Reason and Motivation for the development of

The Dvorak and Vivaldi Loudspeakers from Audio Artistry

The Dvorak and Vivaldi loudspeakers represent major steps forward in music reproduction technology. The Dvorak and Vivaldi offer several distinct advancements over conventional "box type" and "planar type" speakers. These advancements provide sonic improvements readily apparent on any type of program material yet are especially pronounced when you listen to recordings of acoustic instruments captured in natural spaces, and to human voices.

The sound quality of these speakers is the result of many years of research by Audio Artistry's Siegfried Linkwitz, the creator of the Linkwitz-Riley Crossover. Siegfried regularly attends "live" musical presentations to establish an aural reference point which is critical in evaluating the accuracy of any subsequent reproduction. Additionally, in order to gain further knowledge and control over the entire recording process, from the microphone to the speaker, and to be able to effectively evaluate changes to his speaker designs, Siegfried began recording a wide variety of musical performances, including human voices.

From his previous work, Siegfried already knew that conventional box speakers, whether closed, vented, transmission line loaded or incorporating bandpass techniques, were unable to deliver the level of naturalness that he desired. The typical problems with these designs, such as box panel resonances, internal air cavity resonances and diffraction from cabinet edges, color the sound and mask low level detail. Even when these effects are minimized by careful design techniques, the results have not been completely satisfactory. In particular, he discovered that the interaction between the listening room and these types of speakers play a far more important role in actual reproduction quality than originally thought.

At low frequencies, all box speakers spread the sound around equally in all directions, similar to the perfect circles created in a pond when a pebble is dropped into the water. A speaker with this type of radiation pattern is called a monopole since the sound emanates from a single point (see Figure 1). Actually, this equal spreading occurs only at low frequencies, below a few hundred Hertz, where the wavelength of the sound is much larger than the box dimensions. As we move higher in frequency, i.e. up the musical scale, the sound becomes increasingly focused in a single direction. For example, a typical box speaker changes directivity from omni-directional at low frequencies to uni-directional at high frequencies. This variation in the sonic illumination of the room emphazises lower frequencies, creating an unnatural fullness.

A more recent form of the box speaker, known as a bi-polar radiator, reduces the change in directivity with frequency by placing drivers on both the front and the rear of the enclosure. The resulting radiation pattern of this technique is omni-directional at low frequencies and bi-directional, i.e. firing both forward and backward, at high frequencies. While this design illuminates the room more uniformly, the speaker still interacts strongly with the room's low frequency resonances, causes reflections off the wall surfaces and creates a strong reverberant soundfield in the room.

Since the basic closed box speaker design fails to deliver an accurate replica of the original performance, Siegfried decided to seek new ways to reproduce recordings that would exceed the level achievable with current "state of the art" box speakers. Based on experimentation with directional speakers in large, highly reverberant acoustic spaces and some theoretical investigations, he concluded that directivity of the speaker had to be maintained even at low frequencies where box speakers are omni-directional.

The only way to control directivity at low frequencies is via a "dipole". The dipole concept is used in designs such as electrostatic, magnetic planar and some ribbon speakers. A dipole is unique because it radiates sound into the room from two sides of a vibrating surface and with opposite polarity. Dipoles are directional with a so-called "figure-of-eight" directivity pattern over a very wide frequency range that begins below the traditional audio spectrum of 20 Hertz and can be made to extend to the highest frequencies.

There are several dipole speakers available on the market today that have some of the sonic characteristics Siegfried was looking for. While the mid frequency range conveyed by a few of these designs met his expectations, each of these speakers suffered from significant problems in the low and high end of the music spectrum. Their low frequency extension and dynamic range is limited because the volume of air that can be moved is restricted by the practical size limitations of planar membranes. At high frequencies, these dipoles become very directional through multiple beams which develop because the radiator size is acoustically large, yielding a very narrow "sweet spot". As a result, the sound off-axis becomes sonically colored and changes rapidly with shifts in listening position, making precise speaker placement in the room very

critical. Finally, traditional dipoles often present a challenging load to the amplifier.

However, optimally designed, dipoles help solve a number of problems in "real world" reproduction of music. First, the box is eliminated, so box resonances are no longer a significant issue. Next, the dipole's directivity focuses sound toward the listener. This reduces the interaction with the room because, for a desired volume level at the listening position, significantly less sound is radiated towards other parts of the room. Indeed, the total acoustic output from a dipole, when considering all directions of radiation, is only one third the output of a monopole or box speaker. In addition, this attribute also decreases the diffuse, reverberant soundfield in the room by two-thirds! Discrete reflections are lowered since dipoles minimize radiation towards side walls, floor and ceiling. Finally, nearly constant directivity can be maintained over a very wide frequency range leading to a dramatic reduction in unnatural low frequency fullness often heard with conventional speakers. As a result, the sound at the listening position is much less masked by the room. You simply hear far more of the recording and less of the room.

A new approach was obviously needed to overcome the deficiencies of current dipole speakers while retaining their desirable characteristics. To achieve this goal, Siegfried implemented this new dipole design with carefully selected moving coil drivers, the type used in box speakers. With this new approach to dipole design, all the inherent benefits could be realized without the drawbacks of previous attempts, namely:

- Directivity down to the bottom octave of the audio spectrum while minimizing room induced low and mid frequency masking.
- Nearly constant directivity up to the highest frequencies.
- No box to color the sound.

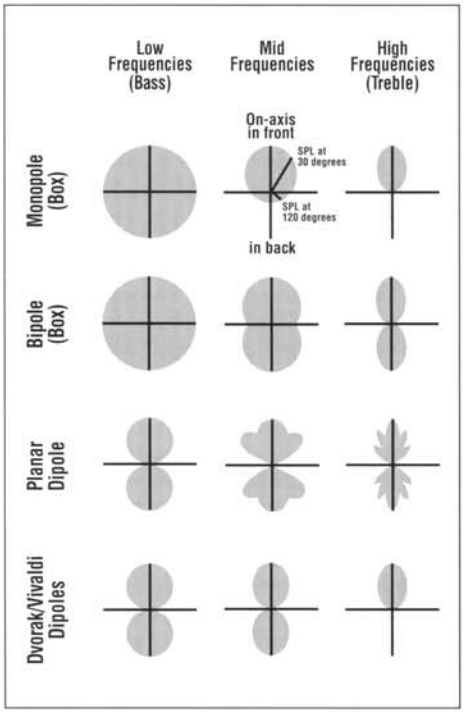

Figure 1. Sound radiation from different types of loudspeakers.
The polar diagrams show the typical change in sound pressure level (SPL) in the horizontal plane with off-axis angle for the three ranges of the audible frequency spectrum. The diagrams give the general trend of radiation behavior without product specific detail and without the radiation behavior in the transition regions between low, mid and high frequencies.

Additionally, the small size of a dome tweeter with a uni-directional radiation pattern of wide dispersion used for high frequencies, avoids the beaming and narrow sweet spot of planar or long ribbon radiators. Also, the Dvorak and Vivaldi speakers are reasonably efficient and present an easy load for an amplifier to drive.

By choosing multiple moving coil drivers with large and rapid excursion capability, the huge air volume and speed necessary for bass and mid frequency playback can be achieved, resulting in high volume levels and remarkable dynamic range. Indeed, these new dipole designs exceed the dynamic capabilities of some of the best monopole speakers.

The Dvorak and Vivaldi loudspeakers from Audio Artistry capitalize on Siegfried Linkwitz' findings from nine years of study, measurement, experimentation and living with dipole designs. These systems offer you the best possible sound in your room because they decrease the room's influence to the greatest possible degree. Room placement is far less critical than for monopole or planar designs, requiring merely that the speakers be at least two feet away from adjacent walls. With either of these speakers in your system, you will be astonished by the amount and quality of sonic detail that, until now, has been missing from your favorite recordings.

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