



HOW TO BUILD A HOVERCRAFT

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Amazing DIY Science Projects



STEPHEN VOLTZ AND FRITZ GROBE

a.k.a. the Coke and Mentos Guys



08 THE SPIDERWEB ILLUSION



Want to magically walk right through a giant spiderweb without it touching you? This fun trick lets you create a video that shows you standing behind a web made of tape that stretches across a doorway. When you walk forward, you appear to melt right through the tape until you're suddenly standing in front of the web!

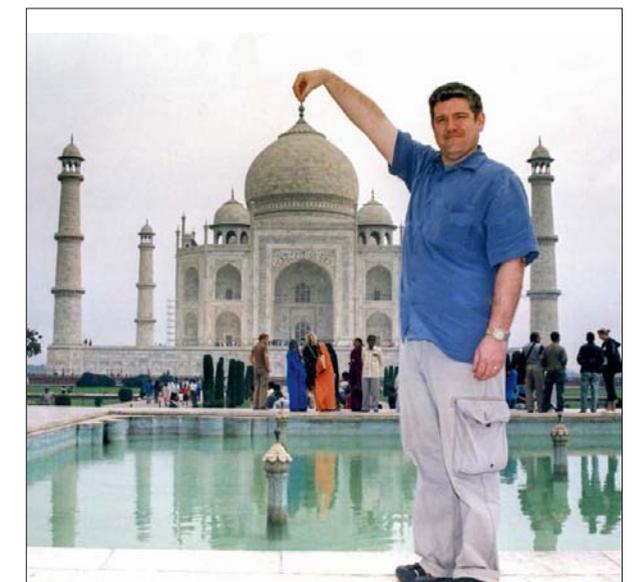
HOW DOES IT WORK?

Two-dimensional images like videos flatten three-dimensional reality and force our brain to make some guesses about what we're looking at. As we saw with *The Face that Follows* (page 12), our brain can misinterpret what it sees. In particular, we guess at how big objects in a two-dimensional image are, based on things like how much space they take up in the image and what context they appear in.

Because of this, our brain can be deceived. Peter Jackson's *Lord of the Rings* movies do this a lot. He films in a way that tricks us into thinking that all those adult actors playing hobbits are much smaller than they actually are. This optical illusion is called *forced perspective*.

With the right camera angle and the right alignment of objects, the enormous Taj Mahal can be made to appear small enough for someone to simply reach out and touch the top.

Here, you use the technique of forced perspective to make an image that looks like a spiderweb stretched across a doorway. Actually, it's two separate webs that only look like one.



THE EXPERIMENT: THE SPIDERWEB ILLUSION

This illusion requires a doorway with enough space on one side for the video camera to capture the entire doorway in the image. For the photos in this book, we used a double doorway to make the illusion bigger, but a single doorway will work as well. This project also requires two people: one person builds the web while the other looks through the video camera and guides the web builder.

MATERIALS

- 1 roll of masking tape (blue painter's tape works particularly well)

TOOLS

- a video camera on a tripod
- a ladder or step stool (to reach the top of the door frame)
- 2 small lamps (to adjust the lighting of your video)

HOW TO BUILD IT

STEP ONE: Position the camera on the tripod at an angle to the door and off to the right of the door so that the entire doorway appears in the image. The photo shows a good position for the camera. Once you've got the camera in position, don't move it or adjust the zoom. It must remain fixed in place from now on.

NOTE: It doesn't matter on which side of the doorway you place the camera. However, if you put your camera to the left of the door, reverse the directions listed below (that is, left becomes right, and right becomes left). Further, remember that all the directions we give below are from the point of view of the camera. So when we say "left," we mean left from the perspective of the person behind the camera looking at the door.

STEP TWO: Start making the masking tape web with 3 pieces: 1 connects from the center of the door frame straight down to the floor, and 2 connect from the center of the door frame to the top corners of the door frame, so that it looks like you're making a peace sign.

STEP THREE: Now fill in just the right side and the top of the web, running more strips out from the center of the web to the door frame and then connecting them with short strips of tape going around the web.

HERE'S WHAT THE CAMERA WILL SEE.



HERE'S WHAT YOU'RE ACTUALLY GOING TO BUILD.



STEP FOUR: Now here's the tricky part. You're going to run strips of tape along the wall beyond and behind the door frame so that, from the point of view of the camera, it looks like you're completing the web. This is easiest if there's a wall running back behind the left side of the doorway (as there is in the pictures), but if there isn't, you can position some furniture behind the doorway so that you can connect the tape to the furniture.

Start by attaching a long piece of tape to the left side of the door frame and have one person (the builder) hold it back in the room near the wall (or furniture). The other person (the guide) will look through the camera's viewfinder and tell the builder to move the tape up or down until it looks like it goes right to the center of the web.

Because the far end of the tape is farther away from the camera than the rest of the tape, that end of the tape will look too skinny to the camera. So layer a second (and if necessary, a third) long piece of tape from the same starting point on the door frame to a slightly higher and/or lower end point. This "fattens" the width of the tape on a progressive angle, but in the viewfinder, this will make the tape appear to be the same width for its length. Again, the guide looks through the viewfinder and directs the builder on how to position the tape to achieve this effect.



THE SCIENCE



STEP FIVE: In the same manner, continue to fill in the lower left part of the spiderweb along the wall, with the guide directing the builder to position each piece of tape. As before, each web “strand” will actually be made of multiple strips of tape that fatten the far ends so that they look like the same thickness in the viewfinder.

STEP SIX: Once the web looks right in the viewfinder, use the 2 lamps to adjust the lighting, which should be as even as possible across the entire web. If one part looks significantly brighter or darker than the other, that weakens the illusion. We find it works well to have one light shining on the web in the door frame and one light behind shining on the web that stretches behind the door frame.

STEP SEVEN: Press record! You’re ready to have fun with your web illusion and capture it on video to show your friends. Film yourselves walking through it and tossing things back and forth. What else can you think of? Once you’ve got your video, see if your friends can figure out how you did it!

Forced perspective is a great way to make a toy dinosaur look like it’s attacking you or to make you look as tall as a building. How does it work? It’s all because a camera has only one “eye,” and we have two.

Our two eyes give us slightly different views of the world, which, as mentioned in the Face that Follows, helps us judge depth. Movies in 3-D send each eye a slightly different image, which mimics the way our eyes work in the three-dimensional world, but a regular camera has just a single point of view, and everything it sees might just as well exist on the same flat plane. The “binocular vision” of our eyes can help discern, for example, that a tree is far behind a person, but the two-dimensional image a camera produces can make it look like the tree is growing right out of the person’s head.

Most of the time, two-dimensional images work well. Our brains use experience and other cues to judge the relative depth and the relationship of objects to each other, yet when objects line up in particular ways, our brains are fooled and it can look as though someone’s fingertips are touching the top of the Taj Mahal.

To create the forced perspective illusion, we need two important components. First, we need to align separate objects in such a way that they seem to be relating to each other. Second, we need to remove all the clues that contradict the illusion. (For instance, if two objects are lit differently, that can be a giveaway.)

In *The Lord of the Rings*, Peter Jackson put Elijah Wood, who played the small hobbit Frodo, farther away

from the camera than Ian McKellen, who played the normal-sized wizard Gandalf. But if that’s all he had done, Frodo would have just appeared farther away, so Jackson reinforced the illusion in other ways, such as by placing an oversized mug next to Frodo and a similar but much smaller one next to Gandalf. He also worked hard to make it appear that the actors were looking right at each other, even though they were actually too far apart to do so. Equally important in this kind of illusion are things we don’t see, such as the floor. If we saw the big expanse of floor between the Wood and McKellen, we would instantly realize how far apart they were.

Want to try your own version of this trick? Here’s a simple one. Record a video of one person pretending to push a box while another *giant* person stands behind watching. All you need are a few boxes and a video camera. Line everything up just right, and what the camera sees is this:

Here’s a photo of what you’re actually doing, and the real position of each person:

Don’t show the floor. That would break the illusion. Experiment with forced perspective and see what else you can come up with!



For more ideas, videos, and variations, visit www.eepybird.com/experiments/spiderweb.



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