# Journal of a DSP Loudspeaker Designer

First experiences (1972)

An old Telefunken tube radio and phonograph console was how I first began to enjoy music and stereo sound and imaging. I loved the warm sound but hated the missing bass and attenuated treble. I had to turn up the volume a little more each time I heard a great cut just to get some sound satisfaction. Unfortunately the old Telefunken failed to operate one day and it was more than just the tubes. Since the system really did not meet my ever growing need for good sound I purchased a 25wpc transistor integrated amp and some speakers a friend sold me. At low levels it seemed to improve the attenuated treble problem the tube system had but not the bass and the warm sound turned a little cold. On the good side the stereo imaging was significantly better, which added an additional dimension to reproduced audio. Small improvements such as loudspeaker position, better speakers and amplifiers still did not give the audio sound bliss I craved, it got better but not good enough.

The beginning (1978)

I determined that loudspeakers were where the biggest improvements were needed, I cannot recall why or how I came to that conclusion, possibly from listening to many systems and realizing that a change in the amplifiers or turntable or CD player made small overall improvements compared to changing the loudspeaker which would completely changed the sound of the whole system. As a poor student I could not afford a good pair of loudspeakers so I borrowed a book on loudspeakers from the library. There in the last chapter a few words in a paragraph the author suggested that an active loudspeaker would benefit significantly from directly driving each transducer (driver) and avoid the many issues passive crossovers have. I created my first active loudspeaker using some opamps for the frequency dividing circuit and 3 stereo kit amplifiers directly coupled to the drivers with the drivers in plastic buckets held by electrical tape. WOW, did it sound good. Clean, powerful, but overall it still had issues, only the issues were now different. You would think that volume controls on the active crossovers outputs for the midrange and treble would be all you needed to balance the active loudspeakers tone and overall sound but it was not that easy. The sound was clean and powerful but the frequency response was now very difficult to get right and the stereo imaging was also not right. It would be many years latter that I would return to active loudspeaker development, education, job and family were foremost and I had resorted to using a passive 2-way ported loudspeaker that I had constructed using really nice Dynaudio drivers, that loudspeaker did sound good. Even so I and many others remembered the awesome impression the plastic bucket cabinet active crossover loudspeakers had made.

(2004)

In the 26 years since the beginning I tried out infinite baffle, acoustic suspension, ported cabinets, open frame (no cabinet or a small baffle), quarter wave loaded cabinets, H-frame and variations in between. I realize now that I was experimenting with cabinet types, it seems obvious now but at the time I did not know what I was looking for. Subconsciously I was trying to fix the issue with the tone of active loudspeakers and how they sounded in a room or moved from room to room. Acoustic Suspension Multi-chamber cabinets became the cabinet I would use, why? Well this opens the whole can of worms, cabinet type is the single most important decision a loudspeaker designer can make. My choices came down to a sealed design (monopole) or an open baffle design (dipole) or possibly a design with a high directivity (horn loaded).

Dipole

A dipole design such as using an H-frame for the bass driver and open baffle for the midrange driver or drivers. Ultimately the open baffle design may prove to offer the best sound in a room as it will radiate sound to the front and to the rear. This may have the lowest directivity possible from a single driver. A low directivity is important as reflections from the room surfaces will arrive at the listeners ear with a time delay equal to the path differences from the sound directly arriving at the listeners ears. The delayed sound will interfere with the direct sound and cause peaks and dips in the frequency response as a function of the delays of all the reflections. Since the dipole loudspeaker has a low directivity the reflections will be evenly distributed across all of the room surfaces and the peaks and dips will also be evenly distributed so as to minimize level differences between the peaks and dips. The realization of a dipole loudspeaker that will deliver the sound pressure levels and stereo imaging that I desire would make for a reasonably large loudspeaker possibly requiring two 12” or larger woofers mounted in an H-frame. The real issue for me though is that they must be placed some distance from the rear wall, now this is true for most loudspeakers but monopole loudspeakers do not suffer quite as badly from placement close to the rear wall as dipoles do and my listening room situation is such that they need to be closer to the wall than is optimum. Small rooms are not easy to get great sound in.

High directivity loudspeakers

Since the goal is use my own loudspeakers I needed to fit the loudspeakers into my lifestyle. Frequently the whole family and friends will listen to the system for music and home theater. I use it as part of a combination true stereo and quasi home theater system I say quasi because I currently do not use a subwoofer and the placement of the loudspeakers favour a stereo setup. A high directivity loudspeaker is only going to sound good to the lucky person in the middle. Please note that some low directivity horn systems exist but the horns are quite large, too large for my living space.

Monopole

A low directivity monopole loudspeaker using an acoustic suspension enclosure is probably the smallest enclosure of any design when using the same driver, Typically a ported design will require twice the volume that an acoustic suspension design requires. My design constraints were biggest sound from the smallest enclosure required and closest possible placement to the rear wall and deliver the best sound possible. The multi-chamber approach is to reduce one large chamber into several smaller connected chambers to reduce the wavelength of the largest wave in the enclosure and thus reduce internal resonance. A second benefit is an increase in the damping control on the cabinet by reducing large unbraced panel areas into much smaller areas and so reduce cabinet coloration.

To be continued