The D2W Center Channel Speaker

Design Goals

I wanted to build an efficient, natural-sounding center channel speaker for less than $100. This design goal was driven by my large living room, a modest budget, and my even more modest woodworking skills. I had an entry-level center channel speaker that sounded pinched and didn't match my right and left speakers at all.

My main advantage in tackling this impossible-sounding task was that the layout of my living room naturally places the front speakers in a plane several feet behind the video monitor. Therefore, I didn't need to worry about using shielded drivers, and I could allow form to follow function (up to the level of spousal tolerance) for the center channel enclosure shape and size.

Driver Selection

I was committed to using a Fostex polymer dome tweeter in order to match the replacement tweeters I had previously installed in my front speakers (two-way speakers from an old three-piece DBX Soundfield 3 x 2 RS Plus speaker system). The Fostex tweeters are 4 ohms, with a frequency response of 2-20 khz, an efficiency of 91 db/1w/1m, and rated for 35w RMS. I purchased the tweeters on eBay, but PE (Parts Express) sells many excellent tweeters with similar specifications.

I looked for a 5" woofer/midrange that would complement the tweeters and was attracted to the Westra KF-130-1304, which was available at a buyout price from PE. The Westra driver is very efficient at 91 db/2.83v/1m, has a smooth frequency response from 200-4,000 hz, and it's rated at 4 ohms impedance and 20w RMS.

Enclosure Design

I've read that the typical horizontal MTM center channel suffers from impaired horizontal dispersion, which is usually countered by raising the tweeter in relation to the two woofer/midrange drivers. Given my lack of enclosure constraints, I thought it made more sense to build a simple vertical two-way center channel. However, I was also concerned about the low impedance of my drivers, and the modest power handling of the 5" Westra (20w RMS, 40w max). So I decided to address both issues by wiring the drivers in series (tweeter-tweeter, mid-mid) and building side-by-side two-ways in a single enclosure: hence the "D2W" (Double Two-Way) center channel speaker. This design presents my amplifier with an 8-

ohm load and doubles the center channel speaker power handling capability to a level that works well with a 100w/channel amplifier.

People who believe that potential interference between closely placed identical drivers is to be avoided at all costs will probably stop reading right here. This seems to be a controversial area, and I liked the D2W design concept, so I thought it was worth an empirical test.

I modeled a pair of the Westra drivers in a sealed enclosure in WinISD. Although the optimal enclosure was 0.9 cu. ft., there seemed to be very little drawback to using a somewhat smaller enclosure. I settled on external dimensions of 13.5" wide, 9.75" tall, and 12" deep, which I could construct from one 12" x 6' piece of material. I used 5/8" particle board (would MDF be that much better?), so the internal dimensions are 1.25" less than the external ones, with an enclosure volume of 0.65 cu. ft. The vertical centerlines of the two-ways are 6.5" apart horizontally. Each tweeter and woofer are placed as close together vertically as possible, and each pair is vertically centered in the enclosure, for a simple symmetrical design:

Enclosure Assembly

Before starting the enclosure, I prewired the crossover and L-pad:

The enclosure was built with hand tools (circular saw, jigsaw, and drill; no router or table saw). I used simple butt joints with lots of glue and 1 5/8" drywall screws for assembly. First, I assembled the front (baffle), bottom, and sides of the enclosure, and then drew the speaker hole circles with a compass and cut the openings with a jigsaw. I inserted a vertical brace (3" x 8.5") behind the baffle and mounted the crossover (described later), centered horizontally on the bottom panel, 1" from the back edge. Then I attached the back panel. The speaker at this point of assembly looked like this:

The enclosure then received polyfill lining, attached to the panels with glue, as shown here:

I attached the top panel, let the glue dry, and primed the front and rear panels and edges. The front and rear panels then received two coats of black satin paint. I mounted the L-pad knob (see crossover section) and the binding post plate (parts from PE). I soldered all electrical connections. I attached the drivers to the baffle with 3/4" screws. The top, bottom, and sides of the speaker are covered with red maple vinyl laminate from PE. This excellent laminate is very thin, flexible, and easy to work with, but it will highlight rather than hide any problems with your woodworking, as I discovered.

Crossover

I looked at the Westra SPL/frequency response graph on the PE web site and selected a crossover point of 2,500 hz to minimize the effects of the Westra's uneven, peaky response above 4 khz. I purchased a finished two-way crossover by Dayton Loudspeaker Co. from PE. I imagine that a custom crossover to deal with baffle effects, etc. would be desirable, but this is only my third speaker project (the first two projects were passive subs) and I haven't gotten into crossover design yet.

I included a 50-watt mono L-pad between the crossover and the two tweeters so that I could adjust the tweeter output level, since to my limited knowledge the D2W is a novel center channel design, essentially sporting an "extra" tweeter compared to an MTM design. I thought the speaker might sound too "bright" and require adjustment.

Conclusion

I placed the speaker on a stand to match the height of the left and right speakers, matched the listening distances, and matched the speaker output levels with the receiver's 1 khz setup tone. I set the center channel output to "small" on the receiver to send the bass signal (100hz and below) to the subwoofers. Then we watched sections of "Lord of the Rings" and "The Matrix" from DVDs.

The sound of the D2W center channel speaker is everything I hoped for: smooth, effortless, natural, full-range, and seamless with my left and right speakers. The D2W "disappears" as a separate source of sound. I did not need to use the L-pad to reduce the tweeter output level, so that item could be left out of the design, saving $6 and simplifying the wiring in the enclosure. And I met my budget goal anyway (see parts list).

I don't have any frequency response testing equipment; sorry to disappoint those looking for the all-important frequency response graphs. However, if any of you with such equipment live anywhere near Athens (southeast) Ohio, I'd love to test the speaker, post the graphs, and adjust the design as needed. Feel free to contact me via email: mannd@ohio.edu.

Parts List

PE #	Description	Approx. cost, $
299-120	(2) Westra KF-130-1304 5" drivers	20
	(2) Fostex 1" polymer dome tweeters (eBay)	16
260-142	(1) Dayton 2,500 hz two-way crossover	20
	(1) 6' x 12" piece of 5/8" particle board (Lowe's)	6
260-255	(1) L-pad, 50-watt, 8 ohm mono (optional)	6
260-020	1/4 sheet of red maple vinyl laminate	4
260-301	(1) nickel-plated binding post	2
	Parts Express shipping charges	8
	1/4 bag of department-store polyfill	1
	Misc screws, glue, press-fit grill guides, a bit of grill cloth	5
	Primer, paint	5
	TOTAL	$93

About the Designer

Doug Mann (mannd@ohio.edu) is a faculty member at Ohio University during working hours. In the evenings and on weekends, he putters around his country estate, drives in autocross races, builds speakers, and enjoys family life with a tolerant spouse, a teenage daughter, a son studying at OU, and two English Cocker Spaniels.