

## Magnetic Sculpture Kit

Build this magnet sculpture and experience the magic of rare earth magnets firsthand. Two powerful NdFeB magnets attract each other making it appear as if the cube on the cord is levitating.



### Step 1: Care and Feeding

This project uses some serious magnets, and with that comes serious potential for damage and injury. Here's the obligatory lecture to help you avoid trouble...

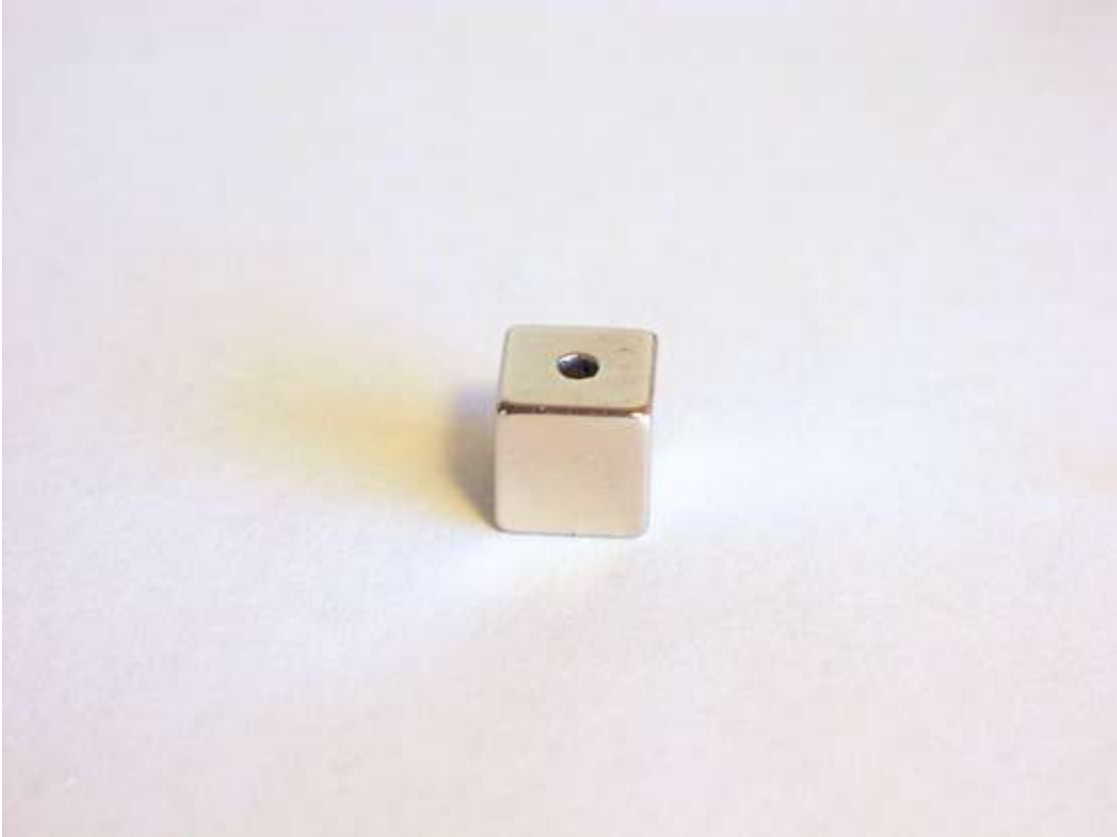
The rare earth magnets used in this project are an alloy of Neodymium, Iron, and Boron (NdFeB). They are very strong, capable of affecting each other from more than 18 inches, but not indestructible. Their protective nickel plating can chip and break through repeated impact, sending fragments flying. Do not machine, drill, heat, or ingest these magnets.

Keep these magnets at least a foot away from all magnetic media, including computers, hard drives, floppy disks, cassette tapes, VHS tapes, and credit cards. Keep them away from consumer electronics, including computer monitors, VCR's, TV's, cameras, cell phones, and personal music devices. Keep them away from things you don't want magnetized, like watches and tools. Keep them away from people with pacemakers or other implants.

Bear in mind that magnets will jump to each other (or anything ferrous) if given a chance. It's better to stick a magnet on something large and stable to keep it out of trouble than to

let it wander around.

These magnets are for use by responsible adults; keep them away from infants and children. Handle with care to avoid being pinched. End of lecture, have fun.



## **Step 2: Parts Needed**

You can gather your own parts for this project or use the kit (shown below) from Make magazine. You'll also need:

- sandpaper (180 & 320 grit)
- wood glue (Titebond)
- wood finishing supplies of your choice
- sharp blade for cutting line (utility knife)
- flame for sealing ends of line
- something non-magnetic to use as a spacer

If you're starting with the kit skip to the next step, otherwise, read on for help getting your parts together. You'll need:

two 1/2" by 5" dowels  
two 3/4" by 1 1/2" by 5" end blocks  
one 1/2" cube magnet, part: CHa500D  
one 1/2" by 1/4" disc magnet, part: D250D  
one 3/32" by 3/8" rivet, part: MS20470AD3-6  
one 1/8" by 3/8" clevis pin, part: MS20392-1C7  
length of 100lb test braided Spectra fishing line

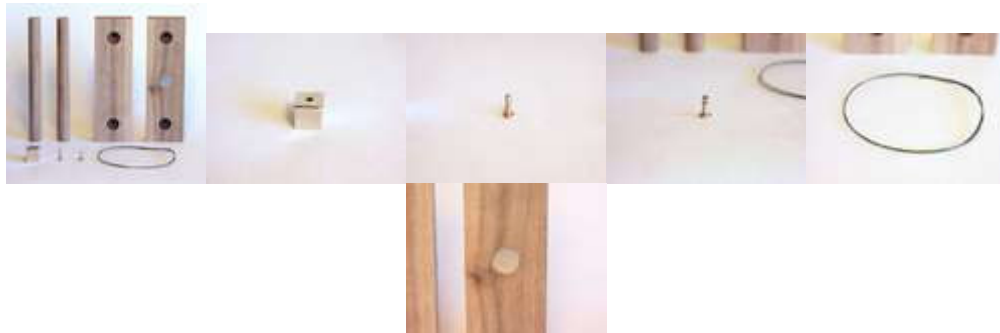
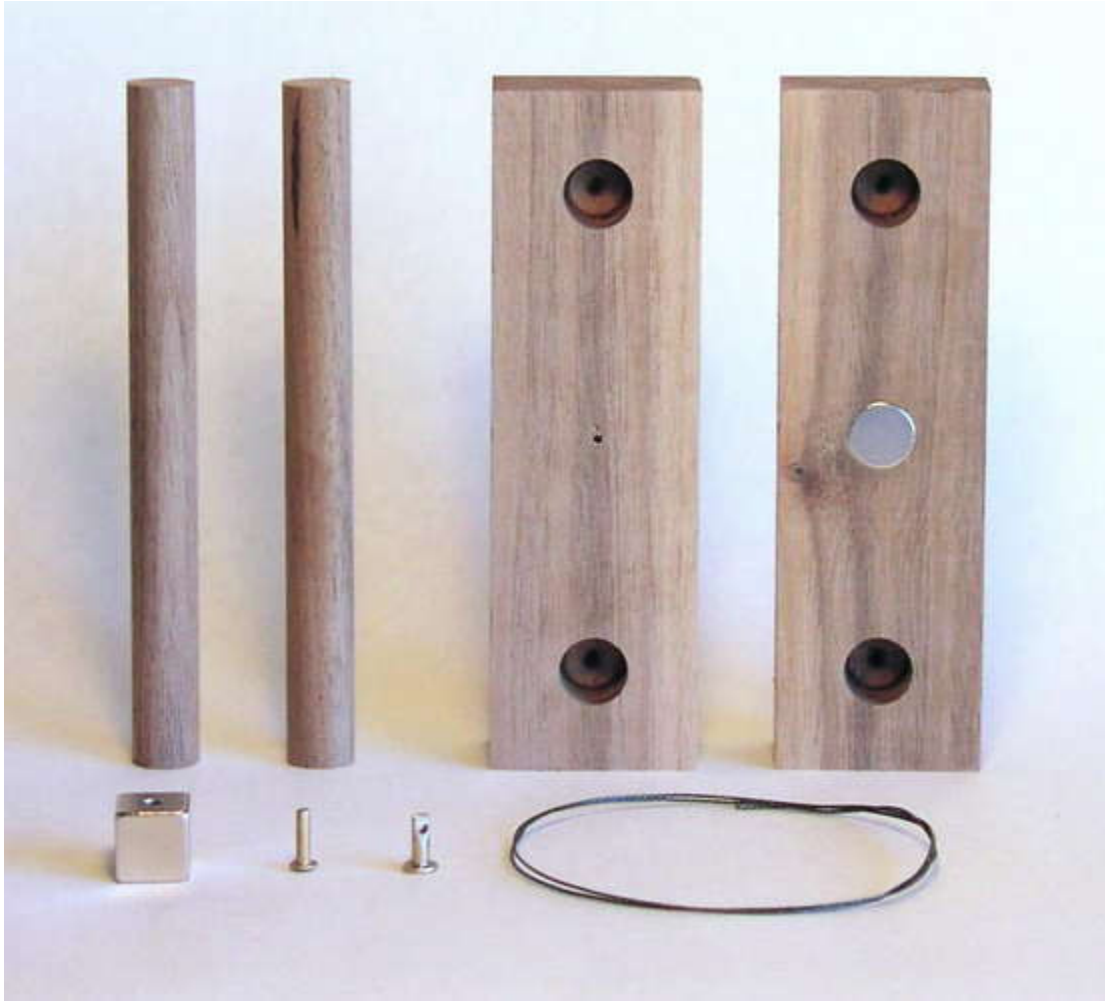
Go to your local big box home supply store for wood. You can use whatever you like, it's nice if the blocks and dowels match, and a hardwood will give you a nicer finished product. Walnut is used in the kit, you'll need to visit a woodworking store to find that.

The magnets are available from Amazing Magnets. Their part numbers are listed.

The rivet and clevis pin are both available from Aircraft part suppliers, such as Wicks Aircraft Supply. You can also check with your local surplus store, they usually have bins of small fasteners that you can search for something suitable. Remove some material from each side of the clevis pin in the area below the hole to provide clearance for the braided line when inserted into the cube magnet.

Spools of braided fishing line are available at sporting goods stores. You may be able to purchase it by the yard from a bait and tackle shop (they keep big spools on hand to load up reels). Spectra line is strong, abrasion-resistant, and has almost zero stretch; properties which make it useful for a lot of things other than fishing (e.g. kite line, r/c sailboat rigging).

Once you've got your pieces rounded up, drill the end blocks about halfway through with holes to receive the dowels. Drill the top block with a 1/2" by 1/4" deep hole for the disc magnet and use some glue to seat it securely. Optionally, drill a slightly undersized 31/64" hole and press-fit the magnet into place. Drill the other block with a 1/16" through-hole for the fishing line. On the side opposite the dowel holes, enlarge the 1/16" hole to within 1/8" of the other side, drill it out barely large enough to accept the body of the rivet with a single strand of fishing line in the hole (should be some resistance). Now enlarge the top of the rivet hole so you can countersink the head when assembled.



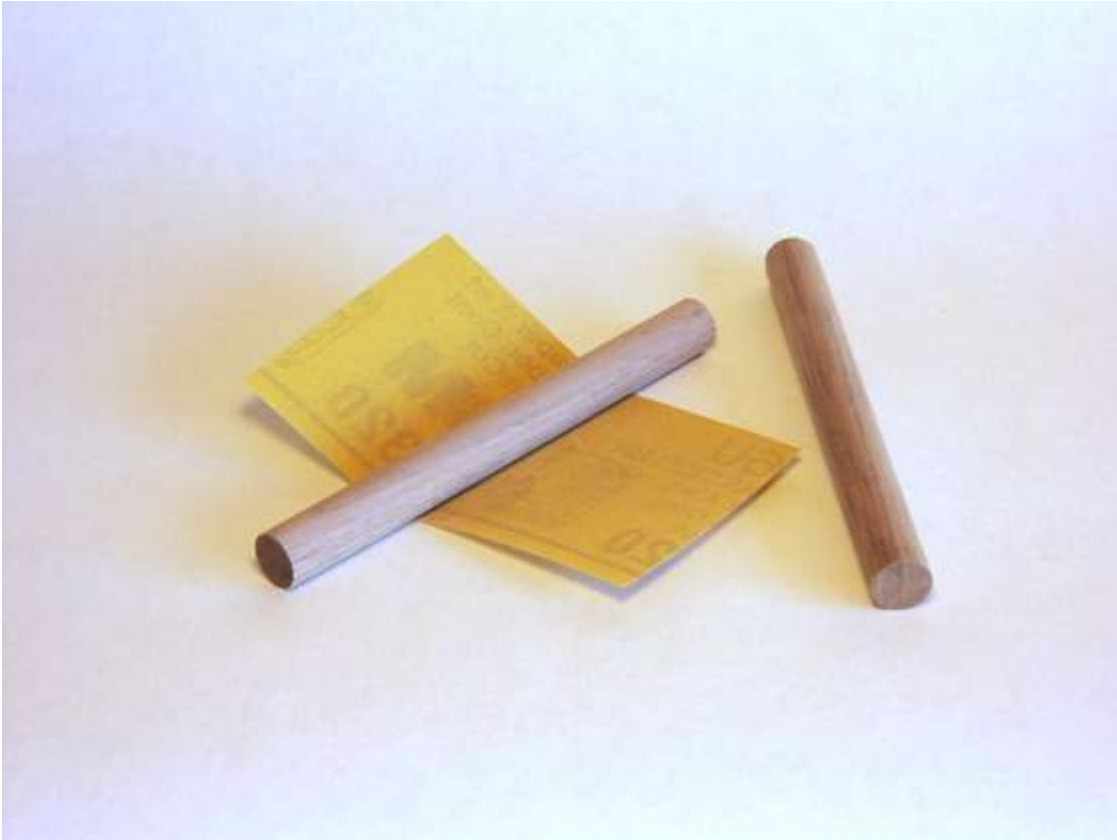
### Step 3: Start by Finishing

It's easiest to finish the parts before they are assembled, so do that first. The degree of finishing is up to you, but a little time invested at this stage will result in a nicer end product. At a minimum, spend a little quality time with a piece of sandpaper to smooth the dowels and blocks.

A good way to keep the flat surfaces of the blocks flat is to tape a piece of sandpaper down on a glass tabletop. Sand with the grain of the wood as much as possible. Start out with 180 grit sandpaper, then move to the finer 320 grit. If you've done a good job on the

blocks you'll have sharp, 90 degree edges, and pointy corners. "Break" each edge and corner by holding the sharp edge/point on the sandpaper and taking a few passes.

Once you've got everything smooth, wipe the pieces down to remove dust and you're ready to apply a finish. Wood finishing is a Big Topic, if you've got a favorite approach, use it here. If not, a simple approach (used for making wooden puzzles) is to dunk the pieces in a 50/50 mix of brushing lacquer and lacquer thinner, then remove them and immediately wipe off the excess. The parts will dry quickly, and then you can rub in a wax finish to add a little shine.



#### **Step 4: Assemble Wood Parts**

Do a test fit to see how all your parts fit. Some joints may be a little snug, but they should fit together without a lot of force. Gentle use of sandpaper on the dowels will convince tight joints to cooperate. Once everything slides together nicely, apply a little glue to the sides of the holes (cotton swab comes in handy here) and slide the dowels into place. Wipe away any excess glue while still wet, let dry.



### **Step 5: Attach Cube Magnet**

The cube magnet is attached to the braided line with a clevis pin. The line is tied through the hole in the clevis pin, and then threaded through the hole in the cube magnet.

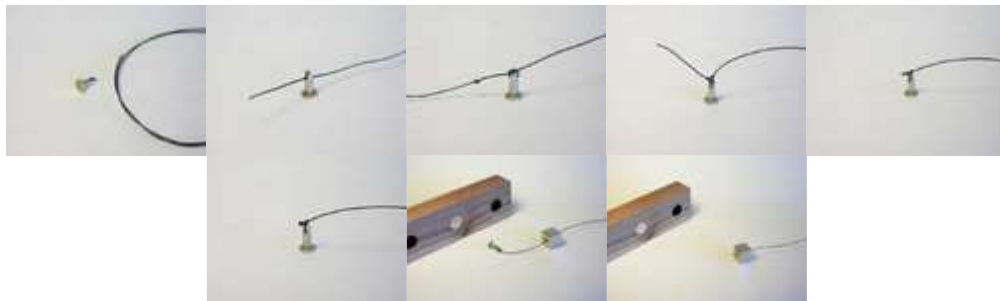
Spectra fishing line is strong and abrasion-resistant, but it's also a little "slippery" for knot tying purposes. We can use that to our advantage, though. Thread one end of the line through the hole in the clevis pin and tie an overhand knot around the end of the clevis. Our goal is to keep the knot small, so it doesn't show beneath the cube, so the overhand knot is a good choice for that. On the other hand, it will slip, and this is slippery line. The solution is to tie another overhand knot on the loose end of the line to act as a stop knot (see series of pictures below).

Pull the stop knot tight, then grasp the clevis pin and pull the other end of the line until the stop knot is pulled up tight against the overhand knot. Now trim the line close to the stop knot and use a flame to melt the new end of the line into a small ball. The ball keeps the stop knot from pulling through, and the stop knot keeps the overhand knot on the clevis from pulling through.

Keeping a firm grip on the cube magnet, determine which end is attracted to the disc magnet. Thread the line through so that the head of the clevis pin will be on that end of the cube.

Once the line is threaded properly, work the knot into the hole in the magnet. Pull on the line to bring the clevis pin's head into contact with the cube, it will stay put once you've got it there. If you need to remove the clevis pin, use a piece of toothpick and push from the end opposite the clevis pin head.

Tip: You can use a permanent marker to color the line black as an alternative to the default green.



## **Step 6: Attach Line to Bottom Block**

This part takes a bit of fiddling. Read through the entire step and look at the pictures before starting so you understand how the pieces relate to one another.

Stand the frame upside down, so you can see the hole in the bottom. Place a non-magnetic spacer (corner of a book, foam packing material) on top of the disc magnet and place the cube magnet on top of the spacer. The spacer will hold the cube away from the disc while you are working on the bottom fastener.

The closer the magnets are, the stronger the attraction will be, but too close and it becomes less obvious that the cube is floating in space. A separation of about 3/4" seems to work well. You're going to need some slack to work with when tying the knot for the bottom fastener, so the spacer should be about 1/4" thicker than the desired separation when finished.

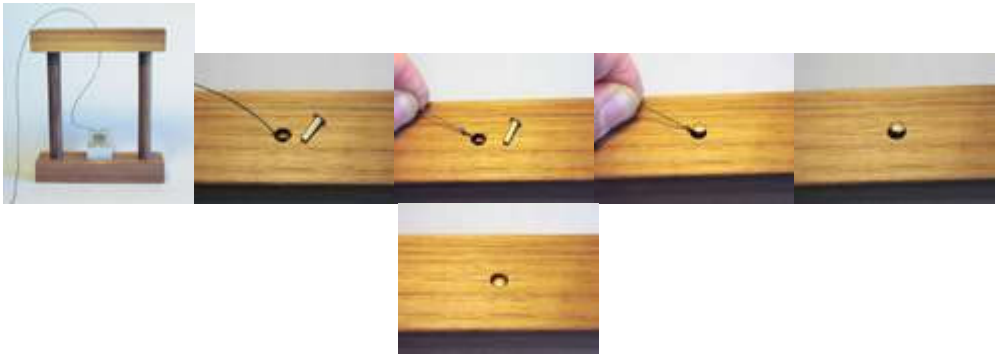
Thread the line upwards from the cube through the hole in the block on top. Pull the line upwards to remove slack, then tie an overhand knot close to the upper surface of the block, about 1/4" from where the line disappears into the small hole.

It's better to tie the knot too far from the hole than too close. If you're too far, you can tie one closer and trim the far one(s) off. If you're too close, you'll have to remove the knot so the line will fit into the hole along with the rivet.

Partially insert the rivet into the hole, leaving the head protruding enough so that the knot can pass underneath to be hidden from view. Grasp the line on the side with the cube and pull the knot down until it jams between the rivet and the rivet's hole. Remove the spacer and check the distance. Adjust spacing to your preference.

Pull the knot out from underneath the head of the rivet, trim the excess line close to the knot, and use a flame to melt the end (as with the knot on the clevis pin). Make sure the rivet hides the line from view, and then push it down until the head is below the surface of the wood. A paper clip comes in handy if you need to push the rivet back out.

Remove the spacer and stand the frame upright.



## Step 7: Done!

Your magnet sculpture is ready for display!

Note: consider the care and feeding suggestions when deciding where your completed project will live. Metal objects nearby (e.g. desk, filing cabinet) can be an attractive hazard.

