11. Hopping Frogs

As the frogs (Figure 11-1) are moved along the floor, they alternately “hop” up and down. Young children have fun pushing the frogs. As a bonus, older children can learn from this toy how a cam and camshaft work.

Figure 11-1. Hopping Frogs Push Toy

Materials and Tools

Following are the lists of parts with their dimensions and the tools required to make this toy. The parts explosion (Figure 11-2) shows how the parts will fit together.

Wood Cut List

Part	Material	Size (thickness, width, length)	Qty
Base	Hardwood	¾" x 4" x 3 ½"	1
Platform	Hardwood	¾" x 1 ½" x 4 ½"	1
Lifter base	Hardwood	½" x ¾" x 3 ⅜"	2
Frogs	Hardwood	¾" x 3 ¼" x 4"	2
Legs	Hardwood	⅜" x ¾" x 2 ¼"	8
Leg connectors	Axle peg	$^{7}/_{32}$"	12
Wheel blank	Baltic birch or hardwood	½" x 4 ½ " x 4 ½"	2
Cams	Dowel	1" diameter x ¾"	2
Axle	Dowel	⅜" diameter x 5 ½" (cut-to-fit)	1
Lifters	Dowel	⅜" diameter x 3 ¾"	2
Push stick	Dowel	½" diameter x 16" to 22"	1
Handle grip	Hardwood	¾" x ¾" x 2 ½"	1
Eyes	Axle peg (optional)	$^{7}/_{32}$"	4

Other Parts

Part	Material	Size	Qty
Paint	Acrylic	Green	
Pen marker	Permanent	Black	
Screw	Dry wall	1 ⅝"	1

Tools required

- Woodworking tools and supplies (see Chapter 2, pp. 14-5)
- Special tools for this toy:
    - Drill bits: $^{11}/_{64}$" or $^{3}/_{16}$", ¼", $^{15}/_{64}$", ⅜", $^{13}/_{32}$", and ½"

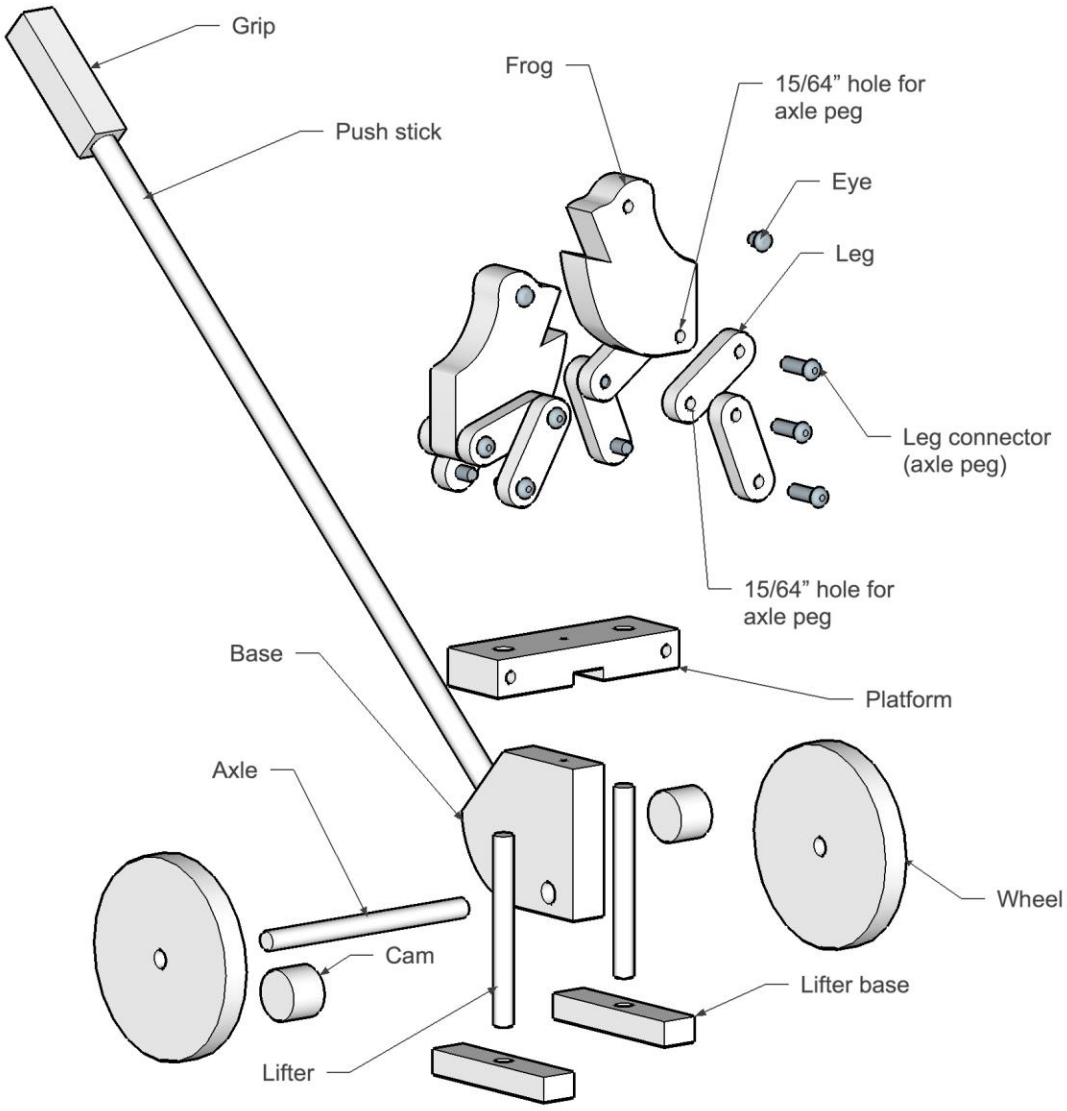


Figure 11-2. Parts Explosion

Plans and Steps

Base

1 – Wood block. Start with a block of wood at least ¾" x 4" x 3 ½". This is larger than the template (Figure 11-3) to allow room to draw the outline of the pattern on the block using the template. The dimensions of the base are given in Figure 11-6.

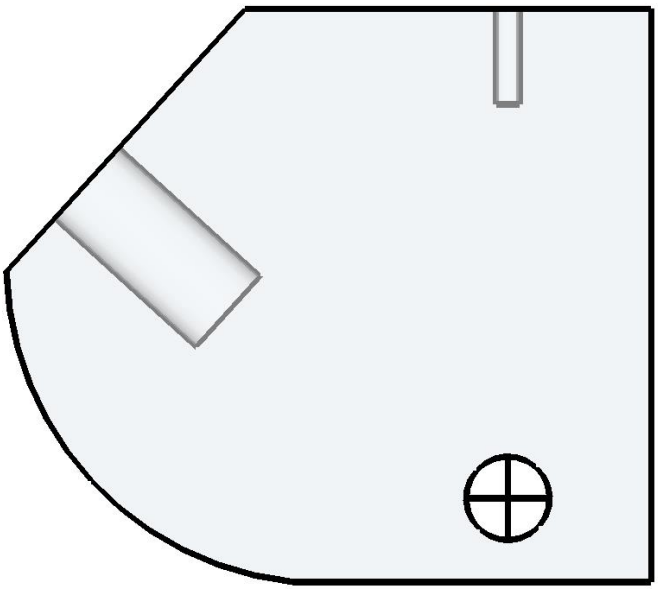


Figure 11-3. Base Template

Warning – Glue Joints and Rotating Holes

Before drilling holes in the base, platform, legs and wheels, review the information in Chapter 2 (pp. 18-9) concerning holes for glue joints and holes for rotating axles.

Router Safety

DO NOT USE a router to round over edges of toy parts **UNLESS** the router is stationary, that is, attached to a router table. See Ch. 18, p. 158.

2 – Axle hole. Drill the $^{13}/_{32}$" axle hole using a drill press if possible. If not keep your drill bit square to the wood.

3 – Shape. Cut the shape slightly proud of the outline. Sand all the edges to the outline, preferably with a stationary power sander.

Round over all the edges except the top with a file and sandpaper to about a ⅛" radius. Or use a stationary router with a ⅛"round over bit.

4 – Holes on edges. See Figure 11-6 for the locations of these holes. Drill a ⅛" diameter hole ¾" from the front edge, centered on the thickness. This is a pilot hole for a screw. Drill a ½" hole 1" deep centered on the thickness of the 45° angled cut for the push stick. Figure 11-4 shows a simple jig that can be constructed for holding the base when drilling the push stick hole.

5 – Sand. Hand sand all surfaces, finishing with 150 grit sandpaper.

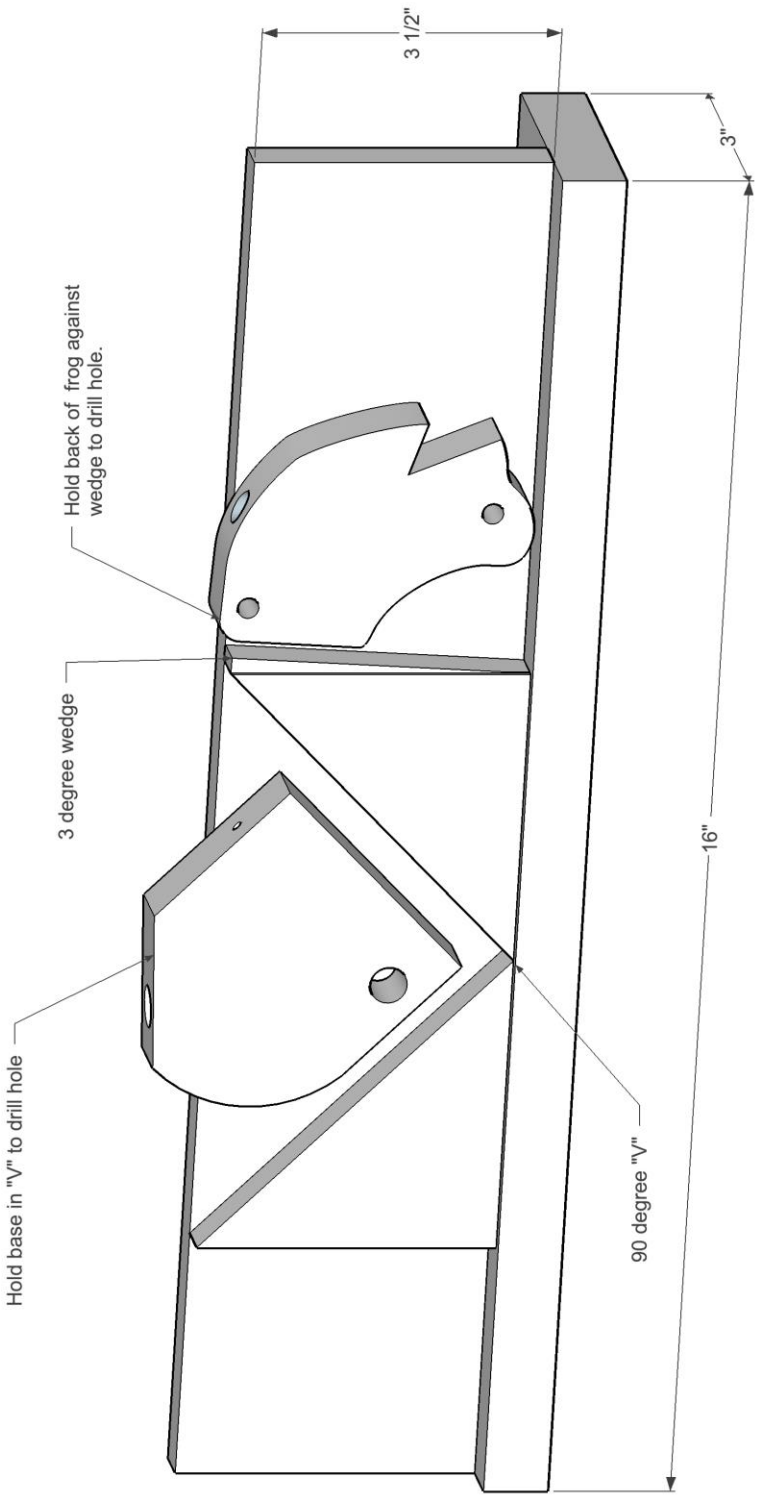


Figure 11-4. Jig for Holding Base and Frogs when Drilling

Platform

1 – Wood blank. Start with a rectangular blank ¾" x 1 ½" x 4 ½". Mark the holes as indicated in Figure 11-5 using a scratch awl or small nail. There are three holes on the top and four on the long edges.

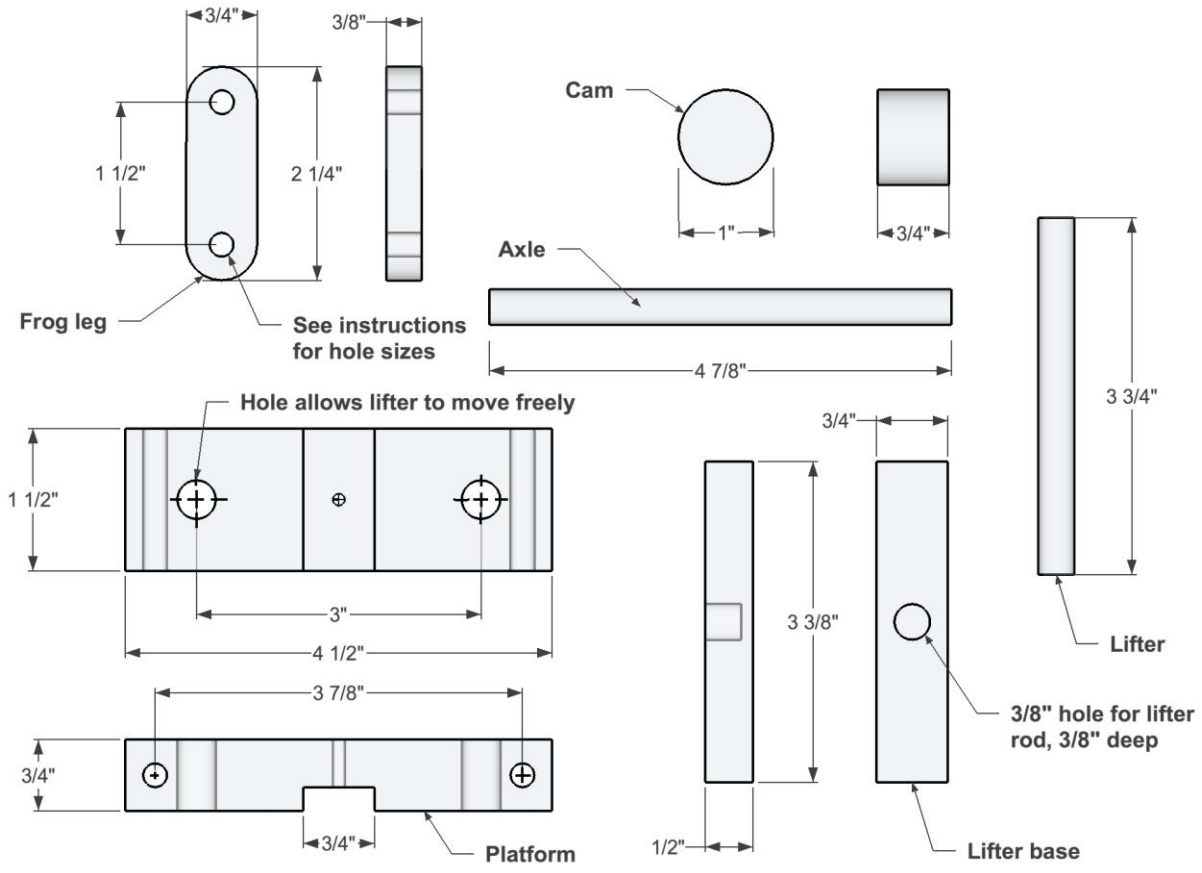
2 – Edges. Round over the edges to a ⅛" radius.

3 – Holes. Drill the two $^{13}/_{32}$" holes on the top of the platform. These holes go all the way through and become the guide for the lifters. Drill the four $^{15}/_{64}$" holes on the edges ⅝" deep. A $^{7}/_{32}$" axle peg will be glued into these holes, so take care the holes form proper glue joints.

Drill an $^{11}/_{64}$" or $^{3}/_{16}$" hole centered on the top. This will be a hole for a 1 ⅝" drywall screw. Countersink this hole to fit the screw.

4 – Dado. Cut a ¾" dado ⅛" deep on the bottom side 1 ⅞" from each end. This can be done with a dovetail saw and chisel or a table saw. If cutting on the table saw use an extension board screwed to your miter guide or push it through using a piece of 1" x 6" scrap wood. See Figure 11-5.

5 – Sand. Hand sand all surfaces, finishing with 150 grit sandpaper.



11-5. Selected Parts with Dimensions (not actual size)

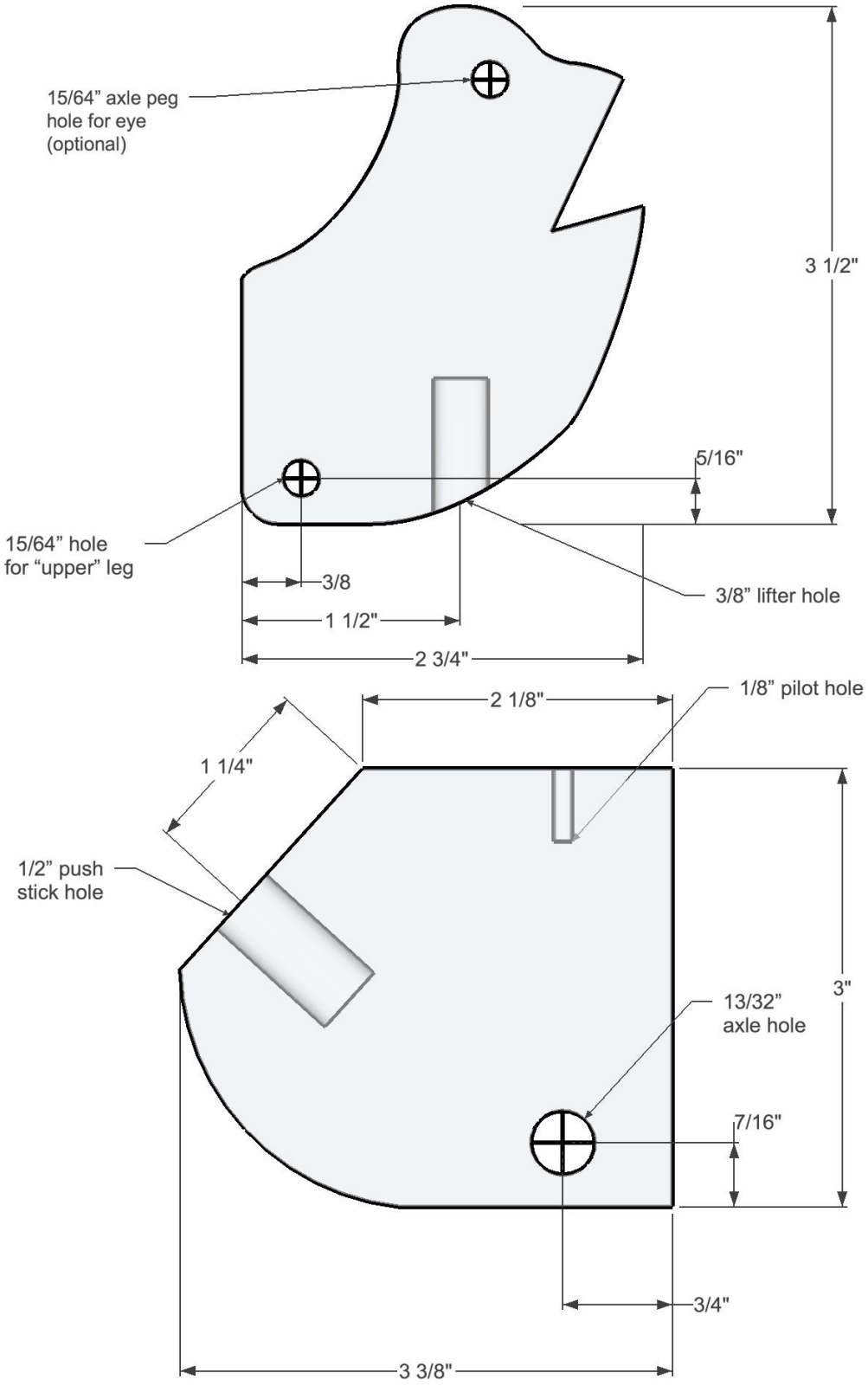


Figure 11-6. Frog and Base Dimensions (not actual size)

Frogs

1 – Wood block. Start with two blocks of wood, each at least ¾" x 3" x 4". These are larger than needed to allow room to place the pattern on the block and cut out a frog from each block. Transfer the pattern to each block from the template (Figure 11-7). The dimensions for the frog are given in Figure 11-6. Using a scratch awl or nail, mark the hole locations for the axle pegs on each block.

The lower hole is for attaching a leg with a leg connector (axle peg). The upper hole is for an axle peg that will serve as an eye. The hole for the eye is optional – depending on how you choose to create the eye.

Creating Eyes

Chapter 21 (pp. 184-5) describes various approaches for creating eyes.

2 – Drill. Using a $^{15}/_{64}$" twist drill bit, drill through holes for the axle pegs that will attach the legs on each side of the frogs and for the eyes (if using axle pegs for eyes).

These holes are best done with a drill press. If using a hand drill, keep your drill bit square to the wood. These holes need to form a glue joint with axle pegs, so take care in getting a proper fit.

3 – Shape. Using a band saw or a scroll saw, cut the shape to within $^{1}/_{32}$" to $^{1}/_{16}$" of the outline. Then sand the frogs to the outline.

4 – Edges. Round over the edges to a ⅛" radius.

5 – Lifter hole. Drill a ⅜" hole ¾" deep in the bottom of each frog to accept the lifter. The hole should be about a 3° to 5° angle to the back of the frog. This keeps the frogs from hitting each other as they move up and down. Use the jig shown in Figure 11-4 for drilling these holes.

6 – Sand. Hand sand all surfaces, finishing with 150 grit sandpaper.

Frog Legs

1 – Shape. Rip a 20" piece of ¾" stock to ⅜" wide on a table saw or bandsaw. If a bandsaw is used be sure to sand the cut edge smooth and flat. Cut the strip into eight 2 ¼" lengths.

2 – Drill glue holes. On **one** end of four of the legs mark a point ⅜" from the end and ⅜" from the edge. Use a $^{15}/_{64}$" twist bit to drill a hole through these legs, as shown in Figure 11-5. These four legs will be "upper" legs, and a "lower" leg will be attached to each of them with an axle peg. Mark these four holes so they are easy to identify later. One way to do this is to place a mark with a felt pen inside the hole.

3 – Drill other holes. On each of the other ends of the legs (there should be 12 more ends) mark a point ⅜" from the end and ⅜" from the edge. Use a ¼" twist bit to drill these 12 through holes.

4 – Round over. Use a file or disk sander to round each end of the legs to an approximate ¼" radius.

5 – Sand. The edges of legs should be sanded to an approximate ⅛"round over. Finally, sand all surfaces of the legs to 150 grit sandpaper.

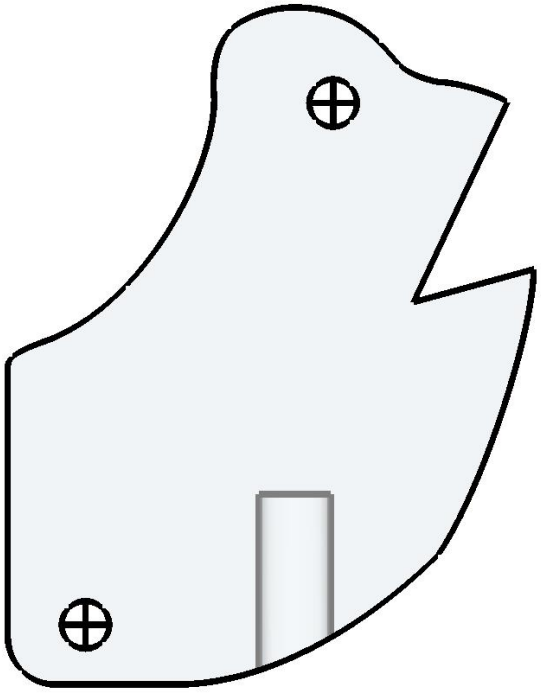


Figure 11-7. Frog Template

Wheels, Cams, and Lifter Bases

1 – Shape wheels. From Baltic birch plywood or hardwood cut out two 4" diameter wheels, each with a ⅜" center hole. Sand the faces and sand and round over the edges to a ⅛" radius.

Jig to Make large Wheels

See Chapters 18 (pp. 155-58) and 20 (pp. 178-9) for ways to make and sand large wheels.

2 – Cut cams. From a longer piece of 1" dowel, cut two ¾" long pieces. Sand the ends flat. These will become the cams that lift the frogs.

3 – Glue cams. Glue one cam to each wheel ⅜" from the edge. Since the face of the cam being glued to the wheel is end grain, it is best to use Titebond Molding glue.

4 – Lifter bases. From ½" thick wood cut out two lifter bases ¾" wide x 3 ⅜" long. On each of the lifter bases drill a ⅜" hole ⅜" deep in the center of one of the ¾" sides (See Figure 11-5).

Push Stick

See instructions in Chapter 2 (p. 20) for building the push stick and grip sub-assembly.

Finishing

1 – Sand and prime. Sand all cut parts to 150 grit sandpaper, then seal all parts and sub-assemblies except the wheel axle, axle peg tenons, and lifters with de-waxed shellac.

Avoid getting sealer, paint and clear finish in holes in which axle pegs or dowels will be glued. One way to do this is to wrap the axle peg tenons and the end of dowels with painter's tape and insert them in the holes, thus keeping the holes clear of finish.

Once dry, lightly sand all sealed parts with a fine sanding pad to remove the raised grain.

2 – Paint. Use green paint on the frogs, legs, and axle peg heads.

3 – Clear coat. Apply one or two coats of water-based polyurethane to all painted and sealed parts (but not to the wheel axle, axle peg tenons, or lifters).

4 – Eyes. Use a permanent marker (black) to draw eyes on the frogs. If using axle pegs shorten the tenons to glue the pegs into the holes for the eyes.

Assemble

1 – Wheel axle. Put glue into the center hole of one of the wheels. Insert the ⅜" diameter 5 ½" long wheel axle (dowel) into the hole from the inside (the side with the cam) so that it is flush with the outside of the wheel. Wipe off any glue pushed to the outside.

2 – Lifters. The lifters should be sanded with 220 grit sandpaper then waxed (any paste wax) to reduce friction. However, do not wax the last 1" on each end where they will be glued into the bottom of each frog and the lifter base.

3 – Glue lifters. Glue a lifter (⅜"dowel, 3 ¾" long) in the center hole of each lifter base. When the glue sets, insert the lifters through the platform and glue one lifter into the hole in the bottom of each frog.

4 – Attach platform. Use a 1 ⅝" drywall screw to attach the platform to the base. The front edge of both base and platform should align.

5 – Dry assemble the second wheel. Insert the wheel axle with one wheel attached through the $^{13}/_{32}$" axle hole in the base. Put the second wheel on the other end of the axle, adjusting it's position so that both wheels clear the lifters by ⅛". Place a mark where the axle is flush with the outside of the second wheel. Take the second wheel off and trim the axle to the mark. Re-assemble the wheels without glue. The cams should be off-set from each other by 180 degrees.

6 – Assemble remaining parts. Assemble the frog legs ***without*** glue to check that everything works smoothly.

The tenons of the 12 axle pegs (leg connectors) will need to be shortened at this time to approximately ¾" in length. Cut them to fit as follows. The ends of the tenons of the four axle pegs that connect a lower leg to an upper leg should be flush with the back of the upper leg when inserted through the lower leg, allowing

for a gap of 1/32" to 1/16" between the legs. Use a Use a spacer to create this gap.[23]

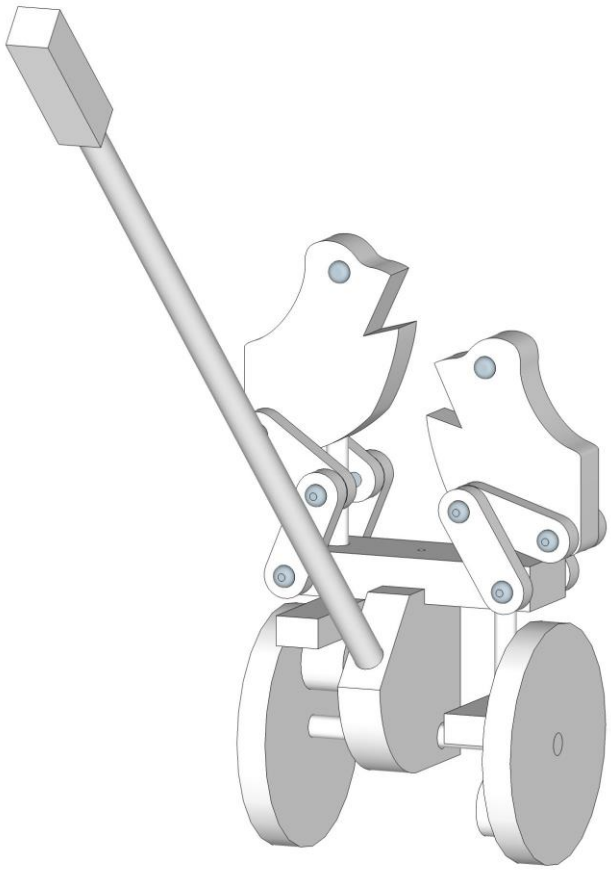
The tenons of the 8 axle pegs used to connect the legs to the frog body or platform should also be about ¾" long and allow for a spacer between the legs and the parts into which they are glued.

In doing the dry assembly, the axle pegs may be loose. To temporarily keep them in the holes, wrap painter's or masking tape on the tenon.

If assembled correctly, the frogs should alternately move up and down as the toy is rolled along the workbench. The finished toy should appear as shown in Figure 11-8. After checking that everything works, glue parts together including removing the drywall screw, gluing the platform to the base, and replacing the screw.

When gluing the leg connectors (axle pegs), be sure to use a spacer between the pieces to allow for movement. If these connections are too tight the toy will not work.

6 – Push stick. Glue the push stick into the ½" hole on the base.



11-8. Hopping Frogs Assembled

[23] The plastic clip used to seal a loaf bread or a piece of cardboard from a cereal box will serve as ideal spacers between the legs