

EQUIPMENT BUILD PLAN

SIMPLE MACHINES

Trammel of Archimedes

Two tapered wooden slides run in crossed grooves on a square base, both pinned to a single handle. Turning the handle sends each slide back and forth along its groove, always slipping past the other at the center. It is a satisfying desk toy, an ellipse drawer, and a lever that keeps switching between first class and second class as it turns.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.

What it shows

Crank the handle as fast as you like: the two sliding blocks race toward each other and never collide.

Key ideas: levers, lever classes, ellipses, linkages, mechanisms

Safety (Adult build / supervision).

Cutting the angled slides and plate edges needs a table saw or similar power tool; this is adult work. Use push sticks and guards for the narrow strips.

CONSTRUCTION

Build it



DIFFICULTY	BUILD TIME
Advanced	3-5 hours
COST	SAFETY
About \$15	Adult build / supervision
GOOD FOR	
Makers, Teachers	

Materials

- ☐ **Plywood or board for the base** · About 10 1/2 × 10 1/2 in
Any convenient size works
- ☐ **Hardwood for the four plates** · 4 square pieces
About 3/4 in thick; each about half the base width minus half the slot
- ☐ **Hardwood strip for the slides** · 2 pieces
Same length as one plate; tapered from about 1 in at the bottom to about 1/2 in at the top
- ☐ **Hardwood strip for the handle** · About 14 in
- ☐ **Wooden knob or short dowel** · 1
Handle grip
- ☐ **Wood screws** · About 10
For the plates (from underneath) and the two pivots
- ☐ **Metal washers** · 2
One between each slide and the handle

Tools

Table saw (able to tilt the blade) or router with a dovetail bit

Drill

Screwdriver

Sandpaper

Square and ruler

1

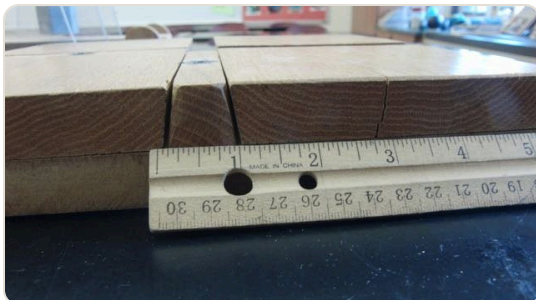
Cut the base

Cut a square base, about 10 1/2 in on a side. The size is flexible; scale everything else to match.

2

Cut the slides

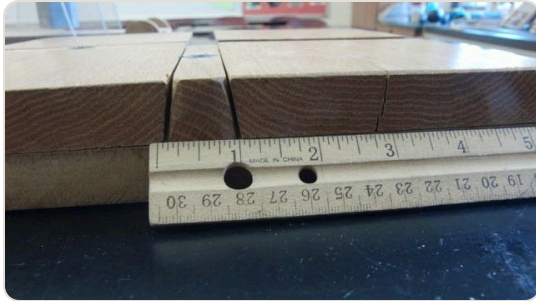
Cut two slides with a tapered (dovetail) cross section, about 1 in wide at the bottom and about 1/2 in wide at the top. Make each the same length as one of the plates.



3

Cut the plates

Cut four square plates. Bevel the two inside edges of each plate at the same angle as the slides, so that neighboring plates form a dovetail groove that traps a slide.



4

Lay out the grooves

Arrange the four plates on the base so they leave two grooves crossing at right angles in the center. Test-fit the slides: they should glide freely without lifting out.



5

Fasten the plates

Screw each plate down from underneath the base, checking the slide fit as you go.

6

Make the handle

Cut the handle about 14 in long. Drill a pivot hole near one end, then a row of holes farther along so you can experiment with different spacings.



7

Add the knob

Fasten a wooden knob to the far end of the handle as a grip.



8

Drill the slides

Drill a hole in the center of each slide for its pivot screw.



9

Attach the slides to the handle

Screw each slide to the handle through a metal washer, one slide at the end hole and the other at one of the row of holes. Leave the screws just loose enough to pivot freely.



10

Test

Place one slide in each groove and turn the handle. Adjust screw tightness and sand any tight spots until it runs smoothly.



THE PHYSICS

How it works

Each slide can only move along its own straight groove. Because both are pinned to the same rigid handle, a fixed distance apart, when one slide reaches the center the other is at its farthest point. They take turns crossing the center, so they never meet.

Every point on the handle traces an ellipse as it turns. The ellipse's two radii are set by how far that point is from each pivot, which is why changing the pivot holes changes the shape of the path. Used with a pencil, the mechanism is called an ellipsograph.

The handle also works as a lever. As it turns, the slides change roles between pivot (fulcrum) and load, so at some moments it acts as a first-class lever (fulcrum between effort and load) and at others as a second-class lever (load between fulcrum and effort).

GO FURTHER

Variations

- Build it larger or smaller; the base size is not critical.

Using it

- Turn it slowly and ask students to explain why the slides never collide.
- Tape a pencil to the knob end over a sheet of paper and draw an ellipse. Change the pivot hole and compare the shapes.
- Pause at different positions and have students identify the fulcrum, effort and load, and the lever class.
- Use it as a puzzle object: what is it for? Bruce admits it does nothing useful, which is half the fun.

- Machines with more than two shuttles exist; Bruce has worked on a six-shuttle version.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

Slides bind or stick

TRY THIS

Sand the tapered faces lightly and rub them with wax or a candle.

IF THIS HAPPENS

Slides lift out of the grooves

TRY THIS

The plate bevels do not match the slide angle or the gap is too wide; reposition or re-cut the plates.

IF THIS HAPPENS

Handle feels sloppy

TRY THIS

Snug the pivot screws slightly; the washers keep the wood from rubbing.

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