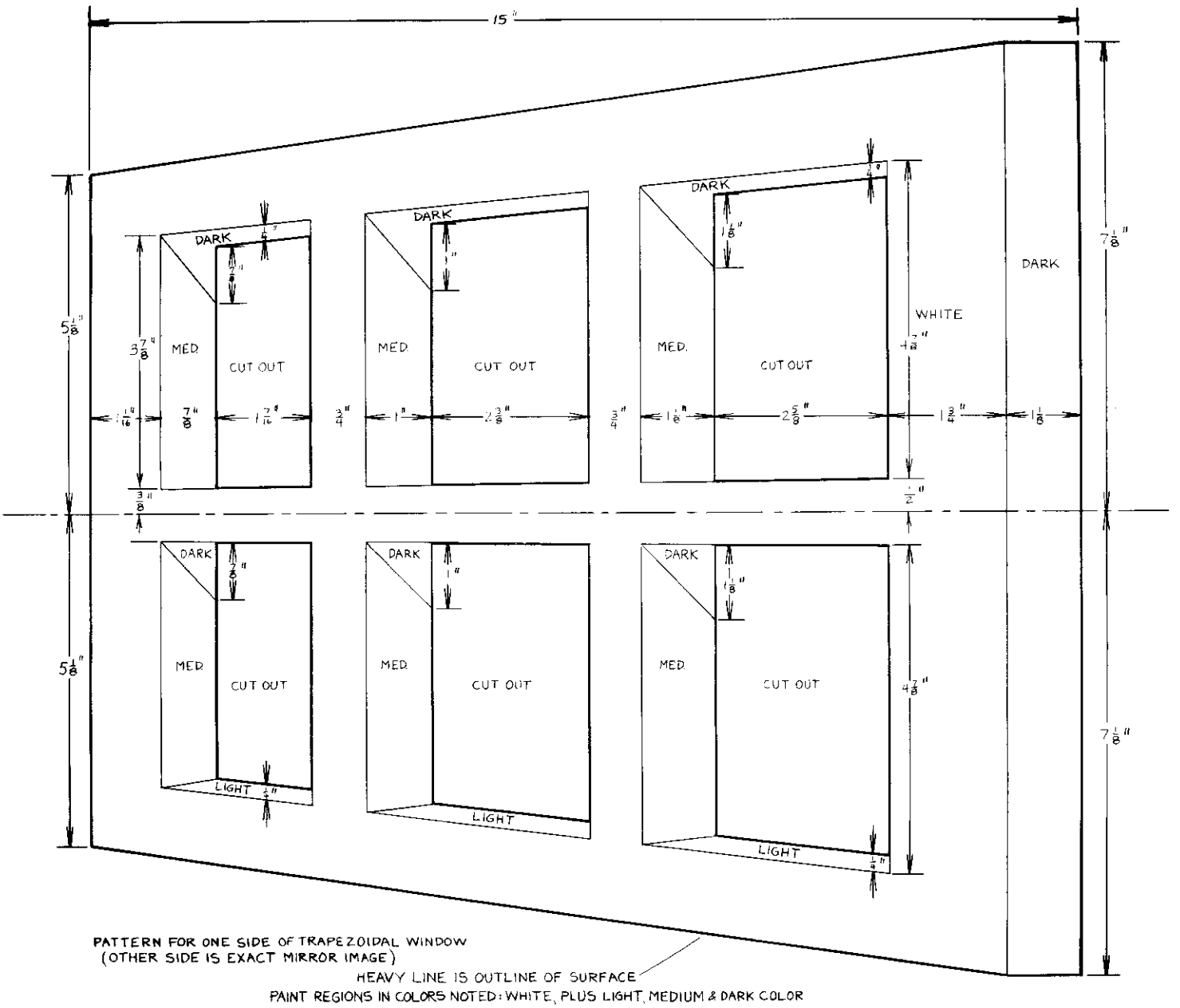


Figure 2 — Pattern for window

Construction

Our window is cut from 3/16" Delrin® or polyvinyl chloride plastic. We found that windows made of Masonite™ were a little too fragile for our museum, where people are encouraged to fiddle with exhibits.

Figure 2 shows the layout for our window; one side is an exact mirror image of the other. To make a good illusion it is important to make both the cutouts and the painted edges straight, sharp, and accurate. We have found that gray paint in the shades noted gives the most convincing window contours, although other colors, even orange, will also work.

Our window is illuminated from 15" above with a 150 watt floodlight. It is important to avoid casting a shadow directly behind the window; it will provide depth cues to the viewer.

The speed at which the window rotates is not critical; 10 rpm works well.

Related Exploratorium Exhibits

AMBIGUOUS OBJECTS

3-D Shadows; Far Out Corners; Impossible Triangle; Multidimensional Shadows; Old Woman or Young Girl?; Reverse Distance; Reverse Masks

SIZE AND CONVERGENCE

Cows; Distorted Room; Glass Camera (Perspective Window Camera); Size and Distance

Exploratorium Exhibit Graphics

Trapezoidal Window

Sometimes you see only what you expect to see.

To do and notice

- Close one eye and watch the rotating window. Notice that the window seems to be swinging back and forth.
- If you walk right up to the window, you will see that it is really going around and around.
- Notice that one vertical edge of the window is shorter than the other. Most windows are rectangles; this window is a trapezoid.

What's going on?

Most windows are rectangles. However, when you look at a rectangular window that is angled away from you, the farther edge of the window appears smaller, and so the whole window appears to be trapezoidal. From past experience, your brain assumes that all windows are rectangular, and that the shorter edge is always the edge farthest away.

But the rotating window in front of you really is a trapezoid. When the shorter edge of this trapezoidal window moves closer to you, your brain refuses to see it as closer; it assumes that the window is now rotating in the opposite direction. The window therefore appears to go back and forth.

Table of Contents for Cookbooks I, II, and III