

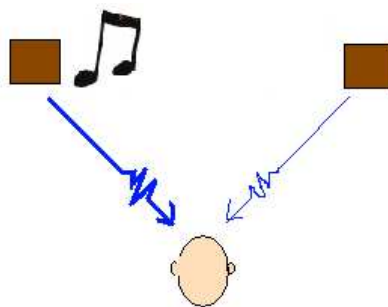
Setup of Controlled-Directivity Waveguide Speakers

I'm probably unusually sensitive to image with a stereo system. I'm one of those guys who was always jumping up to tweak the balance control in pre-remote days, or moving myself to the left or right on the seat to get all the instruments and the singer from sounding like they are crowding to one side. Even for one listener, sweet spots were just too small. And multiple listeners tended to basically get mono from whatever speaker was closer.

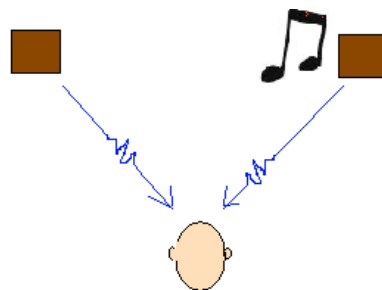
Most people who pay any attention to waveguides have heard about toe-ing them in, but a lot of comments I've seen on forums suggest that many didn't actually get the point. So here are some graphics and words to (I hope) make the idea clearer.

One of the big advantages (in my opinion, **the biggest**) of waveguide speakers is the possibility of having a very wide "sweet spot" and very stable front images. To see how, consider what determines the apparent sound source direction in a stereo setup.

When the same sound comes at us from two speakers, the apparent source direction depends on which speaker's sound is more intense

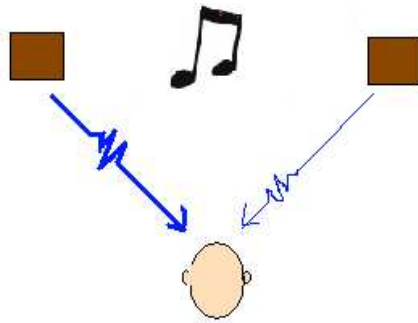


and which reaches us first.



If these factors are similar from both speakers the sound appears to come from somewhere in between the speakers. The intensity and arrival times, if of opposite effect in the two speakers, can also counteract. . If a sound that arrives earlier is not as loud as a copy that arrives later, the perceived location can lie

somewhere between the two actual source directions. (Google "time-intensity trading" for more about this).



Most people, if they think about it all, assume that the ideal speaker would be an omnidirectional point source. Here is a picture to illustrate the intensity patterns you'd get from two such speakers if you could achieve that kind of radiation:



A listener at position "m" will hear both speakers with similar intensity, and being about the same distance from each, a center image will appear between the speakers. But if he moves his head to position "o", a little off-center, he gets nearer to the right channel speaker so it is heard first, and the intensity from the right side also becomes stronger. (In the graphic, sound intensity is indicated by color intensity). So the image abruptly slides toward the right, and if the listener is more than a little off center, the image is mostly crowded near the right speaker. So, not so ideal. Use of a center channel can help a lot with this, but the side speakers are working against keeping the image stable.

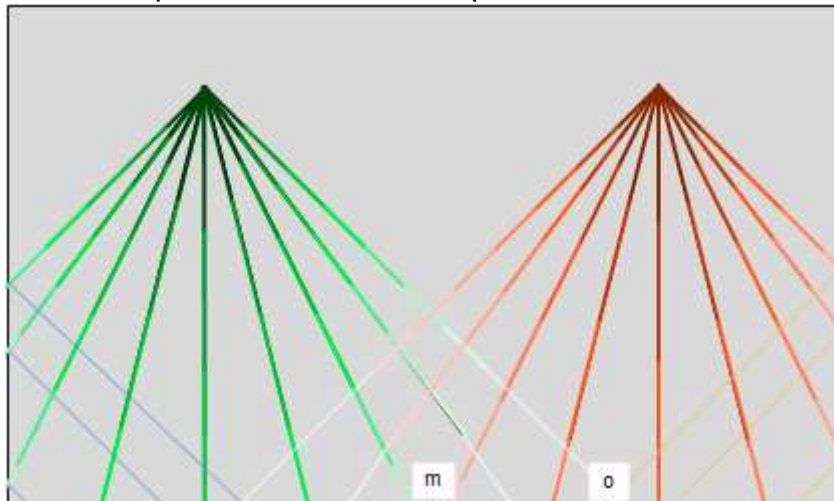
With omnidirectional speakers, the sound going backwards away from the listener will eventually bounce around and get back to him, and if its spectral character is similar, will add some ambience, which if delayed long enough is probably good. But the sound going to the side walls will reflect and arrive at the listener very soon after the direct sound from the same channel, resulting in a coloration from the filtering effect. That's not so ideal, either.

So let's assume we instead have speakers that are directional with a radiation pattern like this:



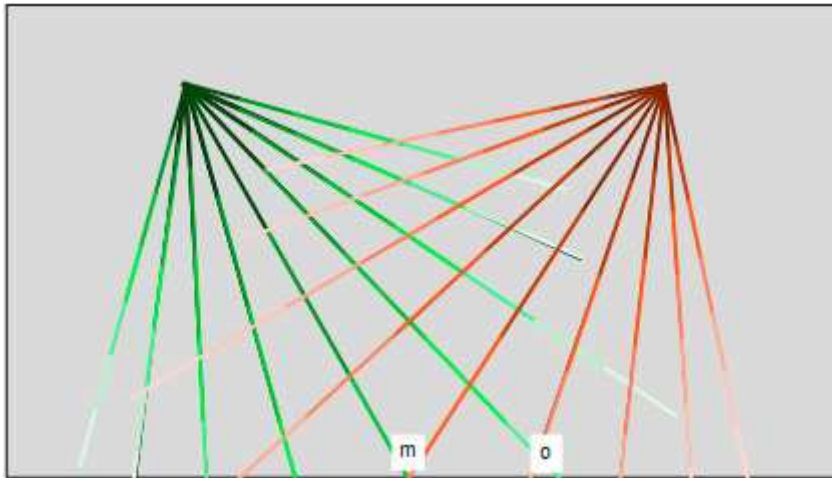
As your listening position gets off-axis (so that the speaker isn't pointing at you so directly), the intensity gets weaker. To be fully helpful, all upper frequencies should do this similarly. For now assume that the whole spectrum keeps the same general shape ("constant directivity") at different angles off-axis, but gets lower in intensity as you go further off axis ("controlled directivity").

Put two of those speakers in stereo and point them forward like this, and:



Oops. ***It's even worse!*** As you move from the mid position "m", where not much direct sound reaches you now, toward "o", you not only get closer to the right channel, but the intensity from the right goes up rapidly while intensity from the left drops down just as fast. The image leaps to the right! And the majority of reflections are near reflections from the close side walls coloring the audio spectra. That's what happens if you take controlled directivity waveguide speakers and set them up firing directly forward. If you need to set up like that, *you are probably better off **not** using controlled directivity speakers* but instead going for something with wider coverage.

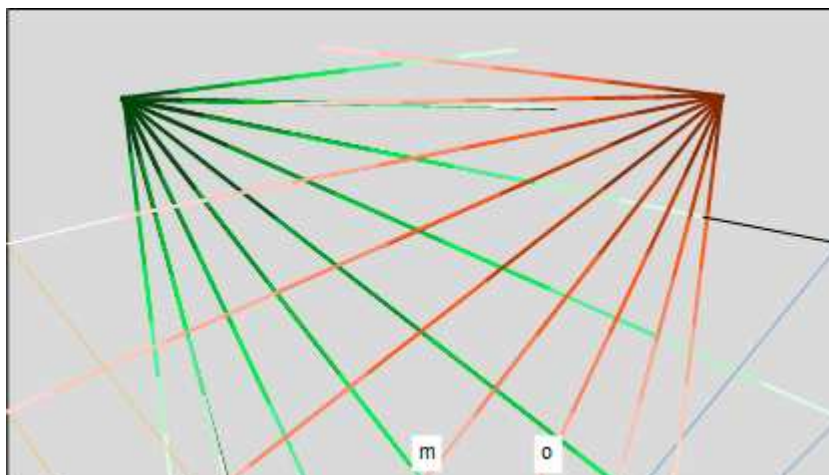
Ok, so we'll toe them in -- aim the speakers right at the center listener:



That's what people often do with speakers that are designed to have flat response on-axis, so that the response of the direct path sound waves is flat (though if the speaker isn't constant directivity, the reflected sound waves will have a different shape).

That's better, because as you go to the right, the intensity of both speakers drop, though the left speaker still drops faster (and its sound of course still arrives later). The image still shifts, but not as badly as without the speakers toed-in. The near reflections off the close wall are much reduced, so that's a plus. And of course if the speakers are designed for proper response only on-axis (and the response shape deviates a lot off-axis), then toed-in like this is the only way to get the designed-for response for direct waves even for a single centered listener.

So, is toe-ing in a "fix" for a defect from a controlled directivity design? Try toe-ing them in **considerably** further. In fact, point each speaker roughly at the furthest listening seat from it:



Now things get more interesting. When you move toward the right, the sound intensity from the right speaker goes DOWN, because you are getting further off-axis from it. The intensity from the left speaker goes **up**, even though you are getting further from it, since you are getting more onto its strong main axis. The intensity goes opposite to the effect of the sound arrival time effect – “time-intensity trading”. When properly balanced (achieved by adjusting the degree of toe-in), the image stays put essentially across all the listening positions, and no matter how much you move your head. It becomes largely independent of the listener’s movements.

Interesting things happen with the reflections, too. The first strong reflections to reach you come from the wall but originate at the opposite speaker, so it is much more delayed and provides a very enveloping effect without coloring the timbre of the sounds.

The effect can be pretty amazing with controlled directivity waveguide speakers. In fact, in my system I now usually sit almost directly in front of my right speaker (because it's nearer to a power outlet I can plug the laptop into, and nearer to the fireplace for warming feet!). And the imaging is stellar and a solo singer stays right between the speakers. If you’ve “heard waveguides”, but they weren’t properly toed-in, then you basically haven’t heard waveguides.

One other pattern-related thing I’d like mention is obstructions in the room. The controlled directivity waveguides also control in the vertical directions, where they are often designed to have a narrower pattern. If you put the speakers on the floor, with the waveguides at knee-level, then they will have strong radiation toward all the various things on the floor of your room: furniture, plants, lamps, etc., and may generate near reflections off of these. But if you arrange the speaker so that the waveguide is near ear level, then horizontally there will be fewer things up there for the sound to bank off of. In my system, that seemed to make a very significant difference. I originally thought I could put the speakers on the floor, tipped up toward my chair and all would be well. But when I put them up on stands instead, there was no way they were going back to the floor again. Try it.