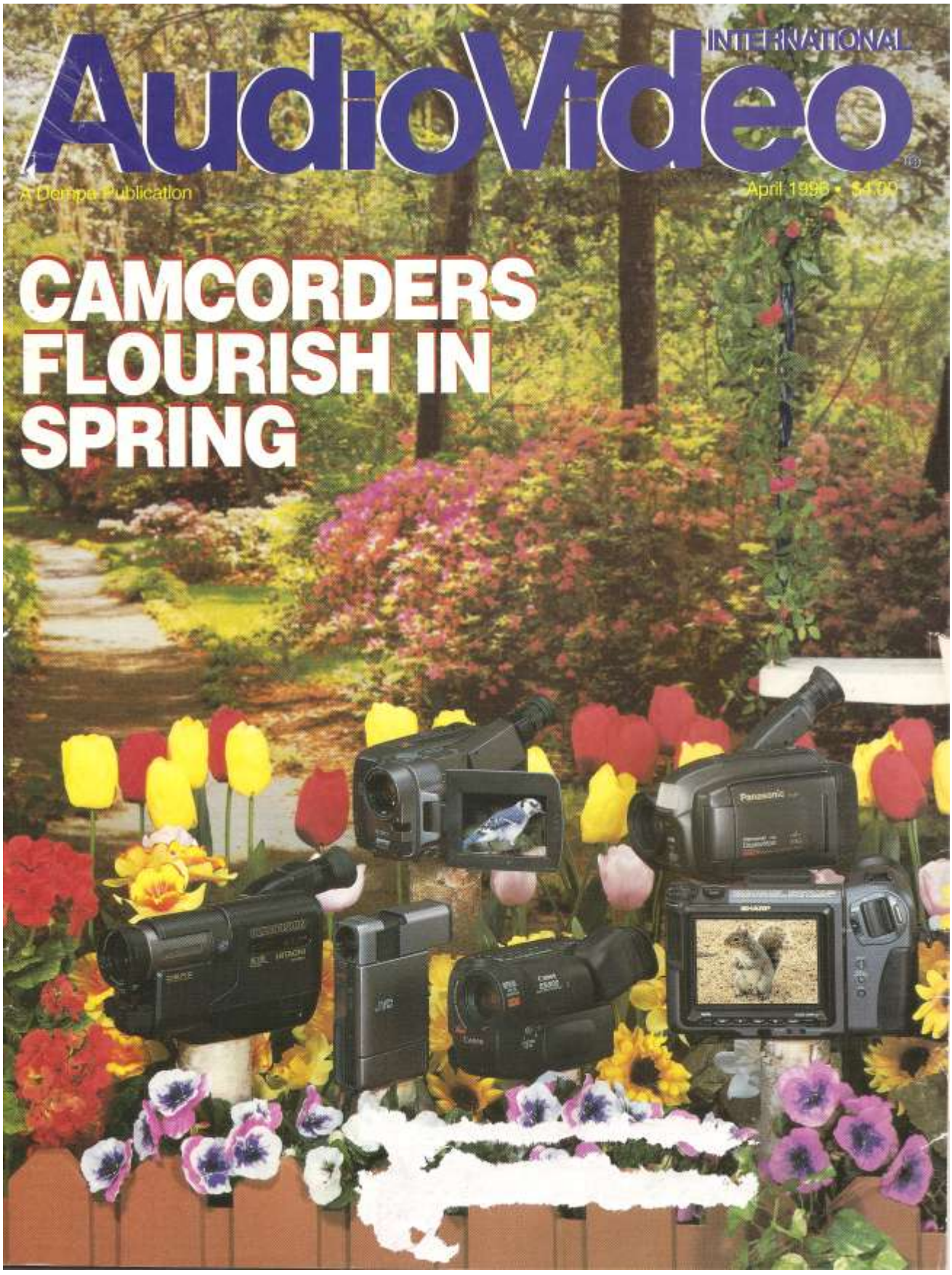

AudioVideo
INTERNATIONAL
A Dempa Publication
April 1998 • $4.99
CAMCORDERS FLOURISH IN SPRING
Panasonic
SHARP

Dipolar and bipolar speakers

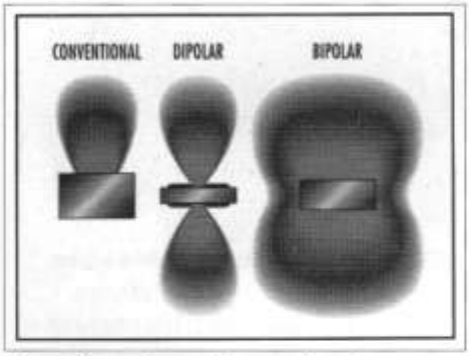
The inside scoop on what the differences —and similarities—are between these two speaker types

BY ROBERT L. BAUM
Menlo Scientific

LATELY, MANY SPEAKERS SELECTED AS *AUDIOVIDEO International* Grand Prix award winners have been "bipoles" or "dipoles." Looking at these products, you can see that some have extra woofers, midranges and/or tweeters facing backwards. Other techniques to get backward-firing sound include not enclosing the woofer, leaving it free to radiate from both the front and the rear, like many amplified guitar speakers.

Still other dipole loudspeakers don't even use conventional cone drivers or even enclosures at all—just one or more large flat planar diaphragms. Is this a plot by driver companies to sell more speakers, or do di/bipoles offer some unique performance advantages?

Dipole and bipole speakers have become almost mainstream—just look at the surround speakers in many home theater systems, as well as the main speakers in many fancier systems. Both surround and front speaker designs use di/bipoles due to the way they radiate sound into the listening room. Both dipole and bipole speakers offer distinct advantages, if the speaker design is well thought out and executed, and properly set up.



Dispersion patterns of conventional front-radiating systems, dipolar systems and bipolar systems (SOURCE: MIRAGE)

BACKWARD BENEFITS

The benefits of dipolar and bipolar speakers are due to the way they send sound out into the listening room. Once you move above the omni-directional deep bass (above frequencies of a few hundred cycles per second), dipoles are able to more or less direct the sound into a figure-eight pattern, putting sound in front of and behind the speaker, but not to the sides (the "null axis"). In dipoles, the front and rear radiation is out of phase, while in bipoles it is in phase—just like two regular speakers (monopoles) back-to-back. Consequently, bipoles do not have a severe null at the sides—output towards the sides is just reduced, as with all regular speakers, because the directivity increases for a given driver as the frequency rises.

DIPOLES: NO CONES, NO BOX

Dipoles have been around for a lot longer than many people realize. Traditionally, "dipole" has meant a boxless, esoteric (read: expensive) planar or electrostatic loudspeaker. Examples include products from Quad, whose ESL, as in "electrostatic loudspeaker", dates from 1953, and was in production for about 30 years; and Infinity, whose Servo-Static dates from 1968.

Most planar loudspeakers have large, extremely lightweight film diaphragms that move back and forth, thereby radiating sound. One of the most critical elements of planar magnetic speakers is the film substrate which has a (ribbon) electrical conductor laminated to it. Pure ribbon drivers, a type of planar driver, pass the audio signal through an electrically conductive corrugated foil diaphragm, typically made of aluminum. Some speaker systems, like those from Apogee, use both types of drivers in the same product.

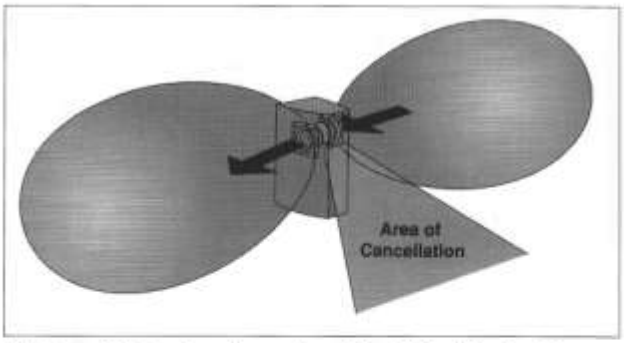
Most planar speaker manufacturers go to a specialist supplier for their laminated diaphragms, such as Lamart Corp. This "converter" has earned its reputation by supplying esoteric, ultra-light laminates to the military, aerospace, satellite, and electronics industries. Lamart's Ed Eick, product development manager, has observed (and supplied) this niche market for years and sees several advantages offered by dipoles: small footprint, light weight, installation flexibility in cars or as in-walls (assuming the rear wave is absorbed). Also, to many people, dipoles offer elegant aesthetics. Eick sees a few disadvantages, such as decreased dynamic range, lower efficiency and low power-handling ability.

NEW & IMPROVED

Aside from electrostatics and ribbon dipoles, two other innovative alternatives may find their way into showrooms.

Linaeum's dipole driver first appeared four years ago in its compact LFX bookshelf speaker. This innovative tweeter used a patented dual-gap magnetic structure, with the front and back diaphragms driven by the same printed circuit voice coil. Linaeum's distribution was limited to high-end audio stores, but about a year ago, a less expensive Radio Shack version was introduced and has been very well received. At the 1996 CES, Linaeum introduced a new generation of mainstream speaker systems, intended for distribution by audio stores, featuring its dipole tweeter.

"Back to the future" is the theme for another unique tweeter technology. The high-polymer piezo film tweeter was first commercialized over a decade ago by Pioneer. This film, when driven by an audio signal, would vibrate and reproduce sound accurately. Pioneer offered both headphones and tweeters, with some versions rolling the film into a C shape, surrounded by a cylindrical horn. Other wide coverage patterns would certainly be practical. The material was developed by Penwalt, but now the technology is owned and produced by the electronics industry giant AMP, who will be working with speaker manufacturers to re-introduce this technology to the audio industry.



The term dipole refers to any two-sided object that emits waves in a figure-eight pattern. In the Boston Acoustics' VRS, this pattern is created by employing drivers that are "out of phase" with one another. This means when one is pushing out, the other is pulling in. This results in two radiating patterns that cancel each other out in the vicinity of the listener, creating a "null" space in the middle of the room.

(SOURCE: BOSTON ACOUSTICS)

Boston Acoustics' Lynnfield VR Series VRS Pro surround

Pok Audio's f/x-2 surround speaker

LEARNING THE LINGO

So, if these doubled-up sound sources (also called "doublets") are dipoles, you might think that a single sound source is a monopole—and you'd be right. Stuff a woofer into a box and you've got a monopole, meaning that above the omni-directional low bass, the sound is generally directed forward into the listening room. Put that same speaker in an open-backed box (not a vented box), and sound from the rear of the speaker cone that used to be trapped in the sealed box can now escape. Presto!—dipole.

UNDER PRESSURE

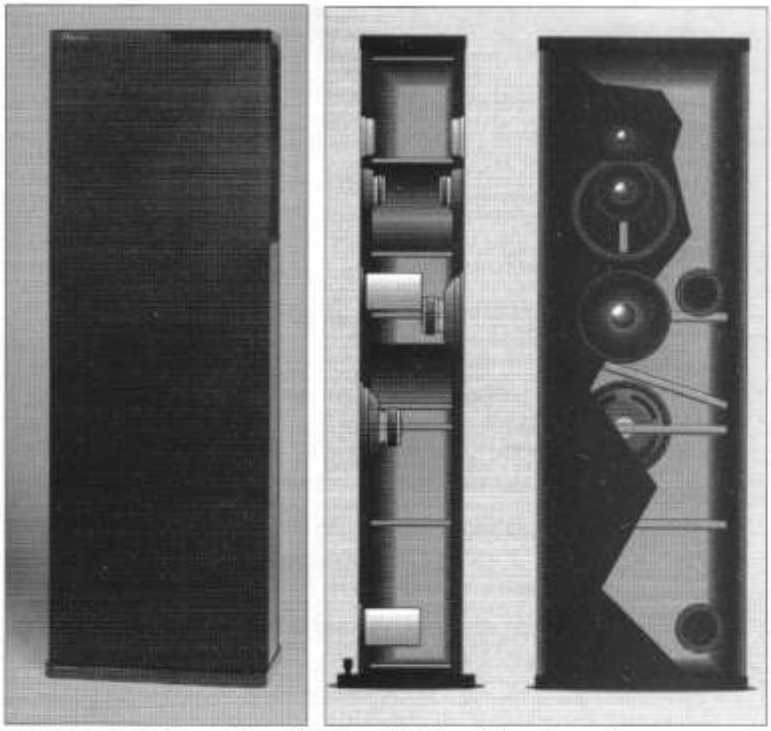
You can think of a dipole as two independent sound radiators vibrating out of phase with each other at the same amplitude. Since they are 180° out of phase, when one side of the diaphragm compresses the air in front, the other side decompresses or rarefies the air in back. Examples of this approach include: Martin-Logan, whose tall and curved diaphragms are visually transparent; Apogee Acoustics, some of whose drivers are pure ribbons, and which was recently acquired by a/d/s/; Infinity, for midrange and tweeters; Magneplanar; Genesis Technology; Stax; and Sound Lab; among others.

DIPOLES & BIPOLES

One major variation on dipoles is bipoles: when the front and rear drivers are hooked up in phase, not out of phase, the cones move in and out at the same time, but face in opposite directions. Why? One reason is because speaker designers can have the spacious reverberant sound field provided by the rear-facing drivers, and also avoid the low-frequency cancellation that is a natural byproduct of dipole operation (the front and rear signals partially cancel each other). Bipole manufacturers include Mirage (its pioneering M-1 was introduced a decade ago), Definitive Technology, Paradigm, along with new entrants to the field Eosone and B.I.C.

Several dipole manufacturers work around this low-frequency cancellation by either using very large diaphragms, or by using hybrids. Hybrids add a regular woofer to handle the bass and a (usually) passive crossover. The price paid is less directivity in the bass, and the added complexity of a crossover. Hybrid dipoles are available from Martin-Logan, Apogee Acoustics, Infinity and Genesis.

Some bipole manufacturers have a complete duplicate set of the drivers on the front of the speaker on the back. Definitive Technology feels its bipoles offer a less diffuse image than dipoles, have more output, particularly in the bass, and are easier to position in a room because they don't need to be so far out from the rear walls. Others feel that dipoles, in general, offer more of a focused image than bipoles. Mirage



Audio Products International's Mirage M1-si and its cutaway image

(from Audio Products International) says it differentiates its bipoles by trying to design speakers that radiate sound in a wide and shallow, as opposed to narrow and deep, pattern. In some models, Definitive, Genesis, Eosone and Infinity also build a subwoofer into a full-range enclosure.

SURROUNDED BY DIPOLES

Dolby Pro Logic and THX surround-sound applications create a sense of spaciousness and envelopment in ambient sounds—like the wind rustling through the trees, rain falling all around, etc. Listeners should not be able to tell where the surround speakers are located—the surround sound should arrive from a lot of indirect paths (bouncing off walls, ceiling, etc.) This is often achieved by mounting the surround speakers high on the walls and aiming the axis of very low sound output (the "null axis"), at the listeners' heads, or actually, a few feet above their heads. The main figure-eight output is then directed forward (to bounce sound off the front wall) and backward (to bounce sound off the rear wall). So, the surround sound takes a variety of longer paths, delaying its multiple arrival times at the listener's ears.

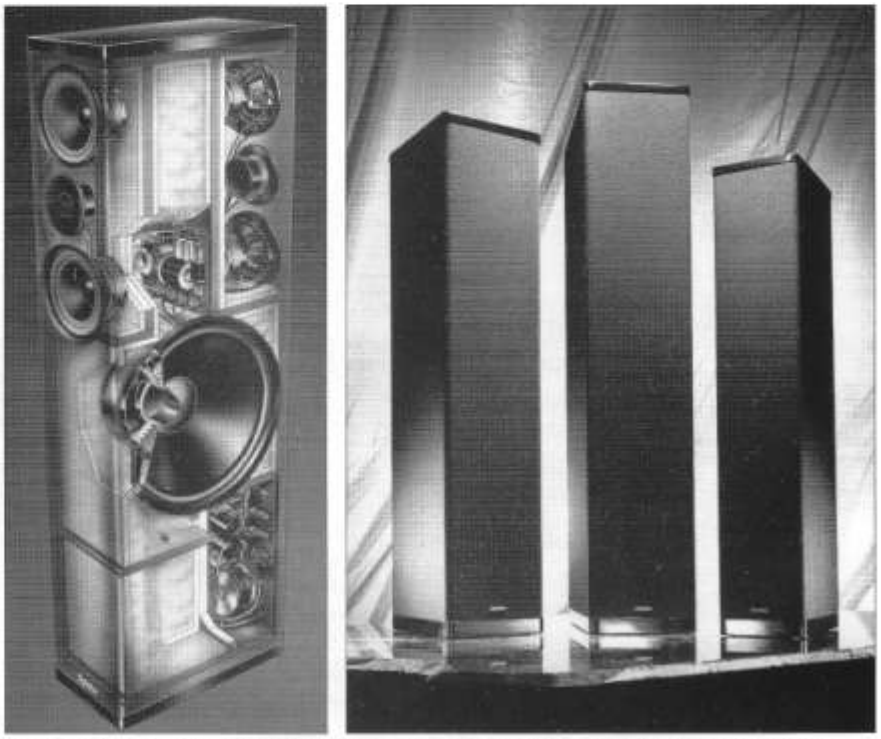
SET 'EM UP RIGHT

If you are getting the impression that setup of all dipoles and bipoles is more critical than regular speakers, requiring a little more time and experimentation—you are correct. But not to worry—it's worth the extra time to get it right. Don't cram dipoles or bipoles right up against the rear wall, because then the rear radiation is immediately reflected back into the room, destructively interfering with the sound coming from the forward-facing drivers. The resulting peaks and dips in the frequency response, and proliferation of early reflections in the time response, degrade the sound. The exception to this is, naturally, surround-sound dipoles, which are designed to have their null axis put up against a wall.

Dipoles sound a lot better pulled out into the listening room. If they have to be near a wall, dipoles should be closer to a side wall than a rear wall. When a dipole is near a side wall, the bass is reinforced, just as it is with regular speakers. Bipoles often sound better when tilted inward, towards the listener, and should ideally be away from all walls. Even non-experts, who often have veto power over a sale, will notice the big difference a good setup makes to bipoles and dipoles.

THE FINAL FRONTIER

Dipole and bipole speakers direct a lot of sound energy backward, where it is ultimately reflected off the rear wall,

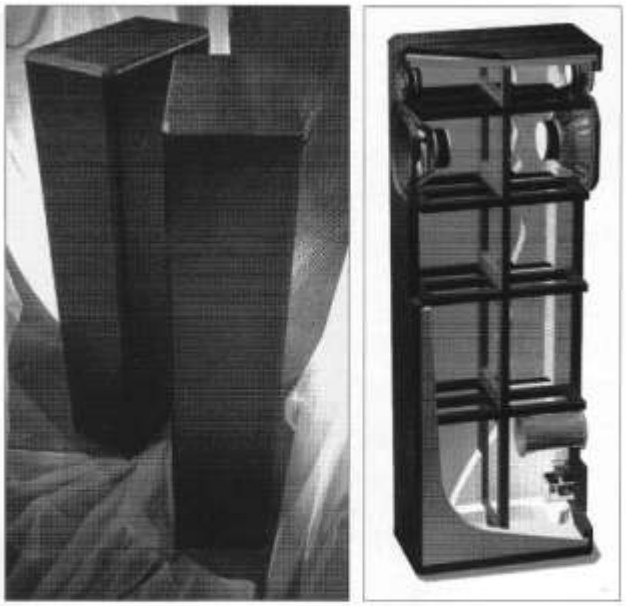


Cutaway image of the Definitive Technology BP2000 (left); the BP10, BP20 and BP8 (right) feature its bipolar technology

back into the room. Since the sound has to travel this extra distance to get to the listeners' ears, it is slightly delayed. This delayed sound contributes to di/bipoles' sense of "space," without interfering too much with the crucial direct sound.

In front-speaker applications, listeners should ideally perceive the direct sound clearly, which will deliver focus and localization. Direct sound is sound that takes a direct path from the source to the listeners' ears, without bouncing off anything along the way. Much of the ambience or reverberation of the space where the recording was made is already contained in the music.

Dipoles and bipoles get their spaciousness by manipulating the reverberant field. Is this okay? Of course. Just look at some very expensive, very good sounding traditional speaker systems, from companies like Wilson Audio, which will put a rearward-facing tweeter into some of its systems, to restore a little of the high-frequency "spaciousness" to the non-direct sound that is reverberating throughout the listening room. And don't forget the traditional planar dipole speakers, like the legendary Quad ESL-63 US Monitor, which is widely respected for its sound quality.



Paradigm's Eclipse/bp bipolar speaker and its cutaway

DIFFERENT SPEAKERS FOR DIFFERENT SITUATIONS

We all know of many regular ("monopole") audiophile speakers that have wide horizontal dispersion of sound for a good soundstage, precise imaging and a clean midrange. So there are clearly a variety of different ways to get subjectively good sound in a domestic living room. Certain speakers are stronger in certain applications.

For example, some home theater driven consumers may be well served by bipoles. Bipoles offer these buyers a big soundstage with a lot of enveloping spaciousness to draw them into the action on their big-screen or projection monitor, greater power handling and more bass than dipoles. Audio-driven consumers who are into pinpoint imaging, super-clean vocals or small classical pieces might prefer dipoles.

Eosone's RSF 1000 powered loudspeaker

Dipoles, by their nature, trade off some deep bass for good control over where the bass goes in the room. For example, a big-screen monitor placed in the nulls between two dipoles will minimize reflections off the monitor and side walls, keeping the acoustical image sharp. Dipoles, particularly full-range dipoles, are also typically wide, tall and shallow speakers. So their sheer size will acoustically shadow the on-axis listener from some of the high-frequency reflections off of the rear walls. Dipoles often have a narrower sweet spot, and more focus, particularly when compared to bipoles. Some dipole manufacturers curve the diaphragm to minimize this. The Quad ESL-63 US electrostatic, on the other hand, uses a unique approach: a series of concentric delay lines to simulate a point source a foot behind the diaphragm. Naturally, the design engineer's ability, the quality of execution, and the skill of the setup can make a huge difference. There are good and bad examples of all types of speakers, as well as great speakers set up so poorly that they sound mediocre.

So, dipoles are more directional than most direct forward-firing speakers while bipoles are more omni-directional. Dipole hybrids split the difference, using a regular woofer for the bass and dipole radiators for the midrange and highs, at the sonic cost of adding a crossover. Dipoles put more of the direct and nearly-direct sound into the listener's ears, not on the side walls of the room.

There are fewer reflections to smear a stereo image, and fewer room resonances are set off. Dipoles and bipoles also offer some of the spaciousness that most listeners like, due to the delayed-in-time backwards-radiated sound. They both can make the room sound bigger. Other speakers can achieve this sense of spaciousness by having multiple drivers operating in the same frequency band.

But properly set up di/bipoles can achieve this without suffering the nasty side effects of very uneven frequency response (due to "comb filtering"). Proper setup of these speakers is well rewarded with great sound, as demonstrated by the recent Grand Prix winners.

Rob Baum works for Menlo Scientific, an audio engineering/consulting firm in Berkeley, CA. His professional experience includes stints at Apogee Sound and CBS Records.