Omni Directional Speaker

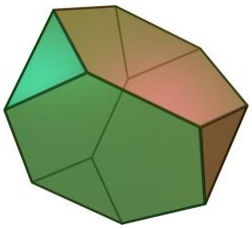
Jaap van Loon, January 2023

Background

An omni directional speaker is a sound source that emits sound in all directions, unlike traditional speakers that radiate forward (except for bass tones, which go in all directions). The claim is that omni directional speakers are better suited to our evolutionarily developed hearing system of ears plus processing by our brain. A condition thereby is that reflections via walls, floor and ceiling are little hindered because our hearing system also needs this sound information to determine the location of a (virtual) sound source.
A reasonable argument for this claim is given by Siegfried Linkwitz in his presentation: Linkwitz AES "Accurate sound reproduction" https://www.google.com/search?q=Linkwitz+AES+%22Accurate+sound+reproduction%22&sourceid=chrome&ie=UTF-8 Parts 2 and 3 are particularly relevant in this context.

System concept

There are several types of (semi) omni directional speakers. In the design described here, four drivers are mounted on the surfaces of a (semi)regular polyhedron. Useful for this project turned out to be the regular tetrahedron and the regular octahedron, whether or not in truncated form (semi-regular). With these shapes, the minimum of four drivers is sufficient.



The shape described below is that of a semi-regular tetrahedron (truncated tetrahedron), made up of four regular hexagons plus four equilateral triangles. This shape is the easiest to build. With a rib length "r", the volume is approx. 2.7 x r^3. In each of the four hexagons a driver is mounted. The uniformity of the spherical radiation field turns out amazingly good (± 1 dB, up to over 5 kHz in the distant field).

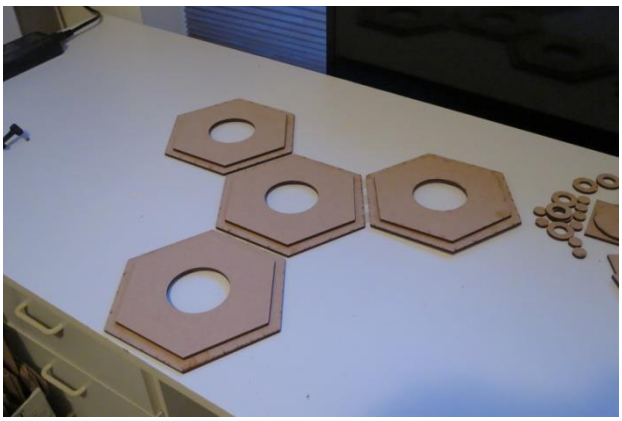
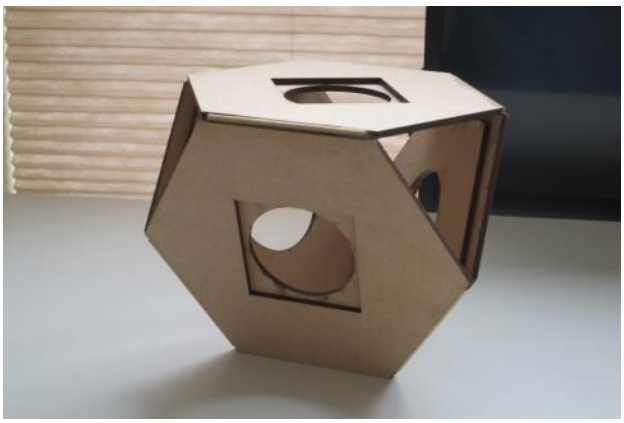
The next step was to find a suitable driver. Of importance was:
- Sufficient frequency range in the high (to avoid tweeters)
- Minimum box dimensions (the ideal omni directional sound source is a point source)
- A reasonable price (after all, eight are needed per speaker pair)

After some research I chose the DMA70-8, a 2.5 inch full range woofer from Dayton Audio. https://www.soundimports.eu/nl/dayton-audio-dma70-8.html

For a Qtb of 0.7, this driver requires a volume of about 0.6 liters net in a closed box. The Fb then becomes approx. 160 Hz. The four drivers then require a common volume of approx. 2.7 liters gross. For this, the rib length of the truncated tetrahedron "r" should be 10 cm. The boxes are normally filled with some damping material.

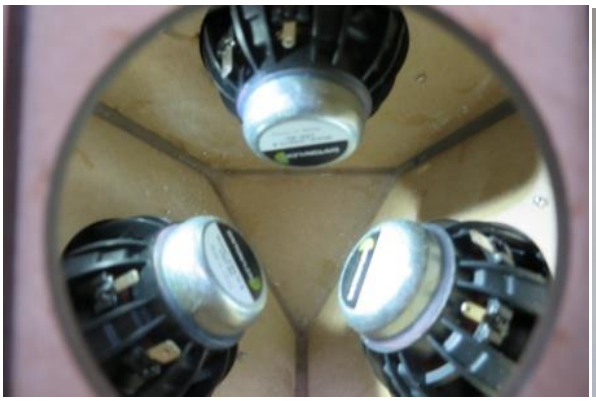
Construction

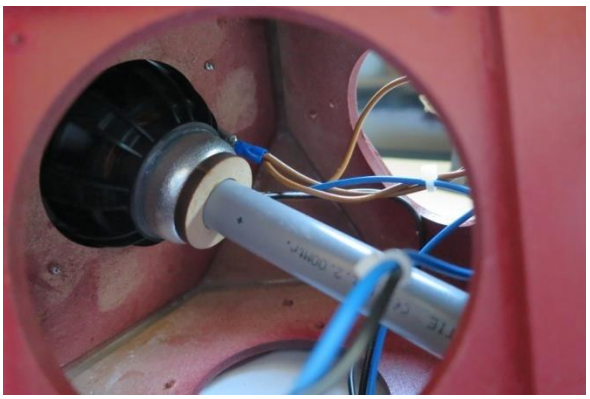
The following pictures give some information about the construction of the boxes:

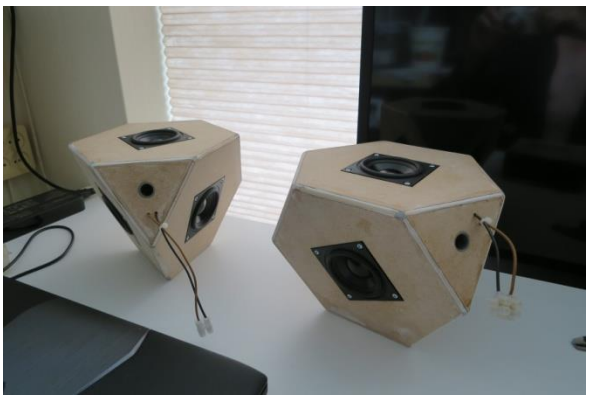





The material used is 4 mm MDF. The hexagons and triangles must be precise to size. In the absence of a saw table, I ordered the material from a laser cutting company. The baffles are held in place with adhesive tape and then folded together. The resulting v-seams are filled with wood glue. Also on the inside, all seams must be glued to get sufficient strength.

When the boxes are glued together, the drivers are placed, the wiring is fitted and the adapter for the stand is mounted. The following pictures give some details. At a later stage, the connections are incorporated into the adapter.



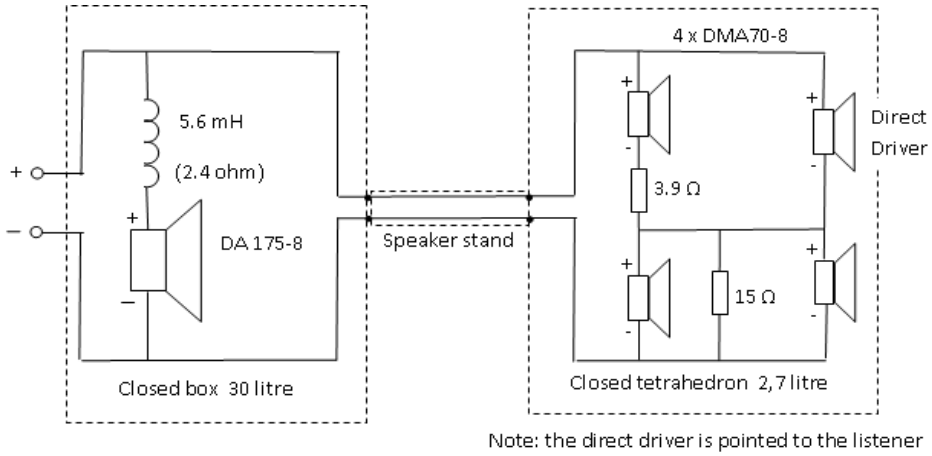





Subwoofers

Due to the relatively high crossover frequency of 160 Hz, it is necessary to provide each speaker with its own subwoofer which must be placed under the omni speaker. The subwoofers also serve as a speaker base.

The drivers are as follows connected to the amplifier:



Note: the direct driver is pointed to the listener

The resistors in the omni speakers ensure that the driver aimed directly at the listener sounds 3 dB louder than the three indirect drivers. This suggest more space behind the speaker.
note: if the speakers are placed far (> 1 m) from the walls, no resistors should be used.

The speaker stands are steel tubes of 12 mm outside diameter. The connecting wires are incorporated into the tube. Omni's, woofers and stands are equipped with "tulip" connectors for "quick release" and simple transport.

Listening

As a follow up I have built a second set of omni speakers, this time based on a truncated octahedron. The driver configuration remains the same.

In the following photo you can see that the direct drivers are aimed at the listener, taking care that only one driver can be seen (this requirement limits the number of drivers in this concept to four). To prevent the remaining single reflection, a piece of damping material has been applied against the wall. Because of this, together with the attenuated indirect drivers, it turned out to be acceptable that the speakers are placed relatively close to the wall.

Here are my personal findings:
The speakers give a nice open sound. Seated in the sweet spot, after some time to get used to it, the speakers as well as the listening room disappear from the sound stage (at least with a good stereo recording). What remains is the sound of the musicians in the room in which they play. The stereo image is sparkling and appears 3-dimensional. All this in an ordinary asymmetrical living room that is not equipped with absorbent or diffuse elements. Outside of the sweet spot, the sound quality, although no longer really 3-d, is still very good.

PS: I think that 4 drivers in a polyhedron is the maximum. This is why:
If you, as an example, take a dodecahedron with 12 drivers, you will always “see” more than 1 driver from the listening position. The drivers you “see” are all at a slightly different distances from your ear, so you get cam forming due to the different delays (no time alignment). These distortions will be probably not exactly the same for the right and left speaker. And because in particular differences between right and left results in a woolly stereo image, cam forming should be avoided.