Exploratorium Cookbook III

A Construction Manual for Exploratorium Exhibits

by Ron Hipschman

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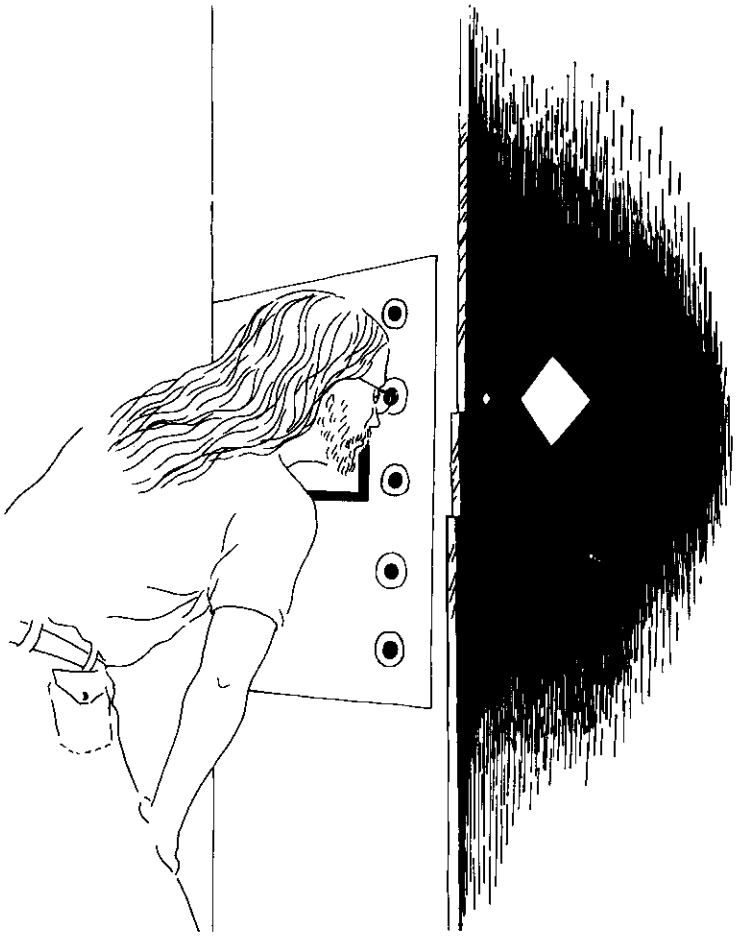
Changing Squares



Description

The visitor looks through a hole in a wall into a darkened room. Inside are two squares that seem to grow and shrink in size. Since the observer is constrained to the use of one eye (monocular vision), it's hard to figure out if the squares are changing in size while remaining at a constant distance or changing distance while staying the same size, or both. By making a conscious decision, the visitor can see it either way.

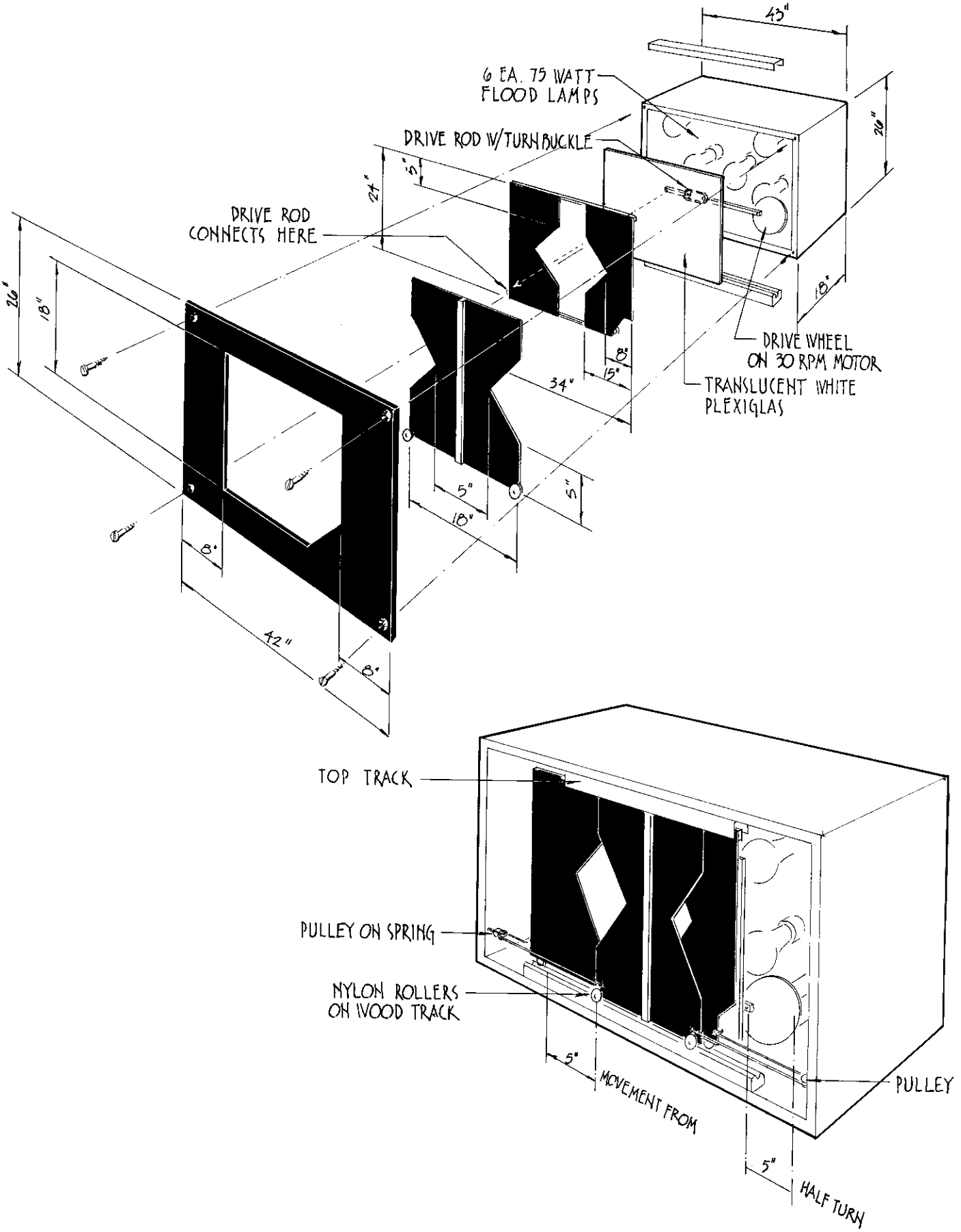
A button on the wall turns on a light in the room revealing the true nature of the device.

Construction

This device works with two thin black panels which are linked together so that they slide from side to side in opposite directions at equal rates. The overlapping panels have complementary right angles cut out of them, such that two square holes are formed that grow and shrink reciprocally (see drawing). Since the panels slide in front of a uniform white rear-lit surface, the effect of the changing squares is pretty dramatic.

The mechanism of this exhibit is housed in a wooden box 43" wide, 26" high, and 18" deep, with a proscenium—18" high and 26" wide—cut in the front for viewing the squares. The front of the box is painted flat black. The squares shrink to 1-1/4" and grow to 8" on a side. To accomplish this, each of the panels slides about 5" back and forth. (This motion is adjustable, as described later.)

The box sits inside a darkened room, 40" off the ground and 6' from the wall through which it is viewed. Visitors stand outside this wall and can look in through one of five eye-holes—each 7/8" in diameter—that are placed at varying viewing heights on the wall. Note that these are single holes meant to be looked through with one eye only—we want to eliminate stereo vision with this exhibit.


43"
6 EA. 75 WATT FLOOD LAMPS
DRIVE ROD W/TURNBUCKLE
20"
24"
5"
DRIVE ROD CONNECTS HERE
26"
18"
18"
8"
15"
34"
DRIVE WHEEL ON 30 RPM MOTOR
TRANSLUCENT WHITE PLEXIGLAS
5"
18"
5"
8"
42"
8"
TOP TRACK
PULLEY ON SPRING
NYLON ROLLERS ON WOOD TRACK
5"
MOVEMENT FROM
PULLEY
5"
HALF TURN

For the illusion to work properly there should not be any visual clues that give away how the squares actually change in size. The panels are made of flat black formica with a thin wooden frame for extra rigidity. We used the formica because we wanted the panels' edges to be invisible, especially where they overlap at the squares' upper and lower corners. The front panel has an hourglass shape with right angles at the "waist." The rear panel, which forms the other half of each square, has two separate pieces of formica held in a thin wooden frame (see diagram). Both panels ride on nylon rollers fastened to their bottom edges; the rollers are attached to the front side of the front panel and to the back of the rear panel, so that the panels can slide face to face as close as possible (ours brush each other as they move).

The panels are linked together with a cord which passes over a pulley at either side of the box, so that if one panel moves to the right, it pulls the other panel an equal distance to the left (the pulley changes the direction). One of the pulleys is attached to the box with a spring—this takes up slack in the system and prevents backlash. A note about the cord: we use the same cord your dentist uses to power his/her drill. This cord, available from dental supply houses, is very strong, very flexible, doesn't stretch, and is extremely durable. We've never had to replace ours. All other types of cable we've tried have failed due to the bending around the pulley. A larger diameter pulley may help if you can't get the dentist cord.

A 30 RPM motor turns a large circular drive wheel which serves as a crank. Attached to this drive wheel is a wooden connecting rod which extends across the box to a pivoting joint on the moving rear panel. As the wheel turns, the rod pushes the rear panel back and forth, and the front panel reciprocates by virtue of the pulleys. Several holes placed at different radii in the drive wheel allow for some adjustment of the amplitude of motion (this adjustment is only done during set-up of the exhibit, and is left fixed once the correct position is found). We've also put a turnbuckle in the middle of the connecting rod to provide for centering adjustment; this centering makes the squares the same size when small or large.

It is important for the background to be uniformly lit. We put a piece of translucent white plexiglas just behind the sliding panels. On the rear of the box we've placed six 75 watt flood lamps, arranged in a squat hexagon and pointing towards the plexiglas. The lamps have household dimmers on them for fine tuning. Be sure to provide some ventilation or substantial heat can build up; the ventilation shouldn't let much light escape, as this might diminish the effect.

We have installed a button on the wall near the viewing holes, which illuminates the sliding panel mechanism with a 75 watt flood lamp. After observing the illusion of the exhibit, the visitor presses the button to see what's really going on in there.

Critique and Speculation

Except for normal light bulb changing, this exhibit is essentially maintenance free. We've put ours in a small dark storage room, a situation that can create conflicts of interest when the stock piles up and blocks the viewing holes in the wall.

Related Exploratorium Exhibits

Size–Distance

Distorted Room; Inverse Square Law; Trapezoidal Window; Wide Eyes; Size & Distance; Cows; Perspective Window Camera; Points of View; Three-D Shadows; After Image; Electric Fish; Eyeballs; Stereo Rule; Moire Patterns; Reverse Distance.

Visual Edge

Gray Step I, II, III; Everyone is You and Me; Grease Spot Photometer; Traffic Illusion; Fading Dot; Rainbow Edges in Your Eye; Cardboard Tube Syllabus; Benham's Disc.

Cues, Dominant

Far-Out Corners; Floating Rings; Horse and Cowboy; Impossible Triangle; Reverse Masks; Trapezoidal Window; Cheshire Cat; Reach for It; Cardboard Tube Syllabus; Gray Step I, II, III, IV.

Depth Perception

Vasarely's Movement Study; Cross Eyes/Wall Eyes; Depth Spinner; DEWA Hologram; Inferno.

Changing Squares

Look through any one of the holes. 

Push button to see what is going on.

Table of Contents for Cookbooks I, II, and III