Performance Media Industries, Ltd.

Those Pesky Cabinets
12/2004

by A. Grimani

I have to do it; you have to do it; everyone gets to do it: Put front speakers in cabinets. Of course you know that a perfectly good loudspeaker ends up sounding like dog doodoo once it's recessed into the cavity formed by the shelves and the panels. The inevitable resonance effects of the cavity totally overcome the beautiful free-field response of the speaker. You could say, "Too bad, I want to conceal the speakers, and all that can come of it is poor sound." But wait a minute! There are actually things you can do to make the system sound OK despite the apparent compromises.

Let's first look at the issues created by cabinet mounting:

1) Bass frequencies are omni-directional so they radiate out in front of the speakers as much as behind them. That means half of the sound gets trapped inside the cabinet cavity. This cavity has a specific set of resonances based on its dimensions, and those resonances will alter the sound emitted by the speaker. Imagine putting your speaker inside a drum; you know that it won't sound the same as it does out in the open.
2) Bass and mid frequency sounds will reflect from the shelf surfaces back into the room with a slight delay compared to the direct sound. This delayed addition will result in destructive interferences at some frequencies, thereby clouding the sound quality.
3) The overall level of the lower mids and bass will be louder than intended, and the speaker will sound thick and congested.
4) The cabinetry may rattle, introducing distortions and at worst making it seem like the speaker is actually broken.
5) Speakers are often below or above seated ear height, so if they aren't appropriately aimed, they are firing away from your ears.

All of the above is bad and will make your high-performance speaker sound like a cheap knock-off you could buy out of the back of a van at the local mall.

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If you want to protect your interests and get full value for your investment, I recommend implementing all of the strategies hereunder. (This is starting to sound like a legal document!)

1) Drill out or create slots in the cabinetry shelves, side panels, and rear panel. If possible, try cutting out all or a large portion of the rear panel. This will prevent the cavity resonance effect and substantially clean up your sound. The holes should be ½" to 1", and you should put as many holes as you can. Make sure no one is watching as you take the paddle drill to the expensive, exotic, wood custom cabinetry… Or better yet, plan the venting in the original design of the cabinet (duh!). Remember to apply light pressure as you get to the end of each hole to prevent punching out a bunch of splinters.
2) Pack absorption material all around the speaker. Dense mineral wool is the best choice, but make sure to wrap it in light-weight black fabric to avoid the itches. Dense fiberglass, dense acoustic foam, or packed polyester batting fill will also work. The absorption material will reduce the resonance effects and tighten up your bass problems.
3) Push the speakers out as far as possible to the front lip of the shelf. This will reduce reflection effects from the cabinetry surfaces.
4) Create an acoustic baffle all around the front of your speakers. The baffle should typically be made of ½" cabinet grade plywood. If possible, it would be backed with loaded vinyl barrier or sound board to damp its mechanical resonance. The baffle plate would then be covered with ½" or 1" medium density absorption (such as Owens Corning 703, Linacoustic, or Dynasound) with fabric lining. The baffle would be affixed to blocking, screwed into the side of the shelving and panels. A baffle plate will entirely stop the rearward sound radiation of the speaker, preventing it from resonating inside the shelf cavity and forcing all the sound forward toward the listener. This will by far result in the largest improvement in sound quality. Watch out for speakers with rear-firing ports; depending on the model, you may need to plug them if you add a baffle (or you may not be able to use a baffle at all).
5) Aim the speakers. A speaker above seated ear height should be aimed down; a Left speaker should be toed in to the middle of the room, etc. With some speakers this can make a huge difference, and with most it just improves the frequency response for a sharper sound. Now, aiming a speaker down when it's mounted in a baffle can be tricky! Do you aim the entire baffle down with the speaker, or do you aim the speaker within the baffle? Both approaches have their advantages, but I generally would rather see an aimed baffle with sufficient absorption placed in the deeper recessed area. This will avoid diffraction turbulence effects. In case you were wondering, the same baffle aiming issues apply for the toe-in of L/R speakers.

6) Test for rattles. A loud single tone sweep from 20 Hz to 500 Hz will typically reveal any rattle problems in the cabinetry. You will need a single-tone generator, such as the Gold Line TS3, or a test disc with a tone sweep. Slowly sweep through frequencies and stop when you find a rattle. Find out what causes it, and fix it with screws, putty, tape, felt, or whatever else you want to pull from that MacGyver kit you got for Christmas.
7) Equalize the speakers. Now that you have baffle-mounted the speakers and treated the zones behind the baffle with absorption and perforations, you will find that the bass is gently but audibly boosted up. You just need some simple compensation to pull down the bass gain. I typically see 6dB gain (sometimes a bit more if the speakers are also close to sidewalls). Today's equalizers will correct the errors without adding audible pollution to the sound paths. The likes of Audio Control, Rane, Ashly, and BSS have figured out how to make powerful devices with clean signal paths, so there's absolutely no reason not to specify equalization into a home theater system. Of course you will need to measure the speaker+baffle+cabinet response with a good analyzer that has spatial and temporal averaging and carefully correct for the bump in bass level until the result is smooth all the way down to 20 Hz.

I know that all this can take some time, but believe me that it's way worth it. I have often turned a nasty-sounding, cabinet-mounted system into an acceptable audio experience through the above sequence of seven steps – and made happy customers with the predictably good domestic harmony that results from hidden speakers. Give it a shot!

This article is based on a column published by A. Grimani in Residential Systems magazine December 2004.

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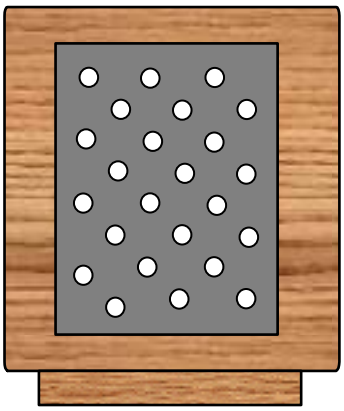
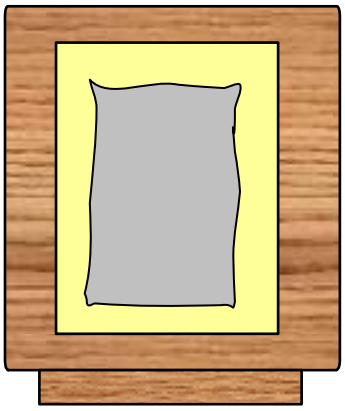
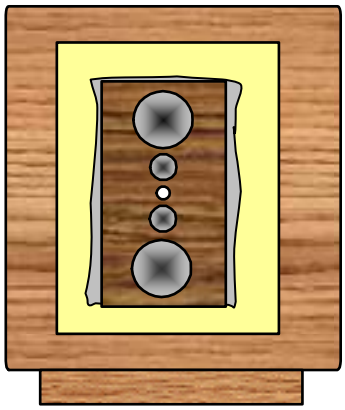
Speakers in Cabinets: Steps to Reduce the Mess



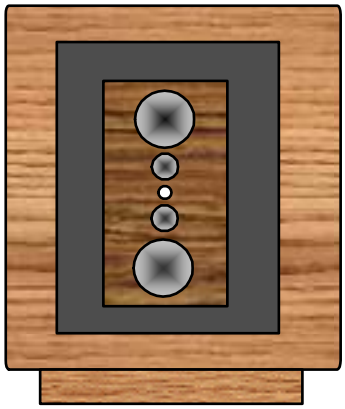
Perforate the sides, back, and shelves.



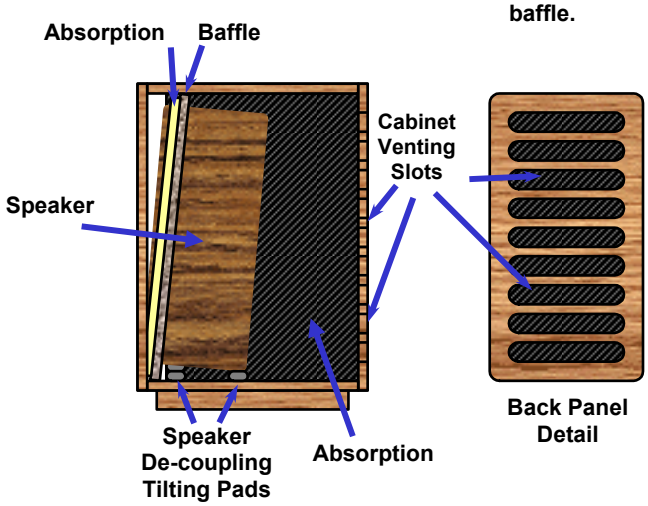
Fill the cavity with absorption.



Place and aim the speaker in the cabinet.



Place baffle board around the speaker and layer absorption in front of the baffle.



A Side View of the Completed Process

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