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Articulated Dragon

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- Tips to help you complete the project and become a better woodworker.

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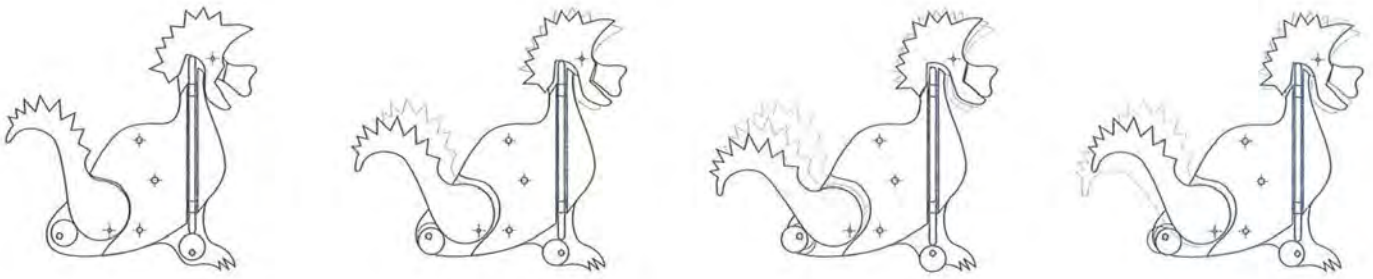
Articulating the Dragon

By John Hutchinson

This world can use all the delight we can afford – and our author is certainly doing his part. Check the pattern for full-size dragon drawings.

Dragons are mythical creatures of many cultures. Evil in some, good in others ... gifted with speech and an appreciation for beauty, their jewel-like eyes reveal a picture of who we are. This little fella was designed to demonstrate our love of fun and function.



Start with the Body Slabs

Begin by making three 1/2" cherry body slabs (pieces 1), photocopying the **Full-size Patterns** on the center pullout and adhering them to the stock with an application of spray adhesive. Rough cut the shapes with a band or scroll saw, staying wide of the lines. Next drill the holes shown on the pattern and stack the slabs, aligning them with dowels through the registration holes. Sand to the lines, using a spindle sander or drill press outfitted with a drum sander to ensure the edges of these parts stay square. Cut one of the slabs on the dashed lines of the pattern to create the mid-body filler pieces.

Once you've completed sanding the slabs, follow the same cut-stack-drill-sand procedure for the walnut hips and cherry legs (pieces 2 and 3).

Forming the Tail and Head Plates

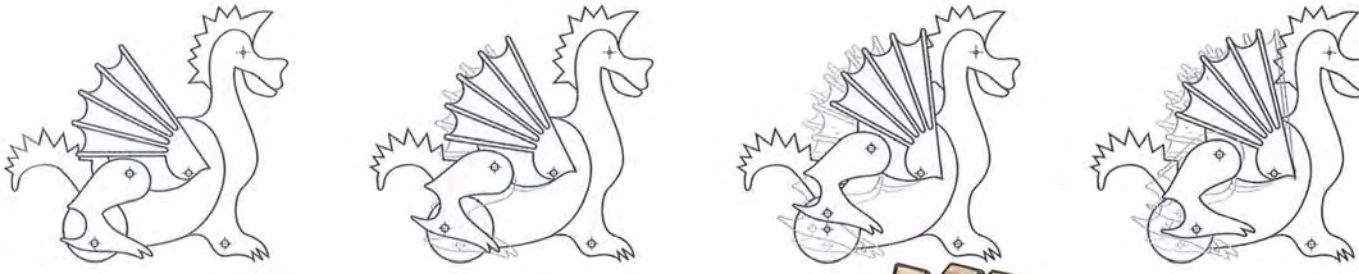
Cut the tail and head plates (pieces 4 and 5) from 1/2" walnut stock, downsized in thickness by 1/16". While you're at it, cut the cherry outer jaws (pieces 6) to size, but lay them aside for now. Since the bottom curve of the tail will be the contact area for the back cam, take extra care with its final sanding. Drill 1/8" holes through the plates for 8d pivot nails. The nails have an outside diameter of 3/32".

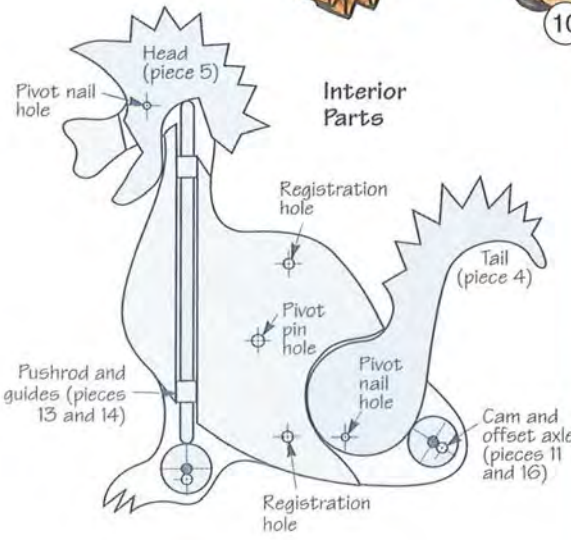
A Pair of Leathery Wings

Regarding materials used for this project, my only indulgence was the 1/8" walnut and 1/2" lacewood used for the bones and membranes of the wings (pieces 7 and 8). Nothing that I have seen approaches lacewood in its resemblance to skin. The two woods look great together, creating this creature's signature feature.

Rough cut the lacewood membranes, drill the pivot holes, and set them aside. Forget about using a saw to cut out the bones. Position the bone pattern on the walnut stock so that the middle bone is parallel to the grain of the wood. Drill the tight inside corners with a 1/8" bit. With the aid of a straightedge, lightly score the

Registration holes align the stacked body slabs while you're cutting and sanding them to their proper shape and size. The Full-size Pattern provides drawings of all the shaped parts and locates the registration and articulation borings. The dragon's wings and legs hide the registration holes once they're applied.





MATERIAL LIST

		T x W x L
1	Body Slabs (3)	1/2" x 6⅝" x 9½"
2	Hips (2)	1/2" x 3¾" x 6"
3	Legs (2)	1/2" x 3¾" x 4"
4	Tail (1)	7/16" x 2⅝" x 6"
5	Head (1)	7/16" x 3¼" x 3¼"
6	Outer Jaws (2)	1/2" x 1½" x 1½"
7	Wing Bones (2)	1/8" x 4½" x 5½"
8	Wings (2)	1/4" x 3¾" x 5½"
9	Rear Wheels (2)	1/2" x 2¼" Dia.
10	Front Wheels (2)	1/2" x 1¼" Dia.
11	Cams (2)	7/16" x 7/8" Dia.
12	Leg Spacers (2)	1/4" x 7/8" Dia.
13	Pushrod (1)	1/4" Dia. x 6"
14	Pushrod Guides (2)	3/8" x 3/8" x 1/2"
15	Pivot Nails (2)	8d Finish
16	Cam/wheel Axles (1)	3/16" Dia. x 6" for both
17	Pivot Pins (bag)	7/32" Dia. Axles
18	Eyes (2)	3/8" Buttons

Figure 1: Lightly score the bones with a utility knife and a straightedge. Then hold the stock with the heel of your hand and complete the cuts with repeated firm knife strokes.

lines with a sharp utility knife (**Figure 1**). Now, with the heel of your hand securing the stock, make repeated pull cuts in the scored lines until you shear the thin walnut. If you take your time, you'll end up with perfectly straight and polished edges. Now glue the bones to the membrane; stack and align the two wing assemblies with pivot pins and finish sand the edges to final shape.

Wheels, Cams and Axles

Form the wheels and cams, pieces 9 through 11 (oak for the wheels, and cherry for the cams), using an adjustable hole cutter. Spin sand all the wheels using sandpaper and a wood block held square to the axle of a wheel turning jig (See **Figure 2**). To ensure they spin freely, downsize the thickness of all the wheels by approximately 1/16". Although the exact diameter of the sanded wheels is not important, the pairs must be equal. A dial caliper comes in handy here.

Now comes the trick that makes the creature operable on a coffee table. Since the wheels must generate a good deal of lifting power, they need to grip the table. Simple wooden wheels would merely slide along a smooth surface — to prevent this from happening, purchase a package of variously sized rubber O-rings at your local hardware store. Using any kind of scratching device (I used an awl), cut a V-groove on the centerline of each wheel's tread surface while spinning it with the turning jig. Put a few dots of polyurethane glue in the groove and stretch an O-ring over the wheel until it snaps into the groove. Instant traction!

Now spin sand the cams and the leg spacers (pieces 12), rocking the sandpaper just a bit to create

Figure 2: Make a wheel sanding jig from a 3/16" threaded rod, a nut, two rubber-backed washers and a wing nut. Use the jig to score the wheels for their O-rings, too.

Animated Toys

Testing Jig

Animated toys are not a new idea. Dancing dolls, music boxes and pull toys have delighted generations of children and adults. If you're building an animated toy from a plan like John Hutchinson's, most of the tricky stuff has already been worked out. But if you're thinking of designing your own, take a tip from John and use a testing jig to ensure all of your interior parts (see front and rear view at right) interact according to plan. To learn more about animated toys, we recommend two books: "The Great Mechanical Wooden Toy" by Ed and Stevie Baldwin (Chilton Book Company) and "How to Make Animated Toys" by David Wakefield (Popular Science Books).

Front View

Rear View

a crown on the cams, thereby minimizing the contact area. Finish sand the cams with very fine sandpaper until they shine. Where the objective in making the drive wheels is to increase the surface friction as much as possible, the opposite is true for the cams. Next, plug the hole left by the hole cutter (in the cams, not the spacers) with an appropriately sized dowel and trim it flush. Sand the sidewall of the cam to reduce the thickness by 1/16" and drill a new 3/16" axle hole, offset 3/16" from the center of the cam (see **Figure 3**).

Forming the Pushrod

A 1/4" dowel (piece 13) is used to transfer the vertical movement of the front cam to the head plate. Rather than drilling a 5/16" dowel shaft for a length of 6" through 1/2" stock, I chose to create two pushrod guide blocks (pieces 14), one at each end. Rip a strip of cherry to 3/8" square, then drill a 5/16" hole centered 1/4" from the end. Now cut off a 1/2" length, as shown in the **Full-size Pattern**. Repeat the process for a second guide block. Cut the pushrod to size and round over the ends.

Figure 3: Offset the cam's axle by filling the boring created by the hole saw and drilling a second hole 3/16" from the center.

Assembly

Since all the parts have registration holes, the final glue-up will go quickly with no sliding during clamping. I used yellow carpenter's glue to mate the flat surfaces and expanding polyurethane glue to secure the wheels on their axles.

First, glue all the center pieces in place, aligned with wooden dowels, to one of the full body slabs (don't forget the pushrod guides). Then test all internal movements by pinning the head and tail plates with the pivot nails (pieces 15). Temporarily place the cams in position, rotating them on the axles that have been friction-fit (not glued) in place.

Although the axles and registration dowels protrude through the outside body slab, they will be covered by the eyes and hips. When you're satisfied that all your moving pieces interact correctly, glue the third slab in place, trapping the head and tail. The cams must be secured to the axles by drilling a 1/16" hole through both cam and axle and gluing in a toothpick.

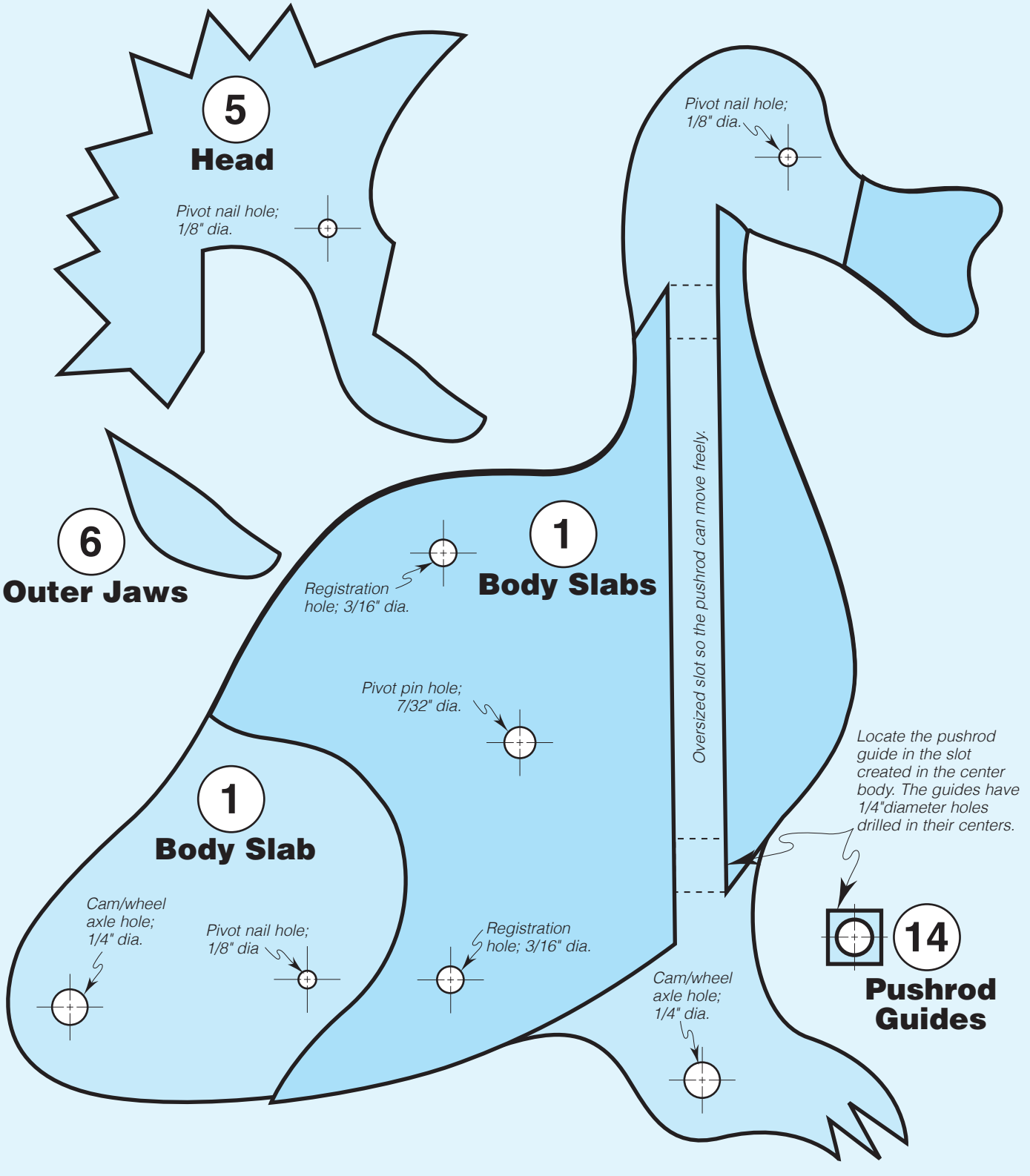
Now glue the hips in place. When the body is dry, position the rear wheels, the wings (glue the leg spacers to the wings now) and the legs, pinning them in place with the pivot pins (pieces 17). Next, assemble the front wheels, axle and cam, and pin the cam to the axle as before. Glue the eyes (pieces 18) and the outer jaws in place.

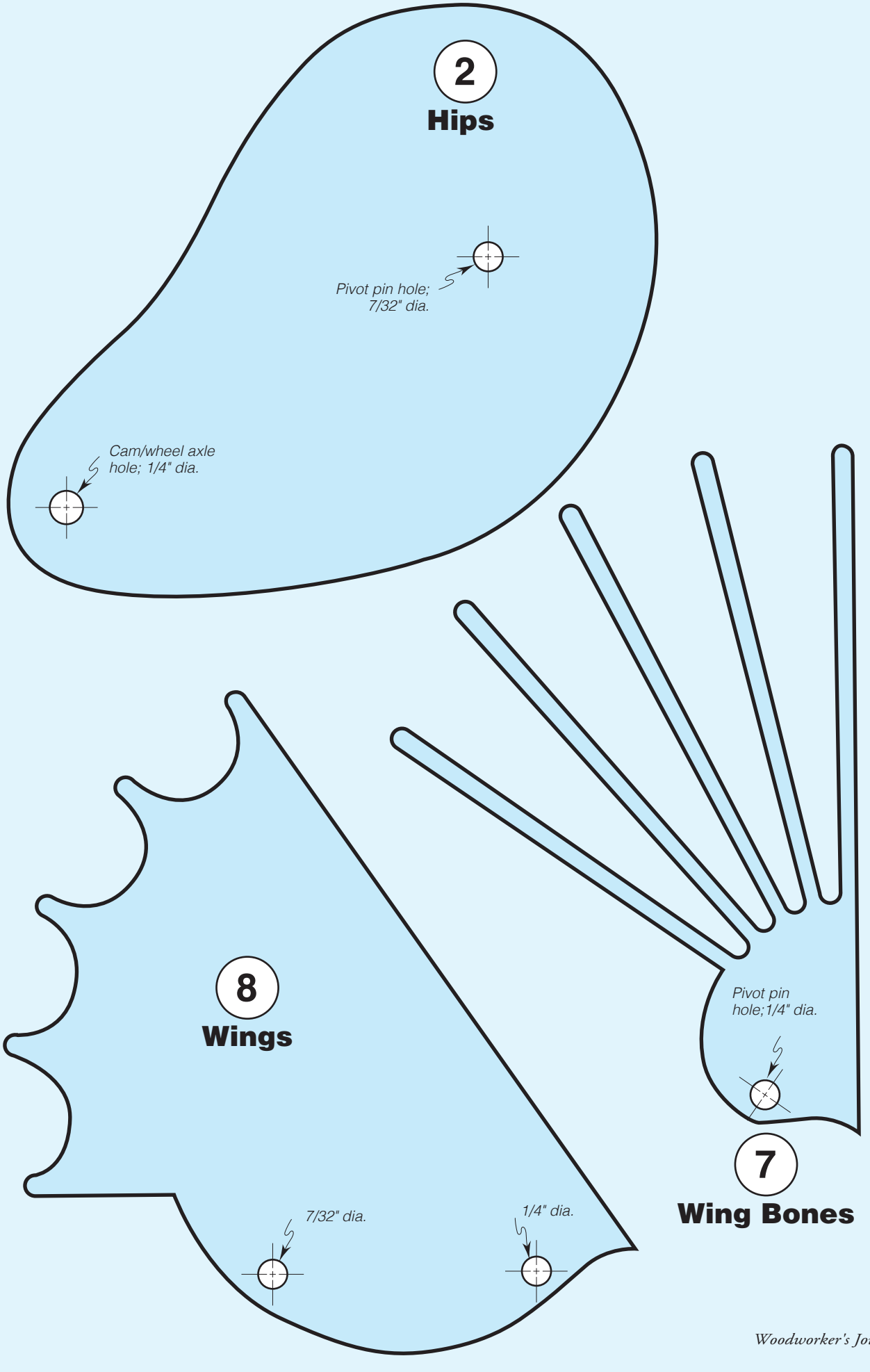
Finish

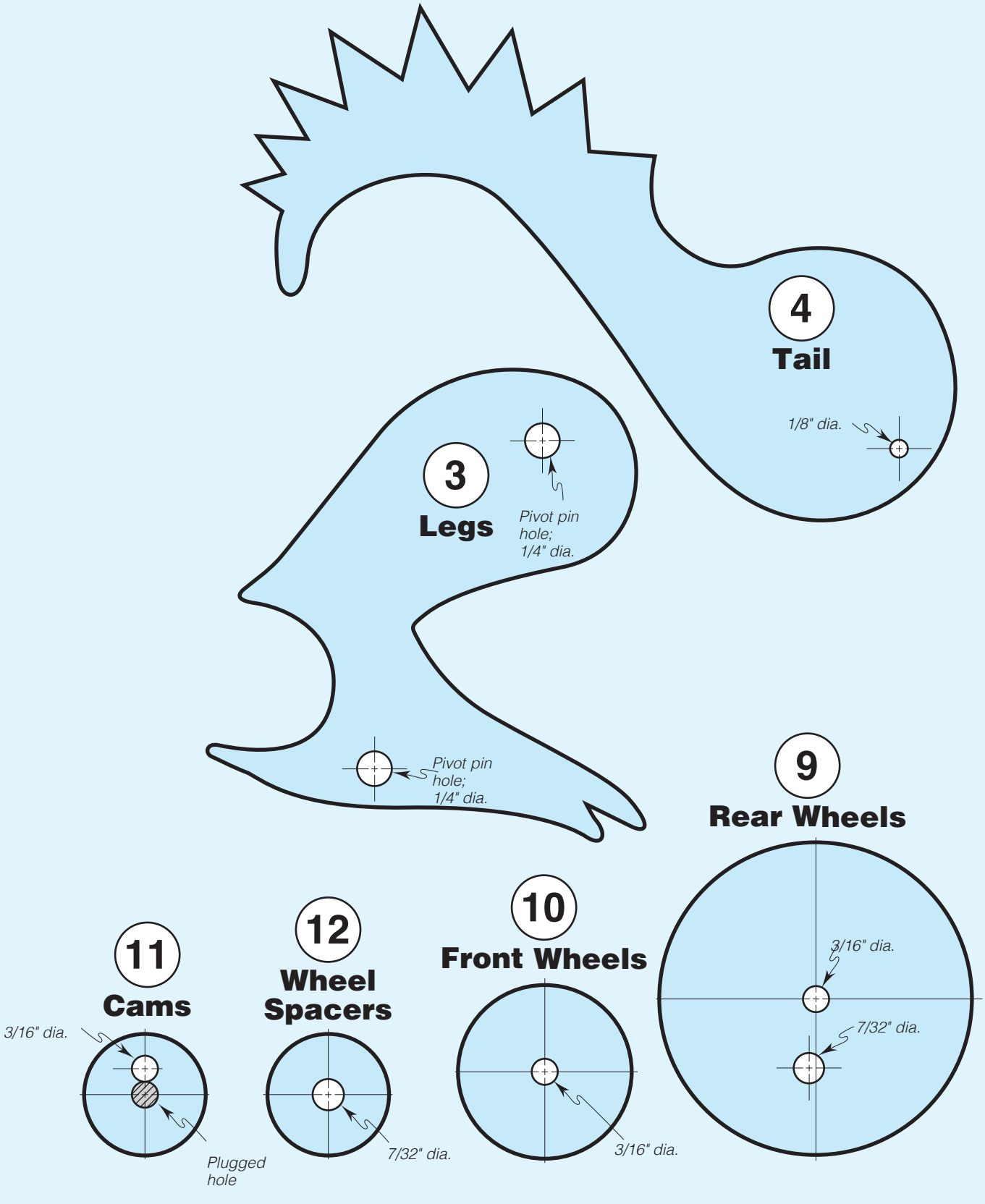
Finish the dragon with a heavy-duty gloss, oil and urethane top coat such as General Finishes Arm-R-Seal to accentuate the contrasting woods. The wet look seems appropriate for a dragon.

Opal Swirtz and her brother John (on the front page of the story) find the dragon to be a fascinating toy. Made from cherry, walnut and lacewood, this mechanical marvel is as interesting to adults as it is to children.

Dragon


5
Head
Pivot nail hole; 1/8" dia.
Pivot nail hole; 1/8" dia.
6
Outer Jaws
1
Body Slabs
Registration hole; 3/16" dia.
Oversized slot so the pushrod can move freely.
Pivot pin hole; 7/32" dia.
1
Body Slab
Locate the pushrod guide in the slot created in the center body. The guides have 1/4"diameter holes drilled in their centers.
14
Pushrod Guides
Cam/wheel axle hole; 1/4" dia.
Pivot nail hole; 1/8" dia
Registration hole; 3/16" dia.
Cam/wheel axle hole; 1/4" dia.


2
Hips
Pivot pin hole; 7/32" dia.
Cam/wheel axle hole; 1/4" dia.
Pivot pin hole;1/4" dia.
7
Wing Bones
8
Wings
7/32" dia.
1/4" dia.


4
Tail
1/8" dia.
3
Legs
Pivot pin hole; 1/4" dia.
Pivot pin hole; 1/4" dia.
9
Rear Wheels
3/16" dia.
7/32" dia.
10
Front Wheels
3/16" dia.
12
Wheel Spacers
7/32" dia.
11
Cams
3/16" dia.
Plugged hole