The CurveArray

This line-array design is ideal for your center-channel home theater setup.

PHOTO 1: The CurveArray.

Line arrays offer a method to achieve high efficiency in a relatively small package. However, conventional line arrays also have a very narrow dispersion angle on their long axis. That's a plus for minimizing early reflections when the cabinet is upright, but a problem in applications where a horizontal placement is the only option, which is very often the case with center-channel home theater boxes.

The CurveArray (**Photo 1**) is intended for horizontal placement, offering the high sensitivity of a line array with the dispersion of a point source. The difference in dispersion compared to a flat array is dramatic. **Figure 1** shows the on-axis and 30° off-axis response of the CurveArray and that of an identically configured cabinet with a flat baffle.

DRIVER SELECTION

When searching for drivers to use in this project, check out the Web for specials and closeouts. The woofers used in the original were 4″ "NSB" closeouts from Parts Express, which I got for 49 cents apiece. Specs—fs 105Hz, Qts .76, vas .1ft^3, Z 8Ω—are fairly common in many 3 to 5″ drivers in the nominal $5 to $10 range. Be sure that you choose full-range drivers, with response to at least 8kHz.

The tweeters I used were 3/8″ dome Onkyo closeouts, Parts Express # 269-780, at an astounding 24 cents apiece (**Photo 2**). These tweeters have no mounting flanges, so they must be glued in place. There are many variations of this Onkyo tweeter available, some with coaxial mounting frames that can be discarded. The nominal crossover is 8kHz, so there's no need for larger than a ½″ dome. However, while a small frame size is also desirable, it's not an absolute necessity. A tweeter frame size up to 2″ in diameter is acceptable.

PHOTO 2: Frameless Onkyo tweeters.

TWEETER PLACEMENT

The CurveArray (CA) design spaces tweeters far wider than usual in a line array. The reason is shown in **Fig. 2**. On the left is a straight array; the shaded area represents the typical 15° high-frequency dispersion angle you may expect from a horizontal array. "X" is the distance from the array where the individual wave fronts integrate at a sample frequency. Minimizing dis-

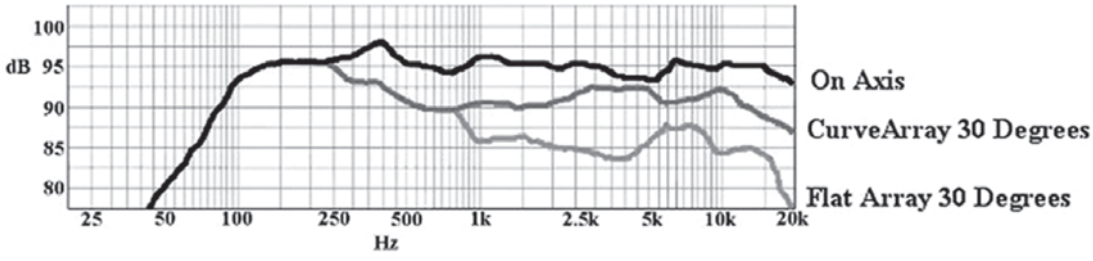

FIGURE 1: Response, on- and off-axis.

tance "X" is necessary to prevent lobing and comb filtering. The usual method of doing so is to space drivers with their acoustic centers no more than a wavelength apart.

The center cabinet is an array that incorporates an outward splay angle. The overall dispersion angle is increased, but so is distance "X," so both lobing and comb filtering are worse than in the straight-faced box. The cabinet on the right shows what happens when the drivers are splayed inward, cross firing. The dispersion angle is wider than with outwardly splayed drivers, yet the "X" distance is less than that of the flat array.

I tested the CA configuration with tweeter spacing half that of the final version, using two tweeters per woofer, and found no improvement below 12kHz. Use two tweeters per woofer if you wish, but considering the bandwidth of home theater (HT) center-channel program material, it's probably not worth the added expense. For that matter, you can make life much simpler by not using tweeters at all. **Figure 3** shows the response of the prototype without them, and the HF response is adequate for most center-channel program material.

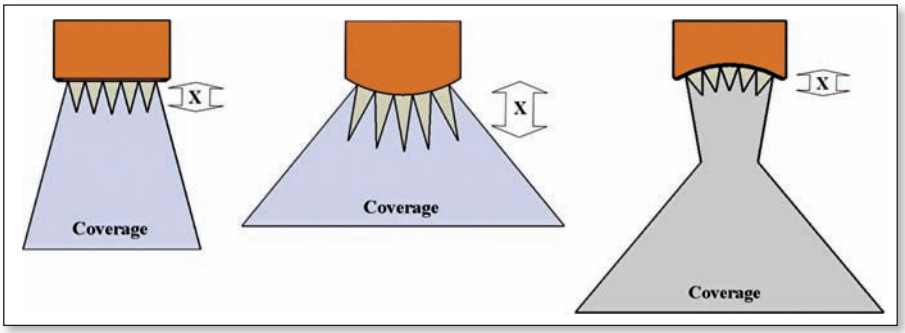

FIGURE 2: Dispersion versus wave-front integration.

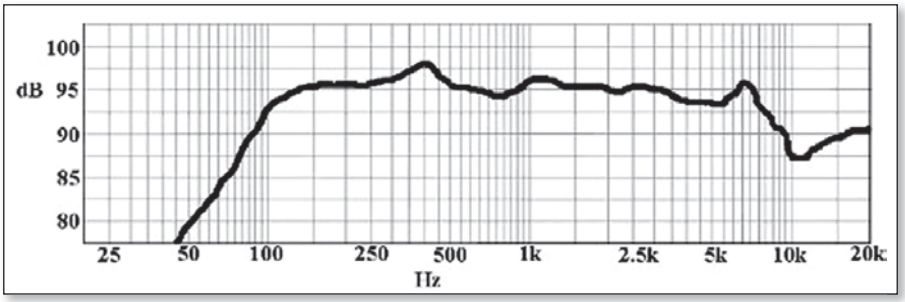

FIGURE 3: Response, woofers only.

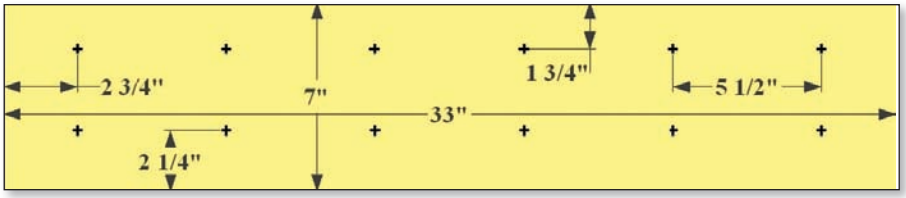

FIGURE 4: Initial baffle layout.

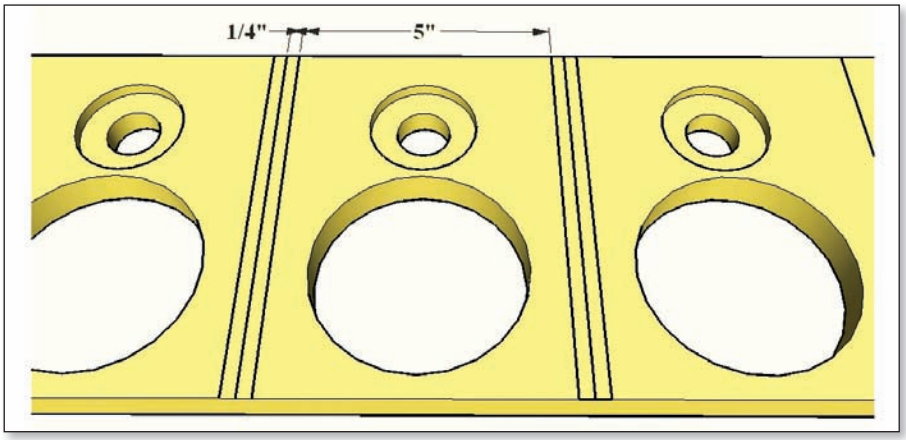

FIGURE 5: Secondary baffle layout.

CONSTRUCTION

You may build the cabinet from plywood or MDF, but solid wood is a viable option, and greatly simplifies the finishing process. I built the original from red oak, using 1 × 8 for the baffle and sides and edge-glued 1 × 6s for the top and bottom. Following these dimensions, you'll need a 6′ 1 × 8 and two 8′ 1 × 6s, while you can use plywood scraps that you may have in your shop or a 1 × 8 pine. The dimensions of the cabinet height and driver spacing shown are for the 4″ midbass drivers used in the original; you may alter them as desired for larger or smaller drivers.

Start construction by cutting out the baffle, 33″ long. The height of a standard 1 × 8 is nominally 7.25″. Trim that height based on your driver sizes; I made mine 7″. Draw two horizontal lines on it—one the radius of the tweeter plus ¼″ from one edge, the other the radius of the woofer plus ¼″ from the opposite edge. Draw intersects on these lines as shown in **Fig. 4**. These are the centers for the holes for the woofers and tweeters, respectively.

Drill holes for the drivers, sized for your drivers and their mounting schemes. For the tweeters I first drilled a 2″ diameter recess in the rear of the baffle, ¼″ deep, then a 1″ hole for the tweeter to fire through, chamfering the exit of that hole to a ½″ radius with a quarter-round router bit. For my woofers, I first routed a 4″ diameter circle 1/8″ deep on the baffle face, drilled a 3¾″ diameter hole and then chamfered the hole on the rear of the baffle, again with a ½″ radius quarter-round router bit.

After drilling the driver holes, draw cutting lines on the baffle per **Fig. 5.** With 4″ drivers, first draw a line equidistant to the driver centers, then draw lines ¼″ to either side of the first, for 5″ baffle segment widths. Cut the baffle segments—four with two 5° edges, two with one 5°, and one 25° edge, per **Fig. 6.** Be sure the angles are facing the correct direction, and that the two end segments

PHOTO 3: Polyurethane glue "fizz-out."

are mirror-imaged. Sand the baffle segments in preparation for finishing before assembling them, because it is difficult to do so after.

ASSEMBLY

You may construct a jig to hold the baffle segments in place for gluing, but there's an easier way. I used "PL Turbo," a three-minute setting polyurethane glue. Dampen one mating surface with water, apply a few thin beads of glue to the other mating surface, then hold the two parts together for three minutes. You can tell the glue has set when it foams out of the joint while curing (**Photo 3**). In this fashion you can glue the six baffle segments together in about 20 minutes, which is probably less time than it would take to fashion a jig. Be careful handling the baffle assembly, because the glue won't fully cure for a few hours. When the glue has fully cured, scrape off the excess with a utility knife and sand the assembly in preparation for applying a finish, taking care not to break any joints.

PHOTO 4: Assembled baffle.

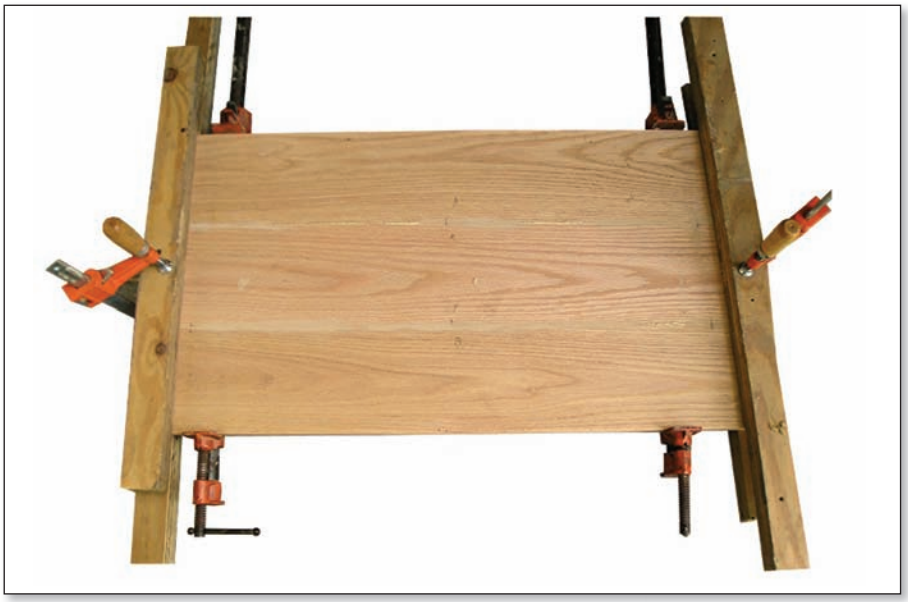

PHOTO 5: Top glue-up.

PHOTO 6: Drivers installed, interior view.

Measure the finished baffle (**Photo 4**) end to end. Initially cut the top and bottom that distance plus 1¾ to 2″ wide, and no less than 8″ deep. Cut the back the same width as the baffle. You may make the cab more than 8″ deep as desired; I made mine 15″ deep, to double as a shelf in my HT unit. You can go even deeper; for example, if you want to use the cab as a TV stand. You also can go wider, adding wings to either side of the baffle, should you wish to match the width of the cab to your TV.

Should you decide to make your top and bottom from solid wood, the easiest way to joint them is with biscuits, clamping them with clamps and cauls to hold them flat (**Photo 5**). Cut the sides the same depth as the top/bottom. The outboard woofer magnets will come close to the sides (**Photo 6**), and with some woofers the magnet could actually hit the sides, so trial-fit the baffle, sides, and a woofer before assembling the cabinet, routing recesses in the sides if required. Glue the baffle assembly to the cabinet top, with the woofer holes being closer to it.

If you have enough clamps, you may glue the baffle, sides, and back to each other and to the top simultaneously (**Photo 7**). Leave an equal amount hanging over the top at either end. If you have only a few clamps, glue the baffle in place first, adding the sides and back after the glue has set. "PL Turbo" is an option if you have no clamps, but standard urethane glue is a better choice if

you do have clamps, allowing you plenty of working time.

If you make the cab 8˝ deep, mount the back flush to the rear of the box, to maximize internal volume. With a deeper cab, you can inset the back from the rear of the cab by 1˝ or so, to hide connectors and to allow "invisible" mounting of an external crossover.

After the glue has cured, screw the bottom in place temporarily. Use a router trim bit and/or sander to trim the top and bottom flush to the sides. Sand the exterior in preparation for finishing, smoothing the joints of the baffle ends and sides. Remove the bottom, fine-sand as required, and apply a finish. My preference is tung oil, which does a professional job with the least amount of effort.

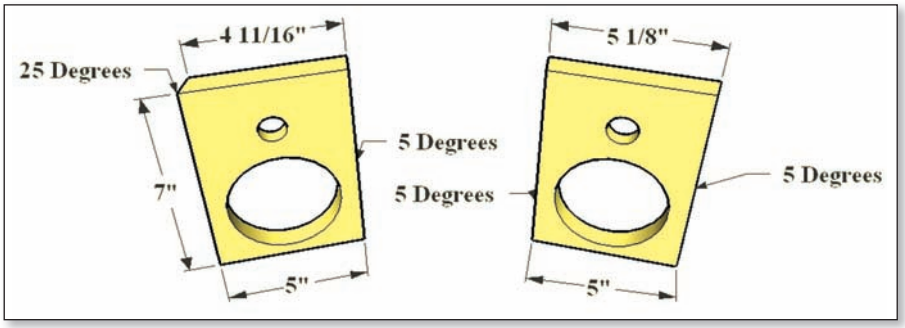

FIGURE 6: Individual baffle segments.

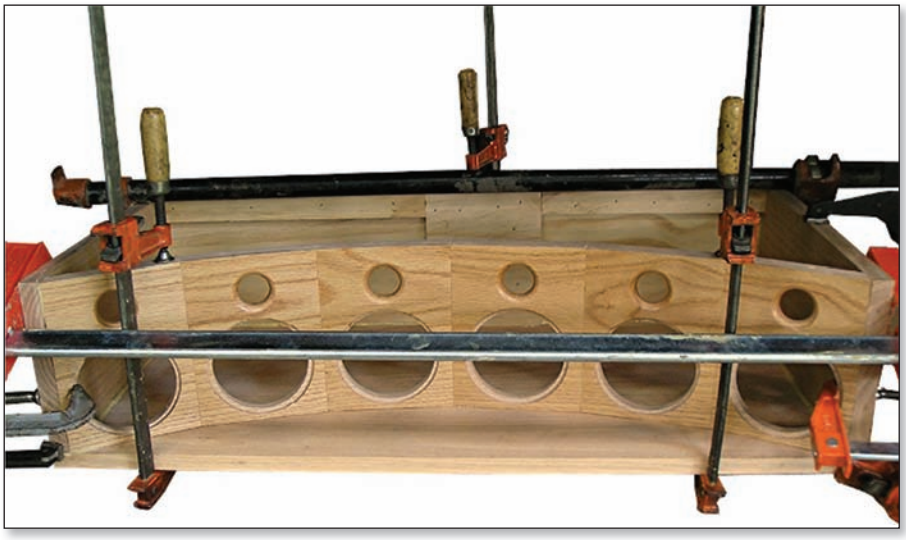

PHOTO 7: There's no such thing as owning too many clamps.

DRIVER INSTALLATION

Install the drivers. For an airtight seal, use a driver sealing gasket tape, such as Parts Express #260-540. With a frameless tweeter such as the Onkyo, glue it in place with a hot melt glue gun, first with a thin bead around the frame perimeter, then thoroughly filling the joint to ensure an airtight seal.

The drivers are wired to give impedance between 4 and 8Ω. I wired those of the prototype in banks of three, each bank parallel wired, the two banks in series. With my 8Ω woofers this gave a 5.3Ω impedance, while the 6Ω tweeters came out to 4Ω. I crossed them over second order at 6kHz, using component values from the calculator contained in my WinISD software (www.linearteam.org).

Install binding posts or a jack through the back, and function-test the cab before loosely filling it with poly batting. Screw the bottom in place, using the driver gasket tape on the joint for an airtight fit. Hook it up and be prepared to lower the center-channel volume on your HT receiver, because it's probably going to be considerably louder than your old center speaker, especially off-axis. *aX*