CUB SCOUT BOOMERANG (BRONZE) TEST 14 – HANDCRAFT
CUB SCOUT BOOMERANG (SILVER) TEST 10 – DISCOVERY

Make a shoe-box camera—we will actually use a tissue box, as these are generally more easily acquired in large numbers than shoe boxes. This is not a camera that can be used to expose film, but rather one that demonstrates the optical principles employed in both our eye and in a camera. While this is a handcraft exercise, it can be used to discuss the function of the eye.

Resources

- Tissue Box
- Black Paper/Card
- White Tissue Paper
- Sticky Tape
- Kebab Skewer
- (100W lamp)
- (Large, black letters)
- (Towel or blanket)

Instructions

1. Mark and cut a hole in the 'small' end of the tissue box. Leave a border of about 15 cm around the edge. Use a sharp knife to cut a slit in the end of the box, then use scissors to cut the rest. To simplify this task, I made up a template (*cf.* Figure 1) out of corrugated cardboard and used this to mark out the square to be cut out of the end of the box. The outside dimensions of the template should be the size of the tissue box, and the inside dimensions those of the hole to be cut out.

    Figure 1
    Viewing Hole Cut-Out Template
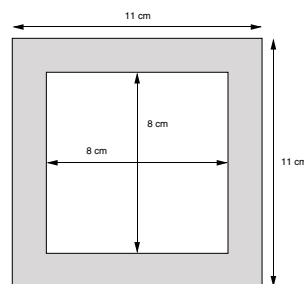
2. Using sticky tape, tape the cover (black paper, card or whatever) over the hole in the top of the tissue box. You will be able to put your hand inside the box, though the hole you have just cut, to help press the sticky tape on;

3. Mark the centre of the end opposite the hole cut in 1. above. An easy way to do this is to draw two diagonal lines, from corner to corner, on the box—the intersection point of these two lines will be the centre;

4. Make a neat hole, ~2 mm, in the centre marked in 3. above. If you are using a metal skewer, or the like, you can probably simply punch it through the cardboard. If you don't have a metal skewer, it is best to make a hole initially with some sharp, fine metal object (a needle, pin or nail) then enlarge it gently with a bamboo skewer, or something of similar diameter;

5. Using sticky tape, tape the piece of tissue paper over the square hole in the end of the tissue box. This should be done as neatly as possible, making every effort to keep the tissue paper flat and taut (without taring it!)—you will get a better image if the paper is not crinkled;

6. Your 'camera' is now ready to use, but we will need a brightly light object to view.

    One way to set up an appropriate object is to hang a rice-paper light shade on a 100W light bulb, and attach some easily recognisable, dark shapes to the outside of the light shade. Since we want to illustrate the fact that the image generated in our tissue box camera is in fact inverted and back-to-front, letters of the alphabet that are different when inverted or back-to-front are a good choice.

    The first time this 'experiment' is carried out, people will not be sure what to expect. Children will often expect to see a perfectly clear, 'full colour' image. If you chance to view an object at just the right distance (we can't focus our tissue box camera, so we just have to take what comes), and in bright light, it can be surprisingly clear, and coloured. In fact, the smaller the hole in the front or your tissue box camera, the clearer will be the image generated. But because the small hole permits less light, the image will then be much fainter and more difficult to see. The ~2 mm hole recommended provides a reasonable compromise between image clarity and visibility.

    Note of course that we have two types of sensors in our eyes: *cones*, which are our colour sensors, and *rods*, which do not detect 'colour' as such but which are more sensitive than the cones. This is why we tend not to be able to perceive the colour of objects in very low light conditions—under these conditions most of our sight is provided by the colour-insensitive rods. Cones also tend to be concentrated in the centre of the retina, while rods are more concentrated on the periphery of the retina, and this is the reason why our peripheral vision tends to be better (although again, largely colour insensitive) than our 'direct' vision under very low light conditions.

    You can actually use the 'camera' to see pretty much anything in sunlight, although it should be remembered that we are not dealing with precision optics here and the image will invariably be a little fuzzy. You will still need a 'hood' over the back of the 'camera' so that your eyes can adjust to the light level of the projected image, which is invariably much lower than the ambient light conditions;

7. The image that appears on the tissue paper back of the 'camera' is only very faint—the light used to project this image, after all, is only that which can pass through the very small hole at the front of the box. In general, it will not be visible if the viewer's eyes are adjusted to normal room lighting (as will usually be the case—they do this for us automatically!). To see the image, you will need to create a 'dark' environment around the viewer's eyes and the back of the 'camera', using something like the black cloth that photographers of old used to drape over their head and camera when lining up a photograph. If you have a large piece of (essentially opaque) black material, well and good, but a towel, or small blanket, or even a jacket draped over the head of the viewer and held closely around the back of the 'camera' will do the trick.

    Remember that the image is projected onto the tissue paper at the back of the 'camera', so that the viewer needs to hold the 'camera' far enough away from their eyes to be able to focus on (something written on) the back of the box.

Resource Preparation

Tissue Box

The size of a box of 200-250 tissues		$0	Recycled

Empty the box!

Paper or Card (black or opaque)

Anything appropriate	~8 cm x 16 cm	$0	Recycled

All that is required here is something to cover over the hole in the top of the tissue box, to stop any light entering (*i.e.* whatever is used needs to be opaque). If you've been really thorough, and saved the piece of the box that was originally taken out of this hole when the box was first opened, that will do just fine! If you are cutting paper or card, you will need a piece around 8 cm x 16 cm to cover the hole in the 'average tissue box'.

Tissue Paper (white)

Anything appropriate	~ 11 cm x 11 cm	$0	Recycled

Cut an 11 cm square, or size to cover the end of the tissue box. The tissue paper (not facial tissues, as were probably originally in the box you are using, but the type used for gift wrapping) should be as light as possible (to allow as much light through to the viewer's eyes as possible, although it must be translucent, not transparent). Some very light weight tissue paper, however, tares very easily, so you need to choose something that can be easily handled by 8-10 year olds. To some extent, you can also iron the creases and crinkles out of used tissue paper—the flatter the tissue paper the clearer will be the image you see in your 'camera', although this is not a critical issue.

Sticky Tape

Any Brand	1/2" – 3/4"	$?/roll	Stationer

Tape suitable for sticking the paper/card cover and tissue paper on the tissue box.

Kebab Skewer

Any Brand/Type	~2 mm dia.	$?/100	?

All that is required is something to make a neat, round hole, about 2 mm diameter, in the tissue box. A bamboo skewer is not usually strong enough to make such a hole 'from scratch'—I made a small hole with the end of a (circle drawing) compass (or pair of dividers), then simply enlarged this with a bamboo skewer, but you could simply make the hole with an appropriate metal skewer.

Light Bulb, Lead and Light Shade

Any brand/Pearl	100W	$?	Hardware Store
Lead Lamp or similar	as required	$0	Borrowed
Rice-paper Light Shade	~55 cm	$0	Borrowed

All that is required is a relatively bright light source to illuminate some easily recognisable object. I used a rice-paper light shade (50-60 cm dia), around a 100W light bulb in a portable lamp lead, and stuck large (paper) letters on the outside.

Large Letters

I simply printed the letters "C", "U" & "B" (Helvetica, 500pt, bold), on a laser printer and cut them out. I then used a few pieces of sticky tape to attach the letters to the light shade. The black letters on the backing of the bright light shade were then very easy to see, and the viewer could quickly recognise the fact that the letters were upside down and reversed, when viewed through the 'camera'.

Towel or blanket

All that is really required here is something to create a 'dark' environment around the viewer's eyes and the back or the 'camera'.

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