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Dave Campbell
Editorial Content Chief, *WOOD* magazine



Adobe Acrobat Reader Troubleshooting Guide

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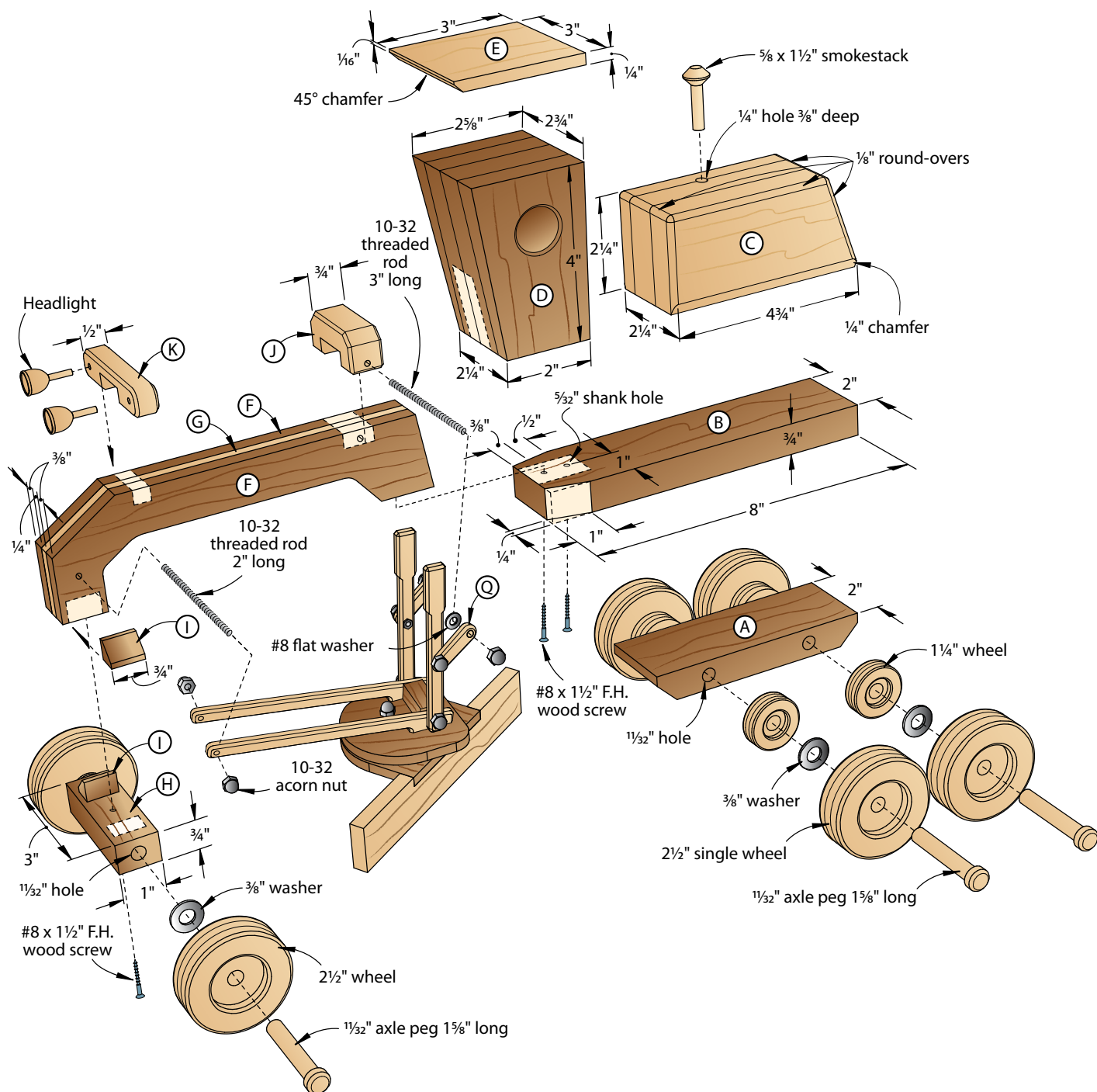
Motor Grader

Round up some maple and walnut and dig in to this scaled-down scraper.

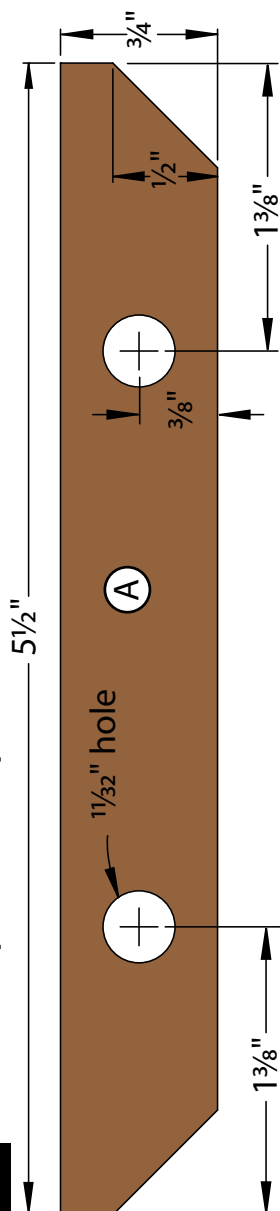
Whether smoothing a path across the carpet, or making lines in the sandbox, this blade runner works hard showing off your craftsmanship. The blade pivots and lifts, but engine noises are up to the operator. A handy kit contains the hardware and specialty parts needed. And check out the rest of our Construction-Grade equipment on *page 9*

Dimensions: 16 $\frac{1}{16}$ "L × 6 $\frac{7}{8}$ "H × 7"W

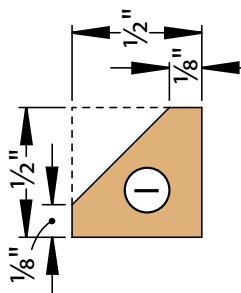
1 EXPLODED VIEW



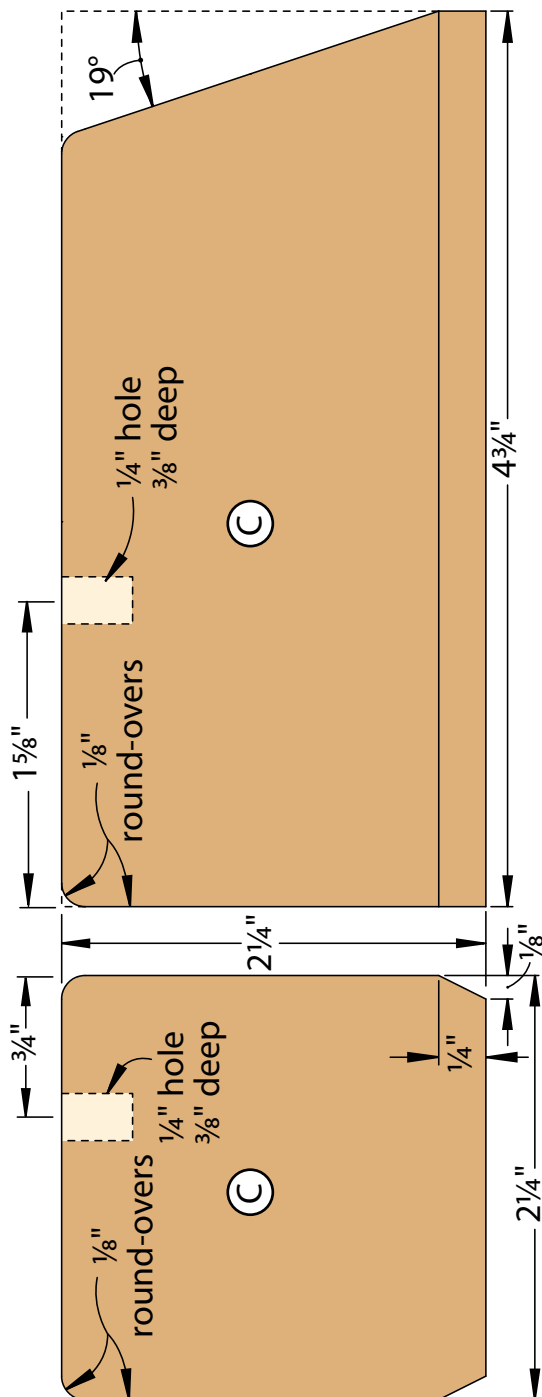
1a CHASSIS (Side view)



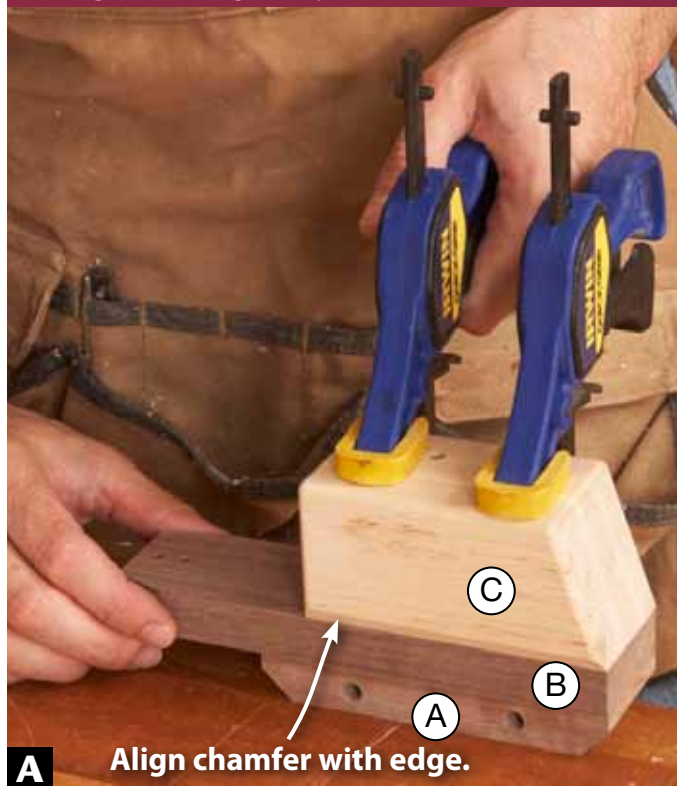
1c FRONT AXLE BRACE (End view)



1b HOOD



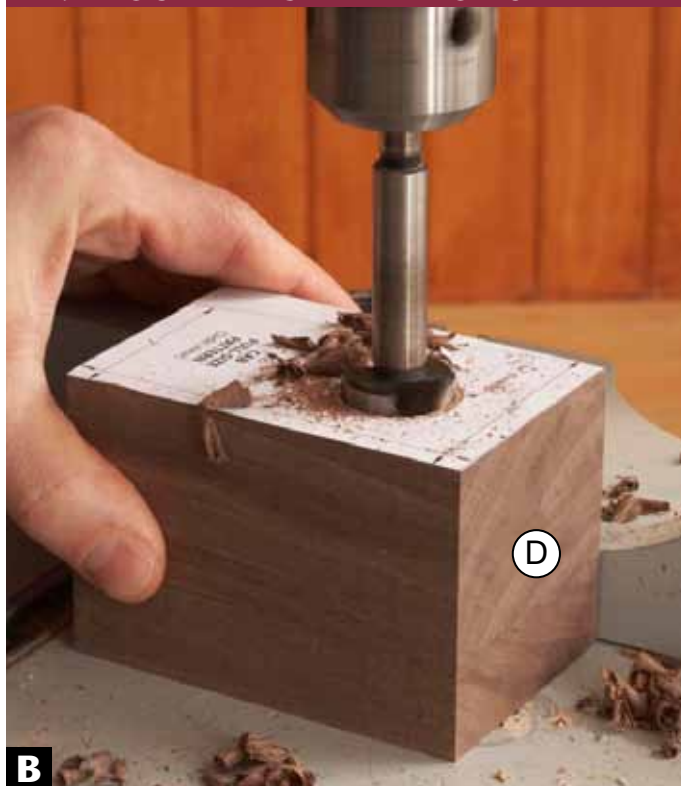
PLACE THE POWER PLANT



A Align chamfer with edge.

Align the edges of the chamfers and the back end of the hood (C) with the edges and end of the chassis assembly (A/B).

DRILL OUT THE CAB WINDOWS



B Bore through the cab (D) with a 1" Forstner bit. Brace the cab against a fence and back out the bit frequently to clear chips.

Begin work at the rear

Note: After cutting and shaping parts, sand them to 220 grit before assembly.

1 From $\frac{3}{4}$ "-thick walnut, cut the chassis (A) and sub-chassis (B) to size [Drawings 1, 1a]. Mount a 45° chamfer bit in your table-mounted router and chamfer the ends of the chassis [Drawing 1a]. On the chassis, drill the two $\frac{1}{32}$ " holes where shown.

2 Lay out the miters on the front end of the sub-chassis (B) [Drawing 1], then bandsaw and sand to the line. On the bottom face, drill and countersink two $\frac{5}{32}$ " shank holes where shown.

3 Laminate three pieces of $\frac{3}{4}$ " maple for the hood (C). Cut the hood to size [Drawing 1] and bandsaw the bevel on the back end [Drawing 1b]. Rout $\frac{1}{8}$ " round-overs on all but the bottom edges. Rout or cut chamfers along the bottom edges of the hood, leaving the ends unchamfered. Drill a $\frac{1}{4}$ " hole $\frac{3}{8}$ " deep [Drawing 1b] and glue the smokestack [Source] in place.

4 Glue and clamp the chassis (A) to the sub-chassis (B) with their sides and

back ends flush. Allow the glue to set for a few minutes, then glue the hood (C) to this assembly [Photo A].

5 Laminate four pieces of $\frac{3}{4}$ " walnut for the cab (D) and plane the blank to thickness [Drawing 1]. Photocopy the **Cab Pattern** from page 11 and spray-adhere it to a side of the cab. Bore the 1" hole where shown [Photo B], then rout a $\frac{1}{16}$ " chamfer around the hole on each face. Bandsaw the taper just outside the line, then sand up to the line.

Quick Tip! A short soak peels away patterns. Apply mineral spirits to the pattern and it will scrape off easily.

6 Plane a 4×13" maple blank to $\frac{1}{4}$ " thick. Rip a 3"-wide strip from it and save the offcut for the control arms (O, P, Q). Cut the cab roof (E) to size [Drawing 1] from the 3"-wide blank and save the remainder for the inner boom strip (G). Chamfer the bottom front end of the cab roof, and glue it on top of the cab (D), centered. After the glue dries, glue and clamp the cab assembly (D/E) to the chassis assembly (A/B/C), centered, and tight against the hood (C).

On to building the boom

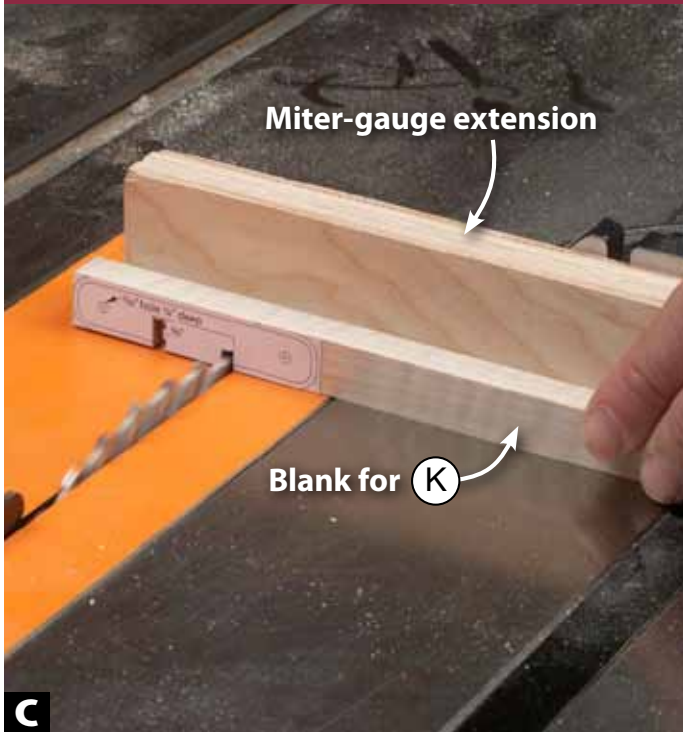
1 Prepare a $\frac{1}{2}$ ×6×12" walnut blank. Rip a $\frac{1}{2}$ "-wide strip from one edge and set it aside for making the front axle braces (I) and pivot-block anchor (N). Plane the remaining blank to $\frac{3}{8}$ " thick and cut the front booms (F) to $2\frac{3}{8}$ ×8 $\frac{3}{4}$ ". Save the cut-off for the pivot blocks (L).

2 Retrieve the blank for the inner boom strip (G) and cut it to match the front booms (F). Laminate the inner boom strip and front booms [Drawing 1], keeping one end and edge flush.

3 After the glue dries, square up the boom (F/G) blank and cut it to size [Materials List]. Make a copy of the **Boom Pattern** and spray-adhere it to the blank. Bandsaw or scrollsaw the boom to shape, saving the cutoff from the bottom edge for use later. Drill the $\frac{3}{16}$ " hole at the front of the boom, transfer the locations of parts J and K to the top of the boom, then remove the pattern.

4 Cut the front axle (H) to size and drill a centered $\frac{1}{32}$ " hole through its length [Drawing 1]. Retrieve the blank for the front axle braces (I) and rout a $\frac{3}{8}$ "

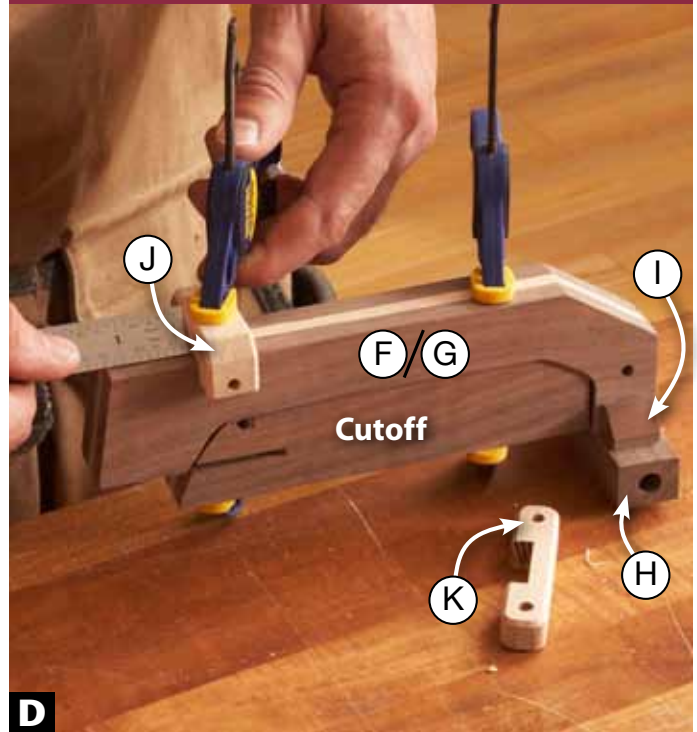
NOTCH THE YOKES



C

Using the pattern as a guide, and a miter-gauge extension, cut a notch in each yoke (J, K). Remove the waste in repeated passes.

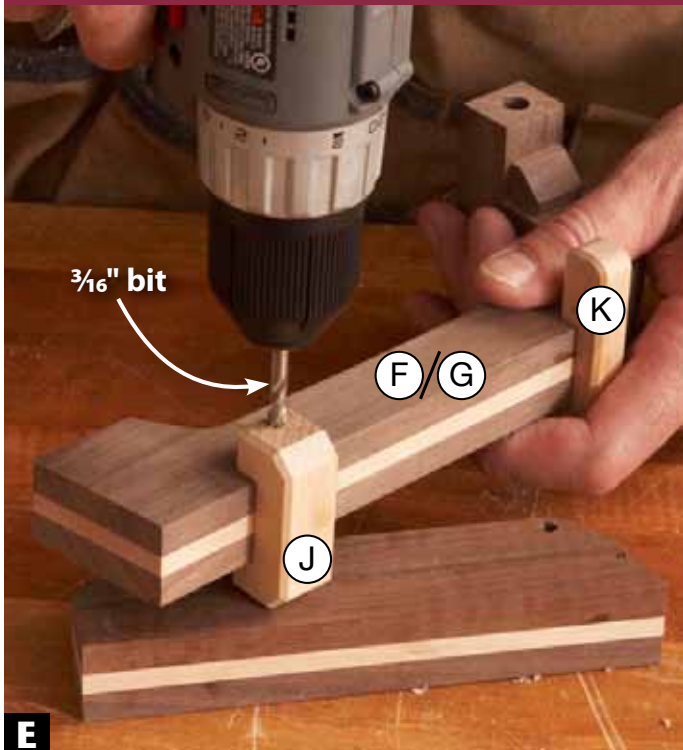
THE CUTOFF FILLS THE GAP



D

Fill the gap below the boom (F/G) with the cutoff to provide parallel clamping surfaces when gluing on the yokes (J, K).

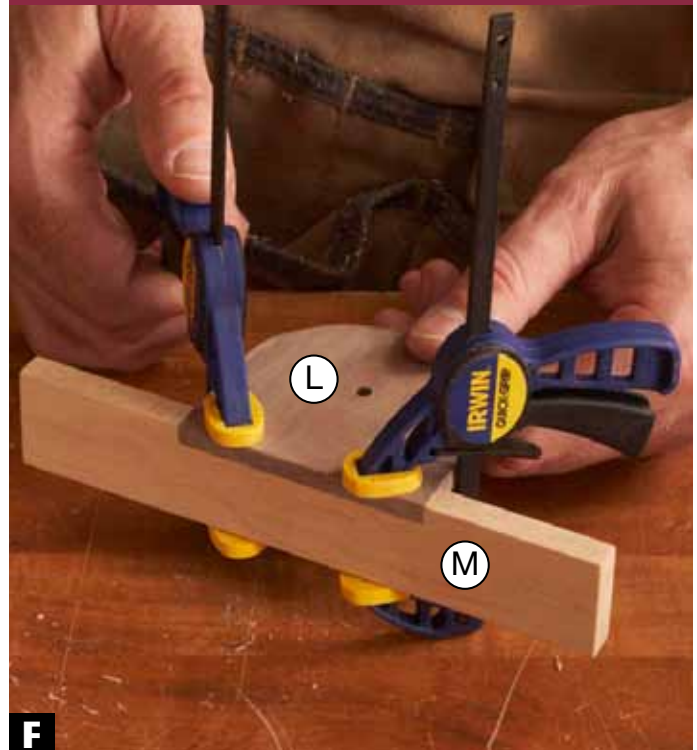
BORE THROUGH THE BOOM



E

With a scrap backing up the assembly, drill through the boom (F/G), using the holes in the yoke (J) as guides.

ATTACH A PIVOT TO THE BLADE



F

Glue and clamp the squared-off pivot block (L) in the notch in the blade (M), flush with the back face.

chamfer along 2" of one edge [Drawing 1c]. Cut the front axle braces to length from the chamfered portion and set the remainder of the blank aside.

5 Dry-fit the front axle (H) to the front of the boom (F/G), centered side-to-side. Drill a countersunk $\frac{5}{32}$ " shank hole through the front axle and a $\frac{7}{64}$ " pilot hole into the boom. Glue and screw the front axle in place [Drawing 1]. Then glue the front axle braces (I) to the axle and boom, centered on the axle's width.

6 From maple, prepare a $\frac{3}{4} \times \frac{7}{8} \times 12$ " blank for the yoke (J) and a $\frac{1}{2} \times \frac{5}{8} \times 12$ " blank for the headlight yoke (K). Spray-adhere a copy of the **Yoke Pattern** and the **Headlight Yoke Pattern** to the proper blanks. Cut the notches in these parts [Photo C], drill the holes where shown on the patterns, then bandsaw and sand them to final shape. At the router table, rout $\frac{1}{16}$ " chamfers around the yoke and headlight yoke [Shop Tip, below].

7 Using the boom cutoff, glue and clamp the yoke (J) and headlight yoke (K) to the boom (F/G) [Photo D], aligning them with the marks made earlier. After the glue dries, drill a $\frac{3}{16}$ " hole through the boom [Photo E].

8 Center the boom assembly (F-K) on the width of the chassis assembly (A-E), tight against the cab (D). Glue and screw the boom to the chassis, and glue the headlights into the headlight yoke (K).

Now make a moving blade

1 Retrieve the pivot blocks (L) blank, double-faced tape it to a flat, 12"-long carrier board, and plane it to $\frac{1}{4}$ " thick.

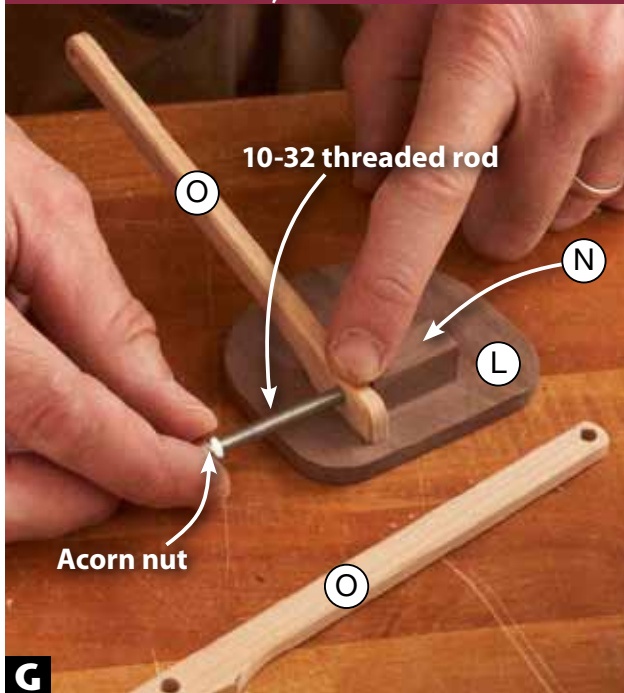
Make two photocopies of the **Pivot Block Pattern** and spray-adhere them to the blank. Bandsaw and sand the pivot blocks to shape. **Note:** One pivot block has rounded back corners, the other has square back corners [Drawing 2]. Stack the pivot blocks with their ends and edges flush, drill the $\frac{3}{16}$ " hole where shown, then remove the patterns.

2 Cut the blade (M) to size [Drawing 2a]. Notch the upper edge to match the width of a pivot block (L). Glue the square-cornered pivot block to the blade [Photo F].

3 Retrieve the walnut strip set aside earlier for the pivot-block anchor (N), cut the anchor to size, and drill a $\frac{3}{16}$ " centered hole through its length [Drawing 2]. Glue the pivot-block anchor to the round-cornered pivot block (L).

4 Make two copies each of the **Forward Control Arm Pattern**, **Vertical Control Arm Pattern**, and **Upper Control Arm Pattern**. Retrieve the maple blank for these parts (O, P, Q), spray-adhere the patterns to it and bandsaw and sand the pieces to shape. Drill the holes and rout chamfers where shown, then remove the patterns.

SPARE THE ROD, SPOIL THE GLUE-UP



G Push a length of threaded rod through the forward control arms (O) and pivot-block anchor (N) to align the pieces during glue-up.

Let the assembly begin

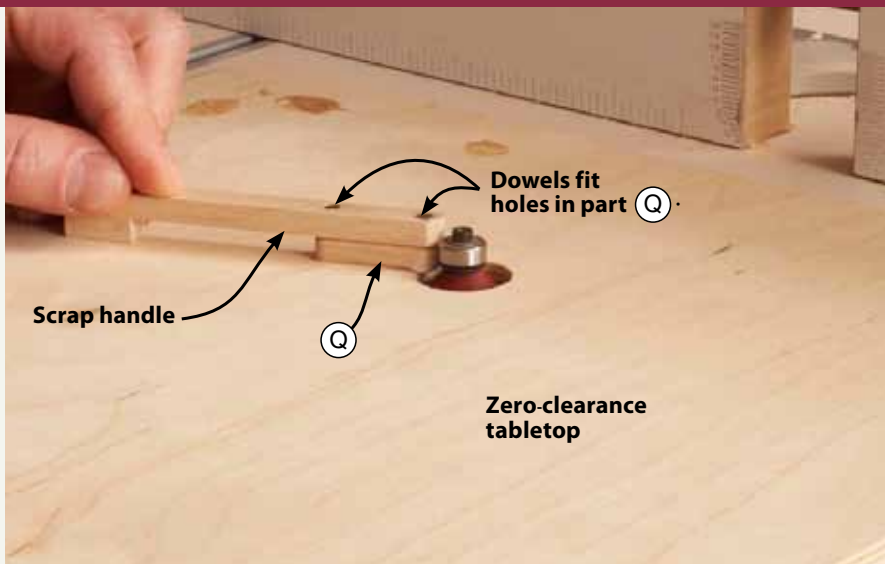
1 **Note:** Do not use thread locker (see page 7) on the acorn or lock nuts until final assembly after the finish is applied. Cut a 2 $\frac{3}{8}$ "-long piece of 10-32 threaded rod and use it as you glue the forward control arms (O) to the pivot block (L) and pivot-block anchor (N) [Photo G]. After the glue dries, join the pivot blocks with a $\frac{7}{8}$ "

SHOP TIP

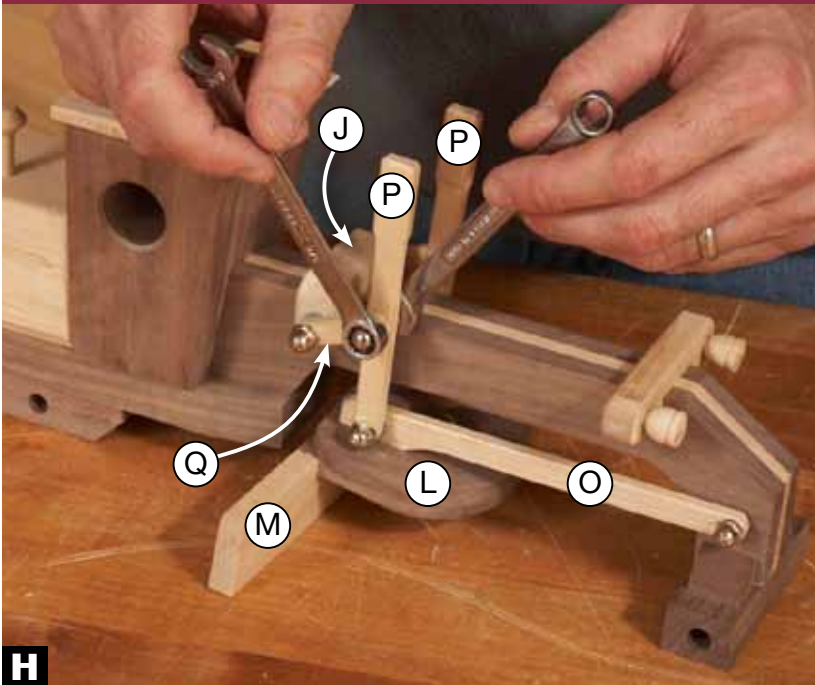
Get a handle on the little things

Attach small project parts to a longer scrap to keep your fingers a safe distance from the bit when routing the edges. For parts with holes (K, Q), add dowels to the scrap to fit the holes in the workpiece so you can easily turn the piece end for end to rout both ends. Double-sided tape works well for fastening the part to the scrap, too.

Also, make a zero-clearance tabletop to support the workpiece right next to the bit. This reduces chip-out and prevents the piece from falling into a too-large opening. In a piece of plywood or hardboard, cut a hole just large enough to expose the bit, and clamp it to your router-table top.



ATTACH THE VERTICAL ARMS



H

Snug the acorn and lock nuts on the vertical control arms (P) to control how easily the blade assembly (L-O) raises and lowers.

BORE TO FIT THE AXLE



I

Grip the wheels in a handscrew while enlarging the holes. Rest the wheel on a scrap to prevent tear-out on the back face.

length of threaded rod, acorn nut, and lock nut [Drawing 2].

2 Using a 3" length of threaded rod, acorn nuts, and washers, secure the upper control arms (Q) to the yoke (J) [Drawing 1]. Slide the 2 3/8"-long threaded rod from the blade assembly (L-O) and position the blade assembly under the boom (F/G). Attach the forward control arms (O) to the boom, then attach the vertical control arms (P) to the forward and upper control arms with lengths of threaded rod, acorn nuts, washers, and lock nuts [Drawing 2, Photo H]. Raise and lower the blade assembly to test the action.

3 With an 1 1/2" drill bit, enlarge the holes in four 1 1/4" wheels [Source; Photo I]. Test-fit the 1 1/4" and 2 1/2" wheels to the chassis (A) and front axle (H) using axle pegs and washers [Drawing 1]. Remove the wheels and all hardware. Tape off the shafts of the axle pegs and apply a finish to all pieces. (We sprayed on three coats of aerosol satin polyurethane, sanding lightly between coats with a 320-grit sanding sponge.)

4 After the finish dries thoroughly, apply a dab of glue in each hole before inserting the axle pegs. Reassemble the blade pivot blocks and control

arms using red thread locker, snugging the nuts enough that the blade pivots and moves up and down but stays in any given position. 🌳

Produced by **Craig Ruegsegger**
Project design: **Kevin Boyle**
Illustrations: **Lorna Johnson**

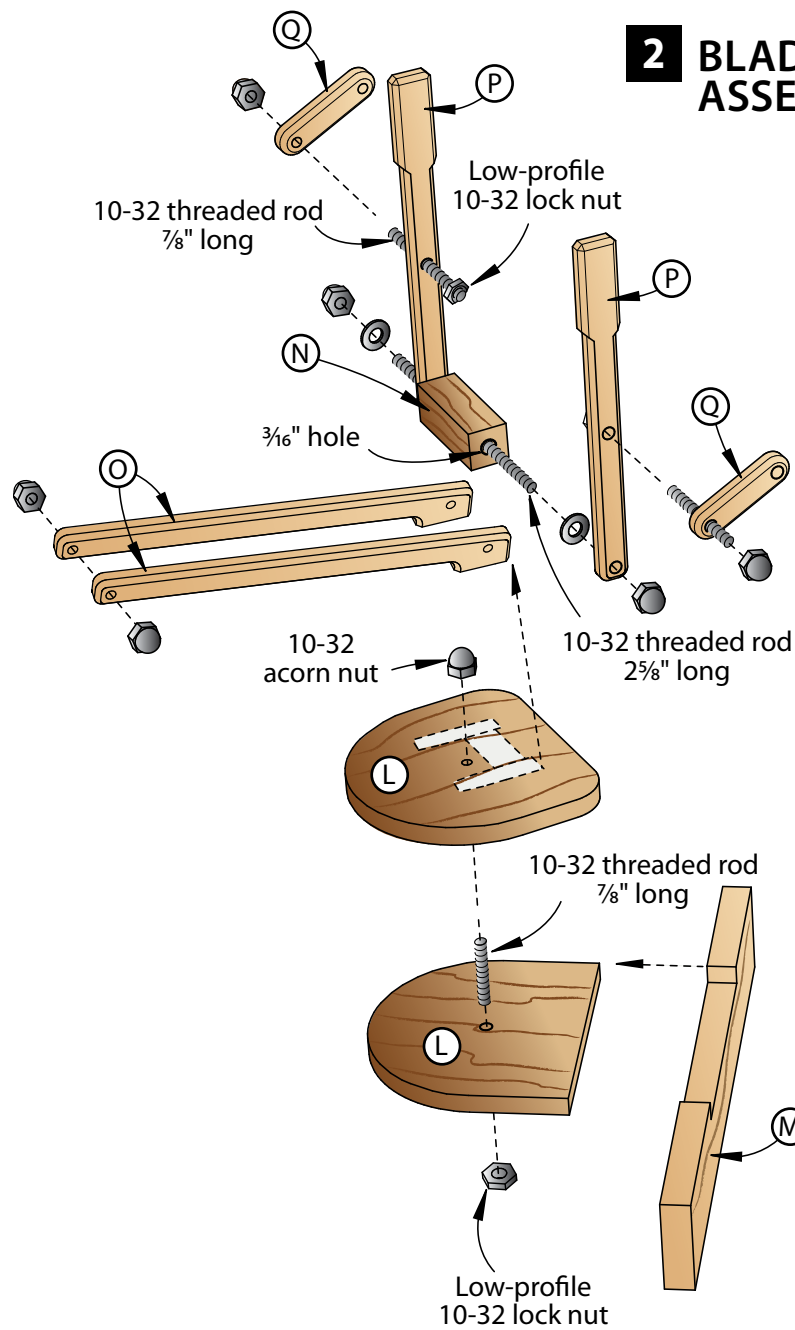
Drip a drop for nuts that stay put

Thread locker goes on as a liquid, then dries solid, preventing nuts from working loose. Choose from blue, green, or red, depending on the application.

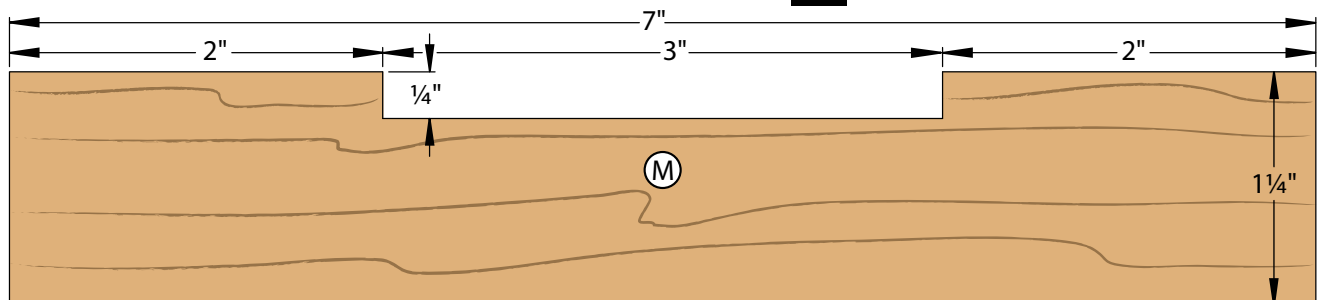
Use blue on assemblies that need to come apart again. Green seeps along the threads between assembled fasteners without taking them apart and locks them in place permanently. Red, *below*, bonds permanently and is what we used on the motor grader. Apply a drop to the end of a threaded rod before spinning on an acorn nut or lock nut.



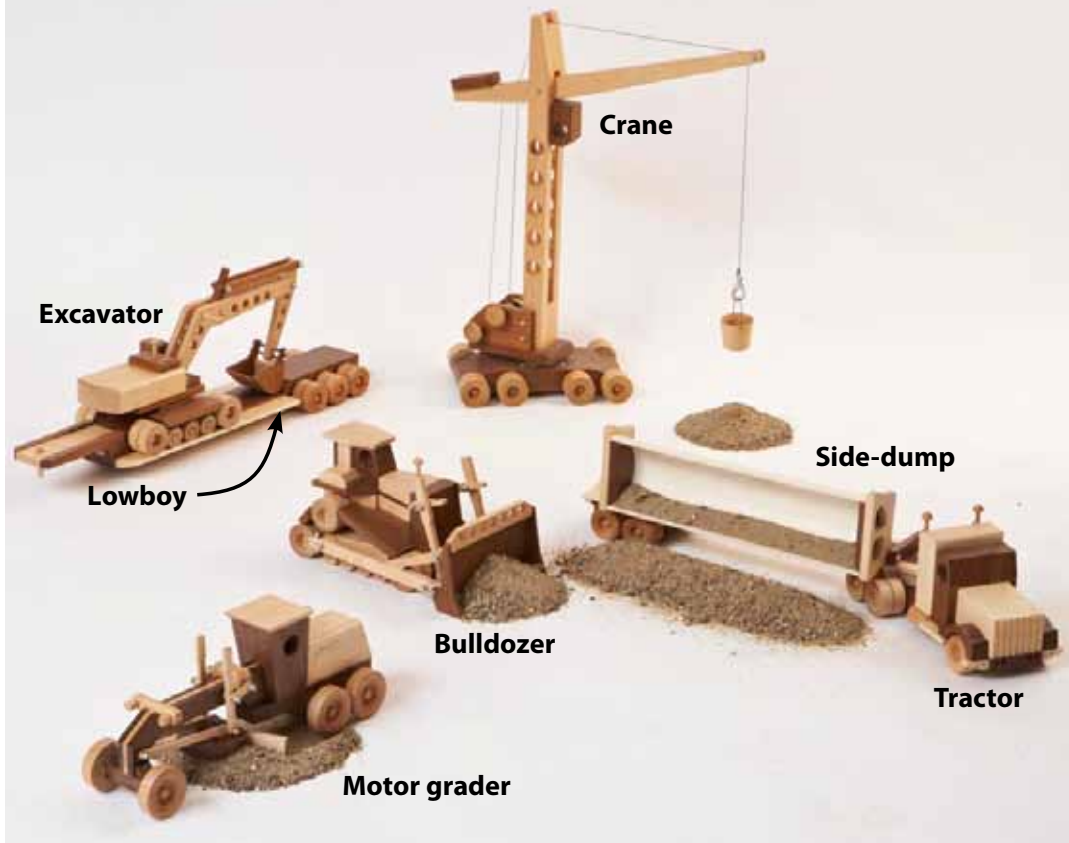
2 BLADE ASSEMBLY



2a BLADE



MEET THE REST OF THE CREW



With the motor grader, our Construction-Grade toy collection expands to seven pieces. The crane (issue 185, September 2008) lifts and lowers its bucket, and spins. Reach and scoop with the articulated boom of the excavator (issue 194, November 2009). The bulldozer (issue 199, September 2010) raises and lowers its blade. For heavy hauling, the tractor pulls both the side-dump and lowboy trailers (all three pieces in issue 205, July 2011). The bulldozer, excavator, and motor grader each fit on the lowboy.

If you don't own these issues, you can download plans for these projects for a small fee at woodmagazine.com/cgtoys.

In future issues, you'll find plans for a skid-steer loader and a dump truck.

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Materials List

Part		FINISHED SIZE			Matl.	Qty.
		T	W	L		
Chassis and boom						
A	chassis	¾"	2"	5½"	W	1
B	sub-chassis	¾"	2"	8"	W	1
C	hood	2¼"	2¼"	4¾"	LM	1
D	cab	2¾"	2⅝"	4"	LW	1
E*	cab roof	¼"	3"	3"	M	1
F*	front booms	⅜"	2½"	8⅞"	W	2
G*	inner boom strip	¼"	2½"	8⅞"	M	1
H	front axle	¾"	1"	3"	W	1
I*	front axle braces	½"	½"	¾"	W	2
J*	yoke	¾"	⅞"	2"	M	1
K*	headlight yoke	½"	⅝"	3"	M	1
Blade assembly						
L*	pivot blocks	¼"	3"	2¾"	W	2
M	blade	⅜"	1¼"	7"	M	1
N*	pivot-block anchor	½"	½"	1"	W	1
O*	forward control arms	¼"	½"	6⅞"	M	2
P*	vertical control arms	¼"	½"	4½"	M	2
Q*	upper control arms	¼"	⅜"	1⅜"	M	2

*Parts initially cut oversize. See the instructions.

Materials key: W–walnut, LM–laminated maple, LW–laminated walnut, M–maple.

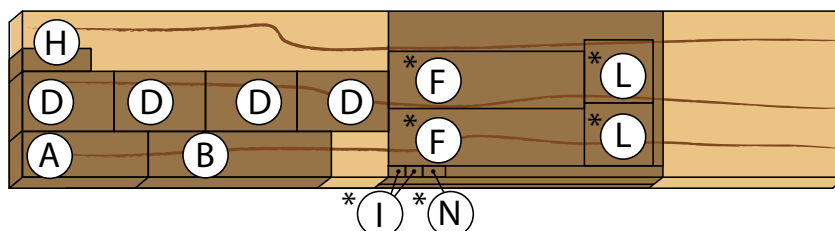
Supplies: Double-faced tape, spray adhesive, red thread locker.

Bits: 45° chamfer, ⅛" round-over router bits; ⅜", ⅞", ¼", ⅝", ⅞" drill bits, 1" Forstner bit.

Source

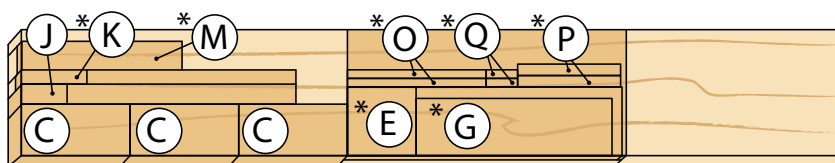
Hardware kit: Each kit contains 1¼" wheels (4), 2½" wheels (6), 12"-long 10-32 threaded rod (1), 10-32 acorn nuts (9), low-profile 10-32 lock nuts (3), #8 flat washers (4), ⅜" washers (6), smokestack (1), headlights (2), 1½"×1⅝" axle pegs (6), and #8×1½" F.H. wood screws (3). Order kit RS-00904, woodmagazine.com/grader

Cutting Diagram

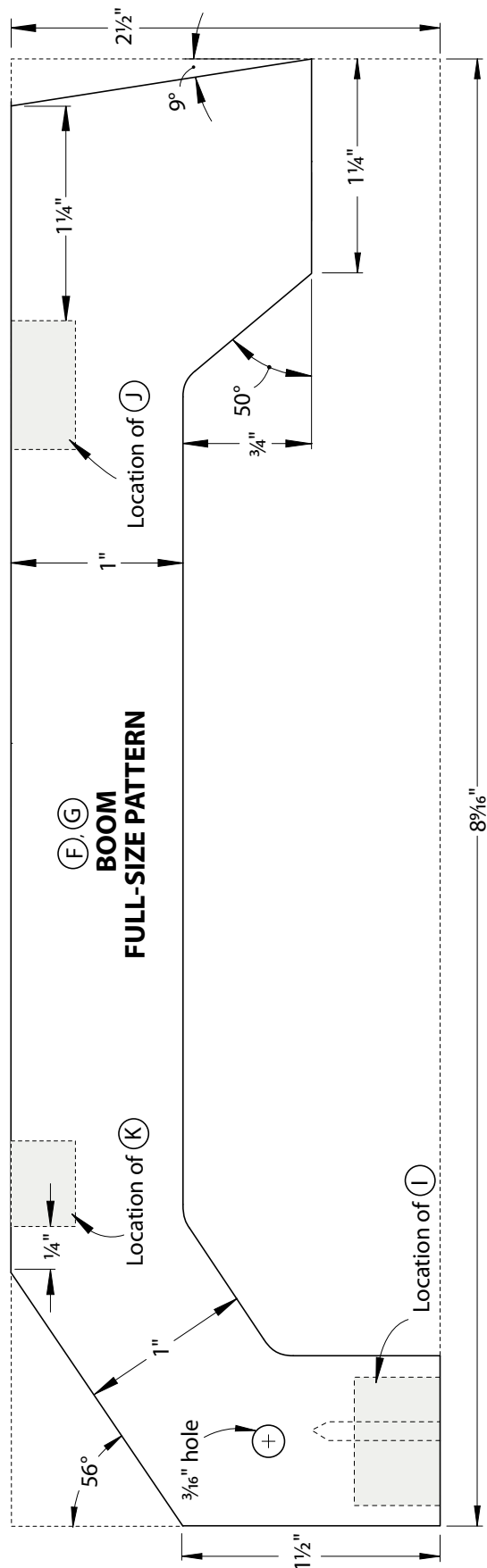


¾ x 7¼ x 36" Walnut (2 bd. ft.)

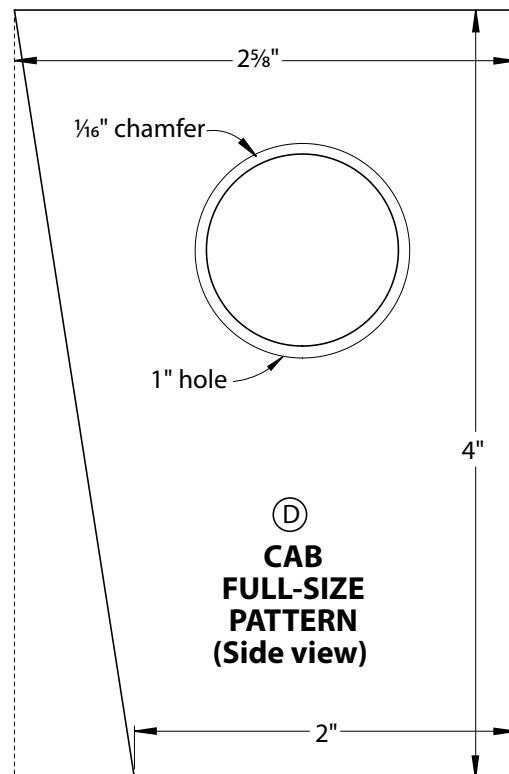
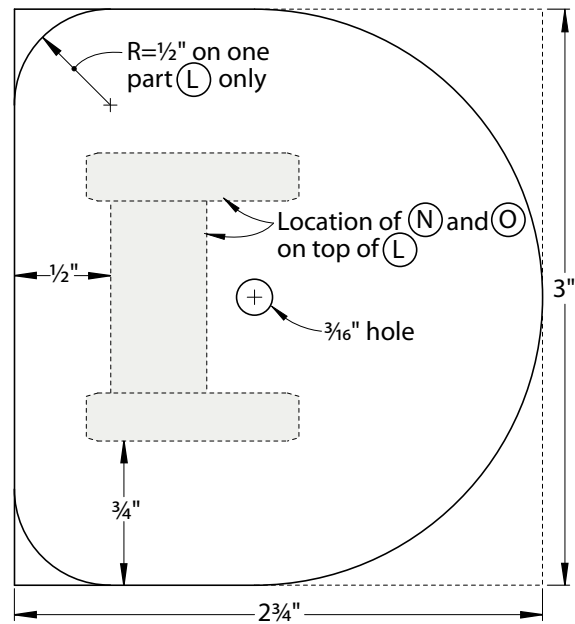
*Plane or resaw to thicknesses listed in the Materials List.



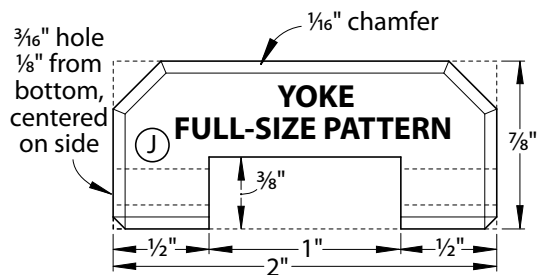
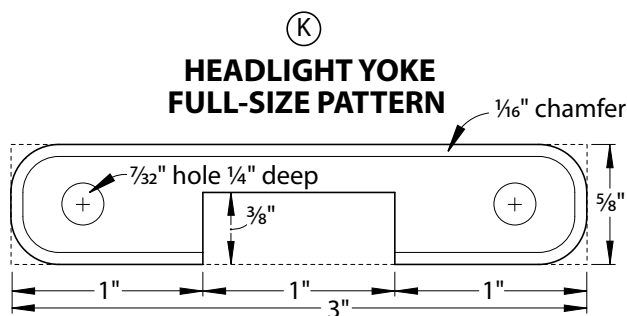
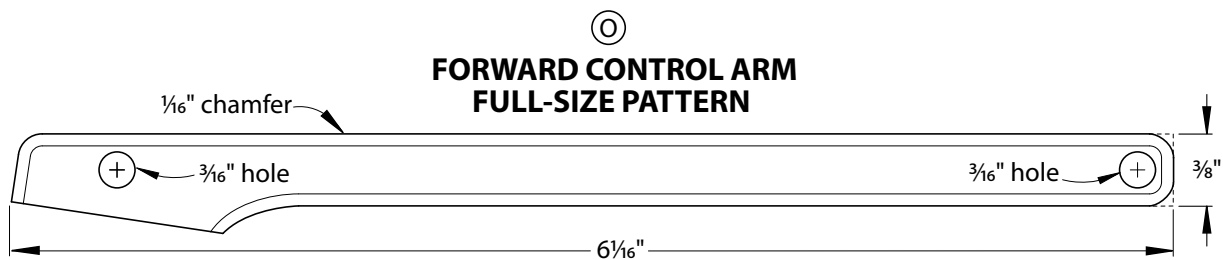
¾ x 5½ x 36" Maple (1.5 bd. ft.)



(L) PIVOT-BLOCK FULL-SIZE PATTERN (Top view)



To ensure full-size patterns are correct size, your printer should be set to print at 100% (not fit to page). Measure full-size patterns to verify size.



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