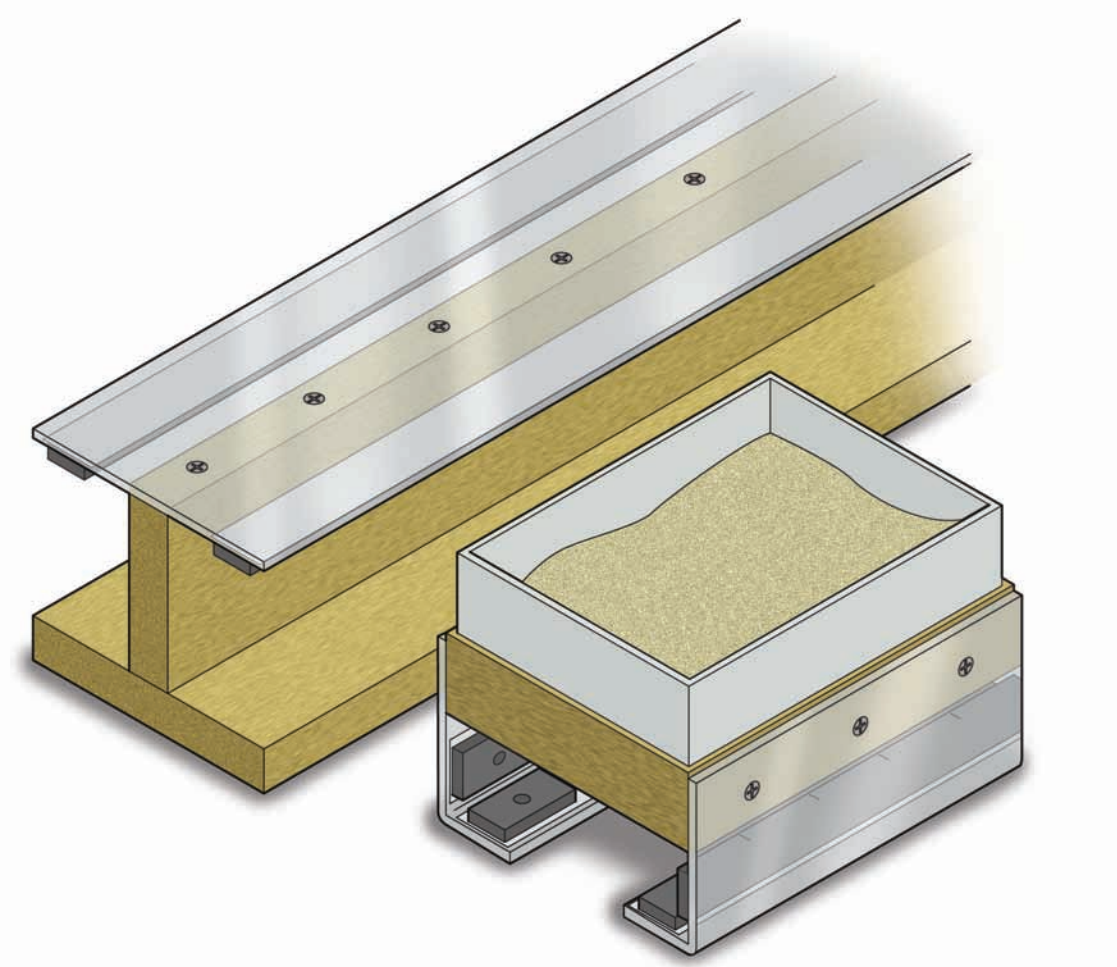
Project #5: MAKE A WORKING MAGLEV MODEL

ONLINE EXCLUSIVE

Don't live in Shanghai and can't wait another 10 years to see a maglev in operation? Enlist a group of friends — or even your whole class — to make a working maglev model with an armload of items found in most hardware stores.

This maglev model accurately reproduces the setup of magnets used in Shanghai's maglev system and is made up of two parts: the train and the track. Much like a full-sized maglev system, the track and train need to be precisely matched to work: At every step in this project, look to see if lines are straight and magnets are evenly spaced.



YOU WILL NEED

- 1 m (3 ft.) of one-by-six lumber, planed
- 1 m (3 ft.) of one-by-four lumber, planed
- 1 strip of clear Lexan (polycarbonate), 7 cm x 90 cm (2-3/4 in. x 35 in.)
- an electric drill with a countersink bit
- nine 2.5 cm (1 in.) wood screws with flat heads
- fifteen 2.5 cm (1 in.) brass wood screws with flat heads
- a roll of double-sided tape
- approximately eighty-six 2.5 cm (1 in.) long latch magnets
- 2 rectangles of Lexan (polycarbonate), 7 cm x 10 cm (2-3/4 in. x 4 in.)
- small, wide plastic container, sand,
- scraps of balsa wood, corrugated plastic board or another flat, smooth material

Train-building tip

It is best to have your lumber and Lexan cut to size at the hardware store (see Part I, Step 1). Lexan is a hard durable plastic and may be difficult to manipulate by hand. If possible, have your Lexan bent to shape at the hardware store (see Part 3, Step 1). Your school shop teacher or a local roofer might also be of help when working with this material.

A Note on Safety

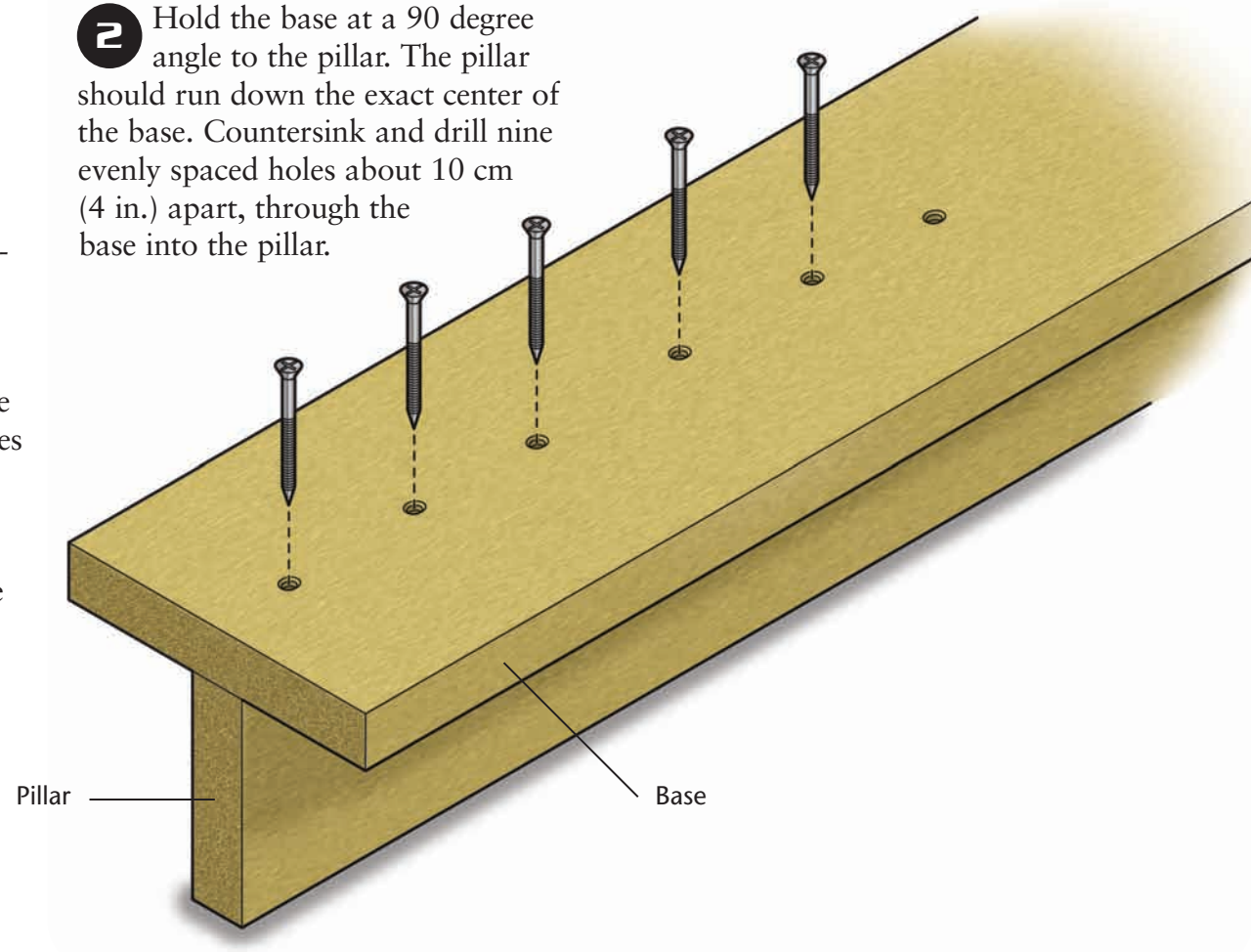
This activity requires many steps, but the results are worth the effort. For safety, enlist an adult's help to build each piece of the experiment. Be sure to wear protective eyewear whenever cutting or drilling into heavy material. And when it comes to using power tools, be smart: Let your friendly neighborhood adult do the work while you supervise!

INSTRUCTIONS

Part 1: Building the base

1 The widest piece of lumber (one-by-six) will make up the base of your track system, and the narrower piece of lumber (one-by-four) will be the pillar. The strip of Lexan will serve as the top of your track. All three pieces should be the same length before you start assembling the track. Here, the lumber has been cut to 90 cm (35 in.). The remaining lengths of wood will be used to make the train.

2 Hold the base at a 90 degree angle to the pillar. The pillar should run down the exact center of the base. Countersink and drill nine evenly spaced holes about 10 cm (4 in.) apart, through the base into the pillar.



3 Screw wood screws into the base. Start at each end of the base. Push or pull the pillar until it makes a straight line down the center of the base, then screw in the middle screw. Drill in the remaining screws, firmly attaching the pillar to the base.

Part 2: Building the track

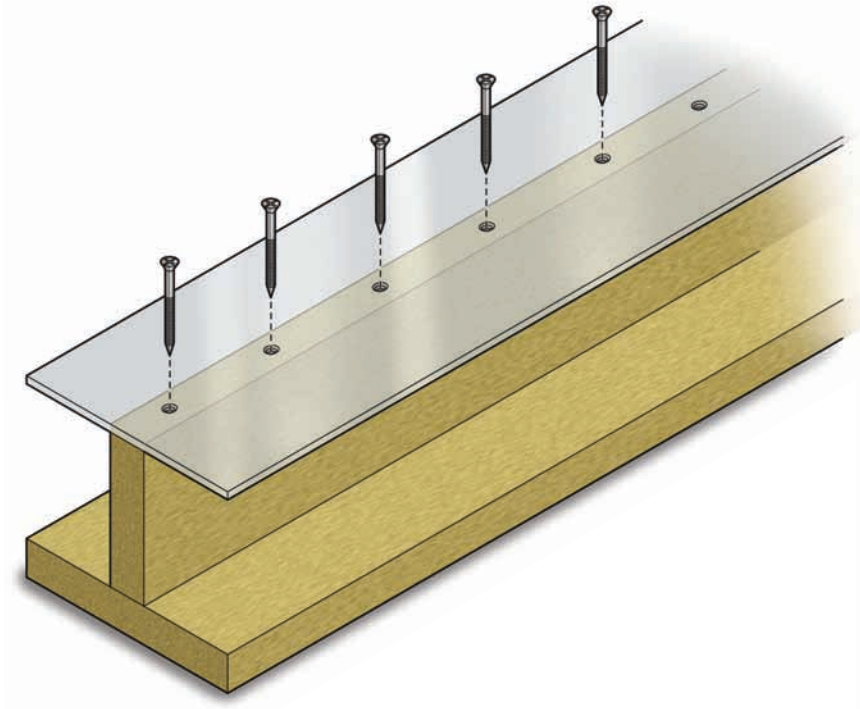
1. Countersink nine holes down the center of the long Lexan strip, spacing them about 10 cm (4 in.) apart. Lay the Lexan strip on top of the pillar; it should be the same length as the pillar. Using the countersinks as a guide, drill nine holes into the pillar.

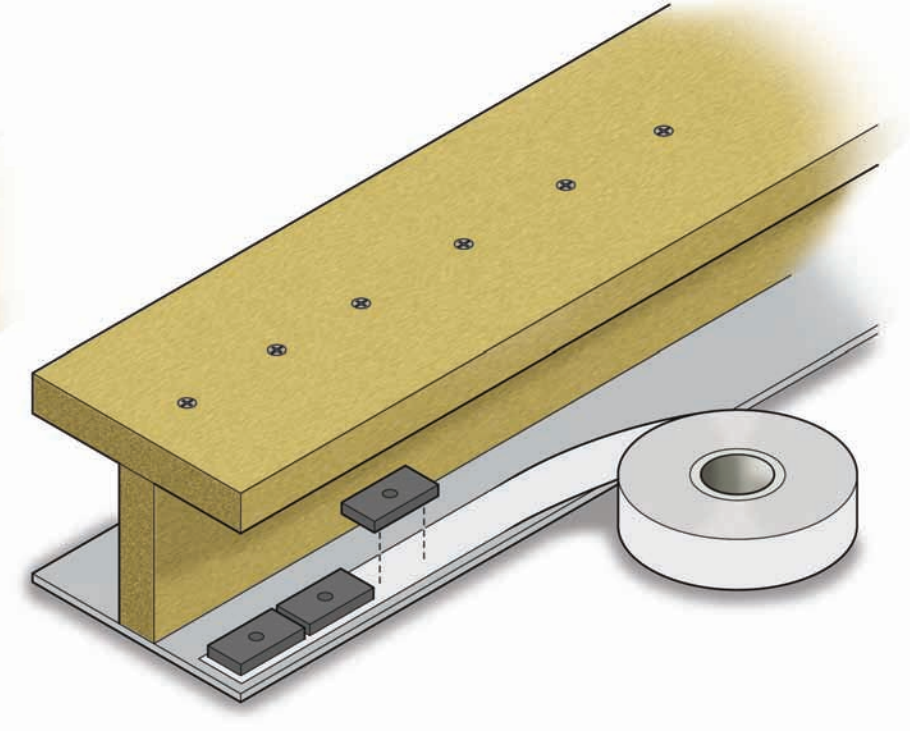
2. Screw the Lexan onto the pillar with brass wood screws. This is your track. The heads of the screws must sit below the surface of the track.

3. Flip your track over. You are now looking at the underside of the Lexan part of the track. Stick a strip of double-sided tape down both the long edges of the Lexan track. If your double-sided tape is wider than the latch magnets laid lengthwise, cut it to fit. Carefully pull off the tape backing.

4. Here's where you install the magnets. Remember, you want the magnets on the underside of the track to attract the magnets on the train, so be sure the polarity of each magnet you lay down is facing the same way. Keep a "test magnet" on hand to check the polarity of each latch magnet before you line it up lengthwise on the tape. Because you're lining up magnets of similar polarity, the magnets will resist touching each other. Don't let them resist! Press them firmly onto the tape.

5. Now test your track by running your "test magnet" down each of the two sides of the track. It should slide along, stuck the same way to both sides of the track.



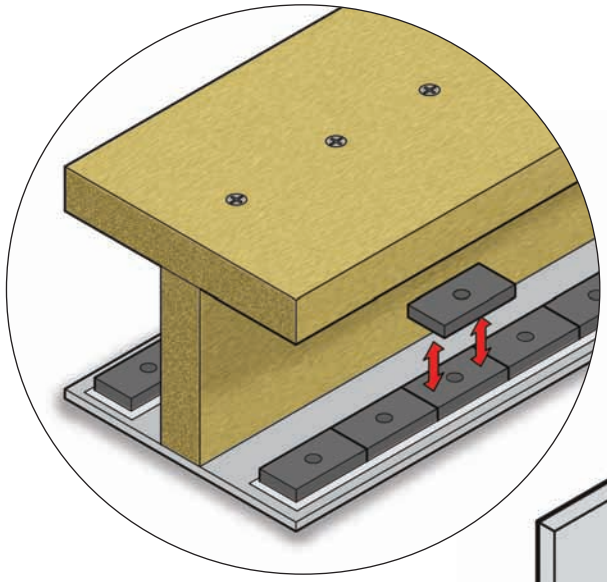


Part 3: Building the train

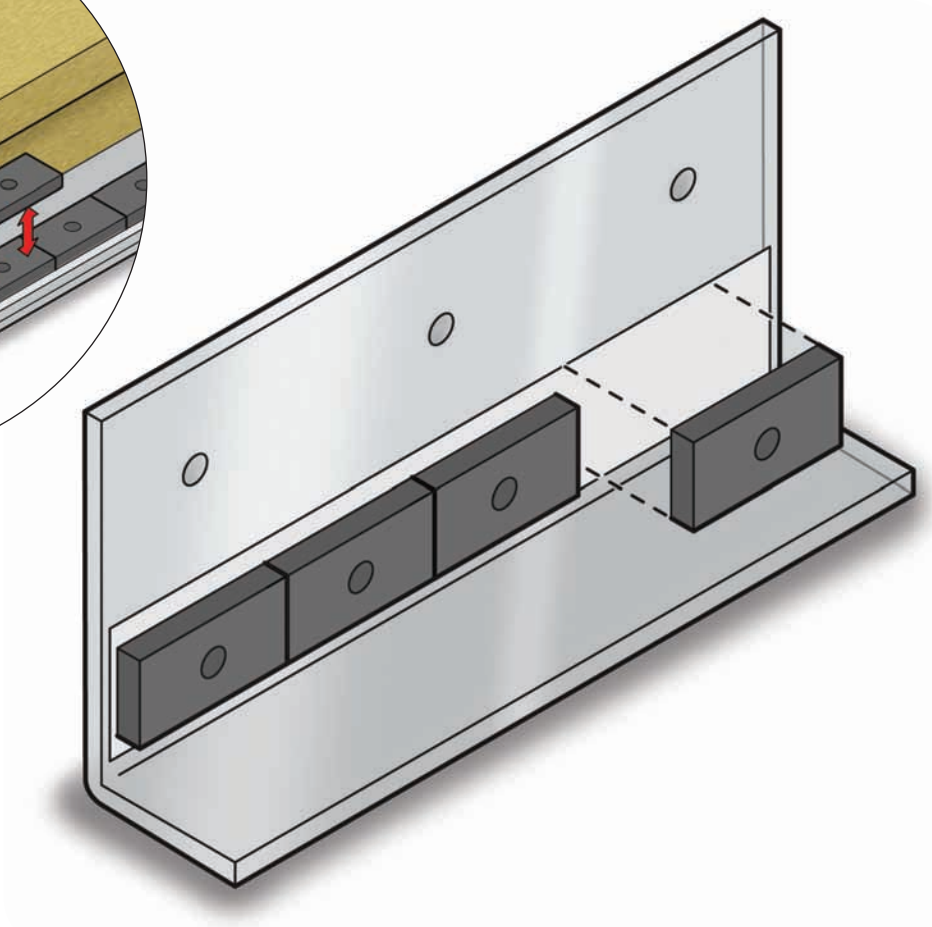
Now that you've become an expert at laying the tracks of the future, it's time to build the train of the future. In order to make your maglev train, you'll need to use more of the materials listed on the first page.

1 You should have two identical rectangles of Lexan measuring 7 cm x 10 cm (2-3/4 in. x 4 in.). Bend one third of each rectangle lengthwise on the edge of a firm surface, such as a tabletop. You now have two L-shaped brackets.

2 The long arms of the L-shapes will attach to the wooden body of the train. About 1 cm (1/2 in.) from the top of one "L," countersink three evenly spaced holes along the length of the bracket, drilling from the back of the "L" (the side opposite the short arm).



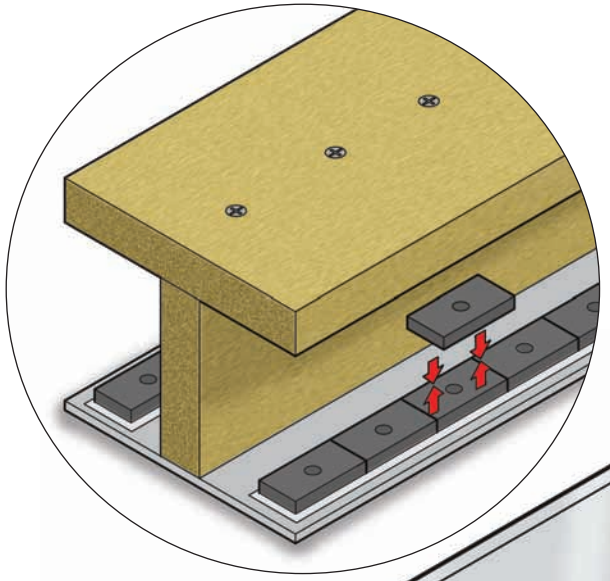
3 Now to install the magnets. Run a line of double-sided tape along the base of the long arm (see illustration). Before laying your latch magnets lengthwise, test the polarity of each magnet: Each magnet should repulse the magnets on the underside of the track. As with a full-scale maglev, these magnets will stabilize your train so it doesn't drift from side to side.

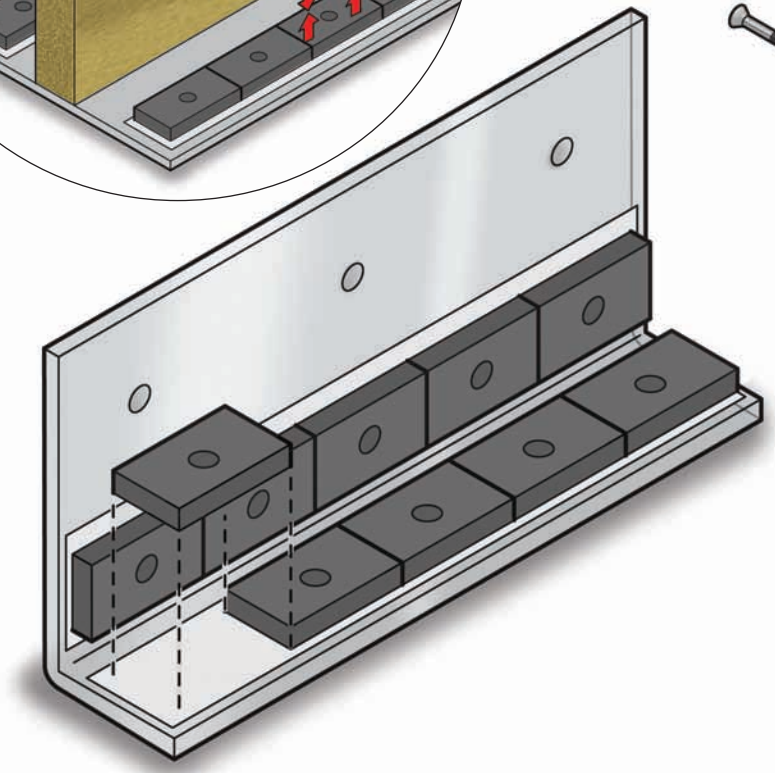


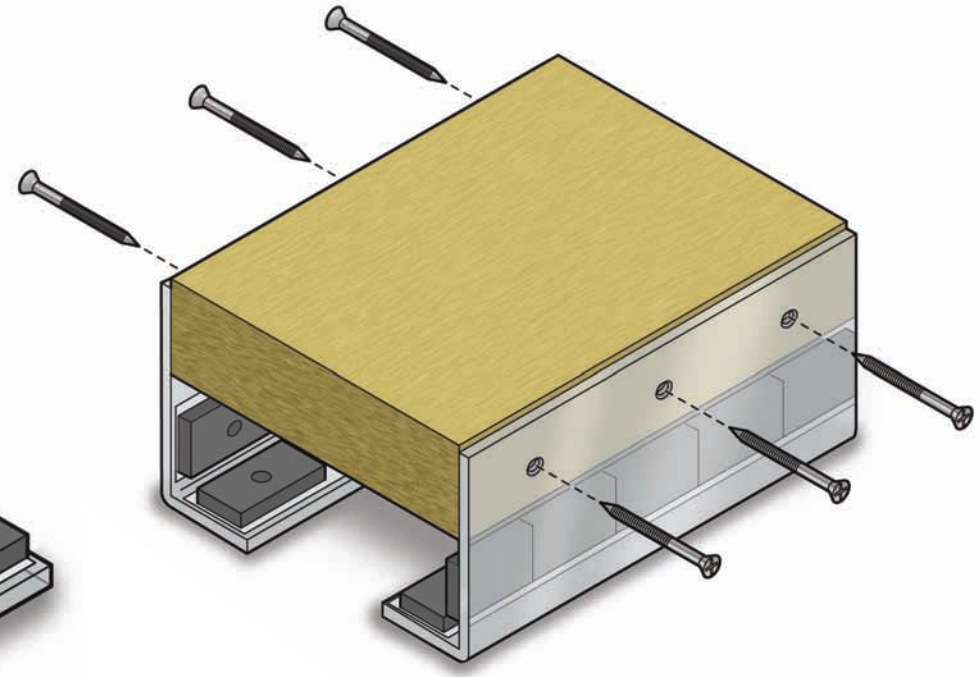
4 Then run a line of double-sided tape along the top of the "shelf" created by the short arm of the L-shape. Leave a small gap to separate the second row of magnets from the first. Again, test the polarity of each magnet before laying it lengthwise: The magnets of the "shelf" of your train should be attracted to the magnets on the underside of the track.

5 Repeat Steps 2 to 4 with the second bracket.

6 With your remaining 10 cm (4 in.) lengths of lumber, cut a block of wood wide enough that — with an L-bracket attached on each side — the magnets on the train line up perfectly below the magnets on the underside of the track. Screw the two L-brackets to the sides of the wooden block using brass wood screws. You're almost finished!

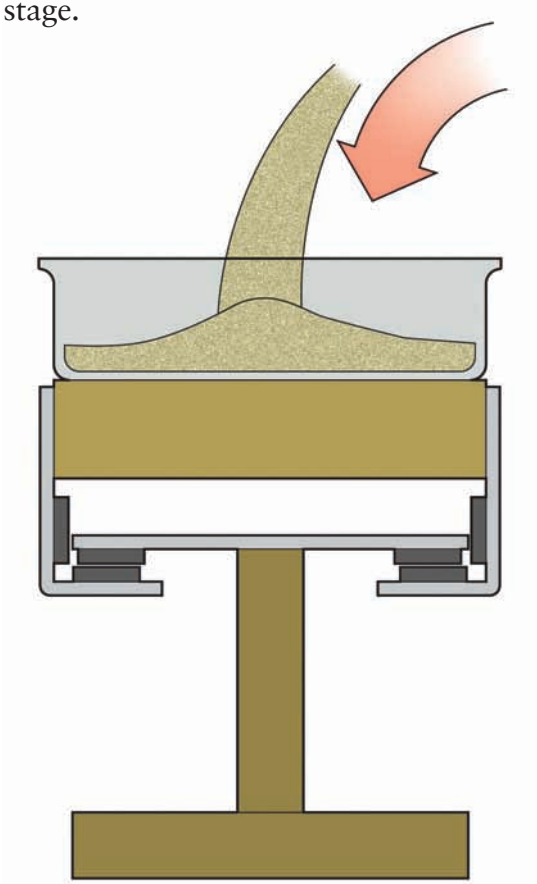




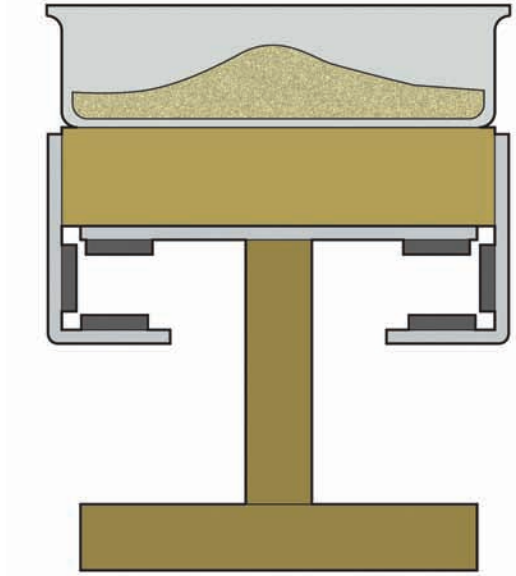


Testing your maglev train

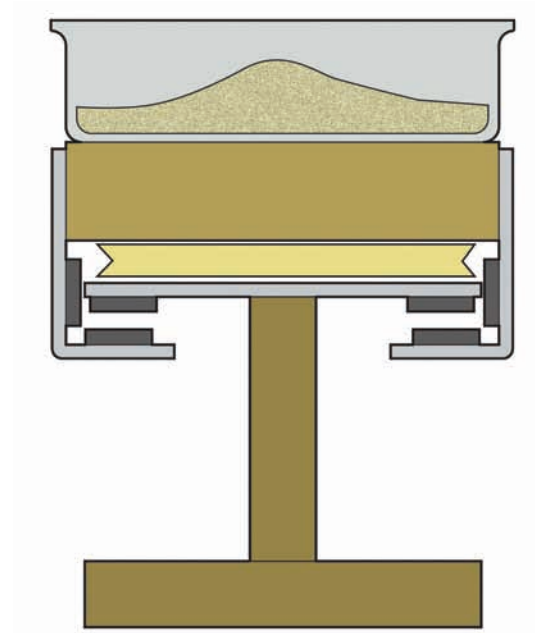
You might have noticed that — unless you are really lucky — your train has a tendency to jump up and "stick" to the tracks before it's able to go anywhere. This is normal and can be fixed at this stage.



1. If your train magnets stick to those of the track, you need to add weight with a low center of gravity to your train. Tape a small, wide plastic container on top of your train and slowly fill it with sand. Keep adding sand until your train just releases from the underside of the track and rests on top of it.



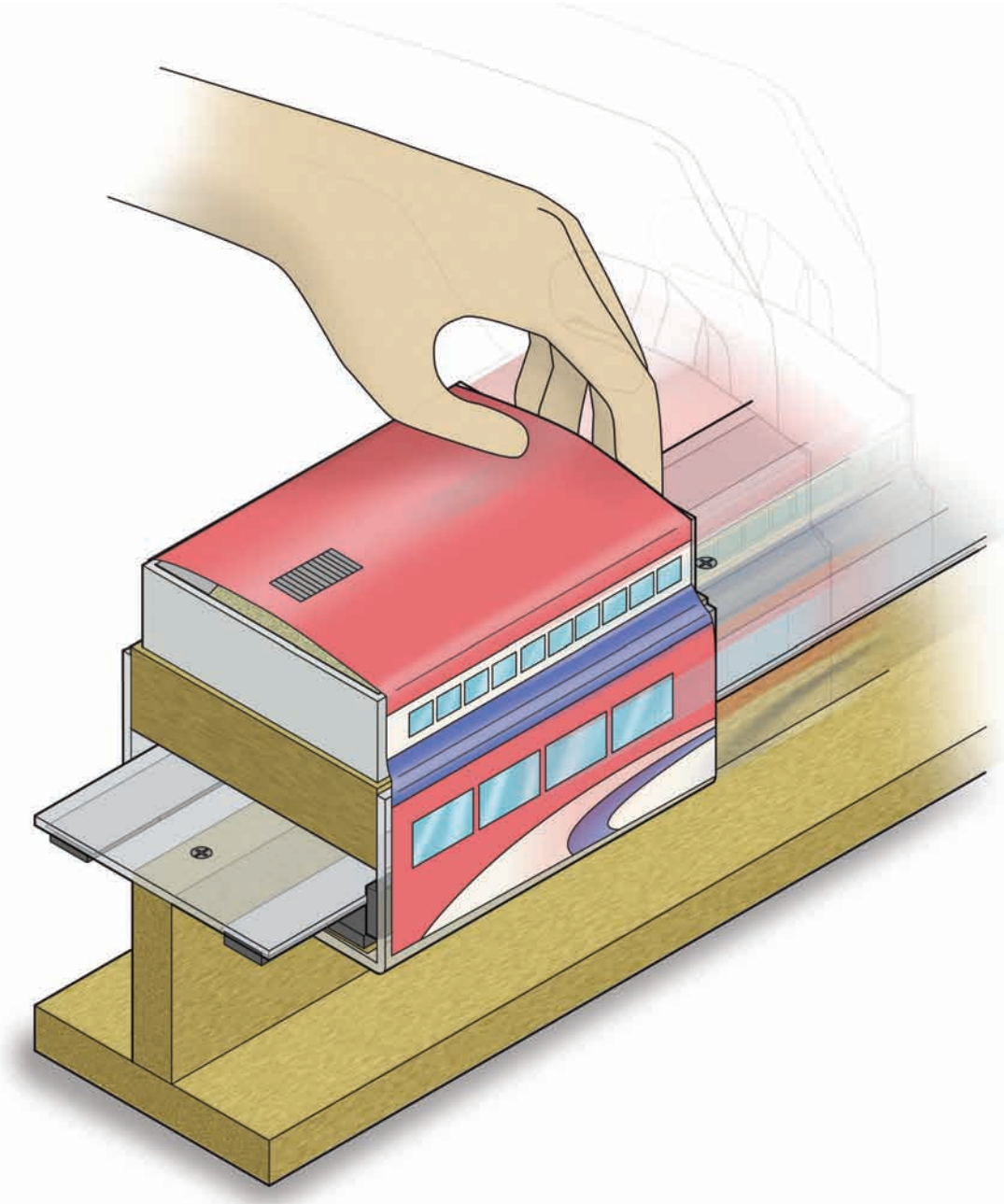
2. At this point, the magnets on the train and track may be too far apart to attract each other. If so, you can tape spacers (thin sheets of balsa wood, corrugated plastic board or another flat, smooth material) to the train's underside to give the body of the train more height and to position the train magnets a bit closer to those of the tracks. (It is easier to bring the train's magnets up toward the track with spacers than to perfectly adjust the train's position with sand.)



3 Continue adding or subtracting sand and spacers until you can get your maglev to "float." The weight must be balanced so that your train hovers between falling away from the magnets and being snatched up by them.

You may not be able to see the space between your train and its track (it may lift by only a fraction of a millimeter), but you will feel the lack of friction when you give your train a firm push from one end of the track to the other.

Congratulations! You've created a working model high-speed railway. All aboard!



Expert Interview

"Maglev trains in use today use computers to turn electromagnetic fields on and off in the right order, many times a second along the tracks. In this model, you can do the same thing without computers by adding and subtracting weights until your model hovers above the rails you'll construct. Believe it or not, the air-gap between a real-life maglev and its tracks is 6 to 10 mm (1/2 in. to 3/8 in.). Your model may have just a small fraction of that gap and still be able to 'levitate.'"
— Laurence Blow, President, MaglevTransport, Inc.