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The Directional Boundary Microphone

by Bruce Bartlett Copyright 2009

Last issue we explained the boundary microphone: what it is and how it works. We covered boundary mics with a half-omnidirectional or hemispherical pickup pattern (Figure 1). They capture sounds equally well from all around the microphone.

To download last month's newsletter with that article, [click here](#).

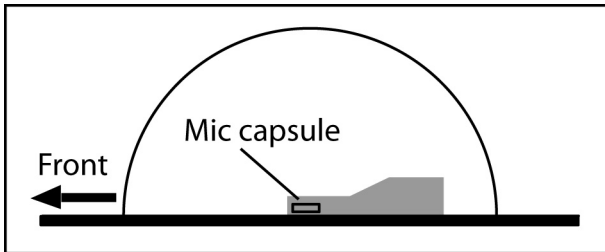


Figure 1. Polar pattern of a half-omni boundary mic (side view)
[fig1-pzm polar.jpg]

Now let's explore boundary mics that are *directional*. They pick up sound mainly from one direction: in front of the mic, over a broad angle. They reject sounds to the sides and rear of the mic. A directional boundary mic has a half-cardioid or half-supercardioid polar pattern. The mic capsule's cardioid pattern is cut in half by the boundary (surface) on which the mic is mounted (Figure 2). Two examples are the Crown PCC[tm] -160 and the Bartlett Microphones TM-125.

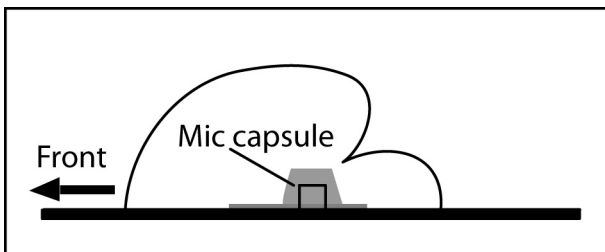


Figure 2. Polar pattern of a half-supercardioid boundary mic (side view)
[fig2-pcc polar.jpg]

Compared to a half-omni boundary mic such as a PZM™, a directional boundary mic provides more gain-before-feedback, less pickup of reverberation, and less pickup of sounds behind the mic -- such as a pit orchestra in a theater.

Suppose you have a half-omni boundary mic on the stage floor to pick up actors. If you replace that mic with a half-cardioid or half-supercardioid boundary mic, you get louder sound before feedback occurs, you hear less muddy-sounding

stage acoustics in the reproduced sound, and you pick up very little of the pit orchestra.

Why not use a mic in a desk stand?

You might ask, "Can I just place a conventional cardioid mic in a desk stand, and get a sound that's as good as a cardioid boundary mic?" No. Let's explain why.

In your work as a sound engineer, you may have to place mics near hard reflective surfaces. For example, picking up drama or opera with microphones near the stage floor, or picking up people at a conference with microphones on desk stands on the conference table.

In these situations, sound travels from the sound source to the microphone via two paths: directly from the source to the microphone, and reflected off the surface (Figure 3). Note that the reflected sound travels a longer distance than the direct sound, so the reflected sound is delayed relative to the direct sound. When the direct and delayed sounds combine at the microphone diaphragm, this results in phase cancellations of various frequencies. A series of peaks and dips is created in the net frequency response.

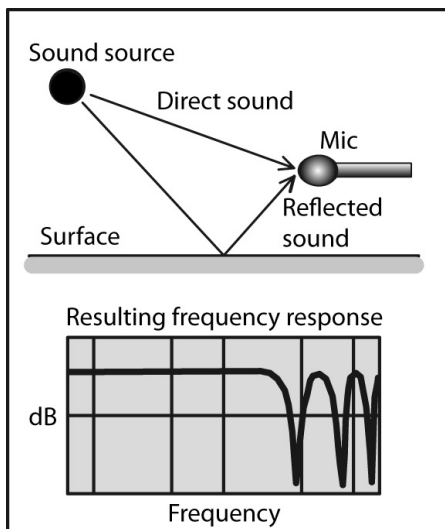


Figure 3. Conventional microphone on a desk stand picks up phase interference. [fig3-mic in desk stand.jpg]

This is called a comb-filter effect. It colors the tone quality and gives an unnatural sound. To hear how it sounds, say "shhhh" about a foot from a microphone while moving a flat panel toward and away from the mic. You'll hear a swooshy, jet-plane effect as the reflected path length changes. That's the comb-filter nulls moving up and down the audible range of frequencies. It sounds like mild flanging.

You get the same effect when you pick up actors with a desk-stand mic. The tone of their voices changes when they move around on stage.

You could lay a conventional microphone on the floor, maybe inside of a foam block called a Mic Mouse. But the diaphragm of such a mic is relatively large. Sound reflections travel a slightly longer path to the center of the diaphragm than the direct sound. Direct and delayed sounds combine at the diaphragm and cancel high frequencies (Figure 4.) The result is a dull or dark sound, as if you turned down the treble.

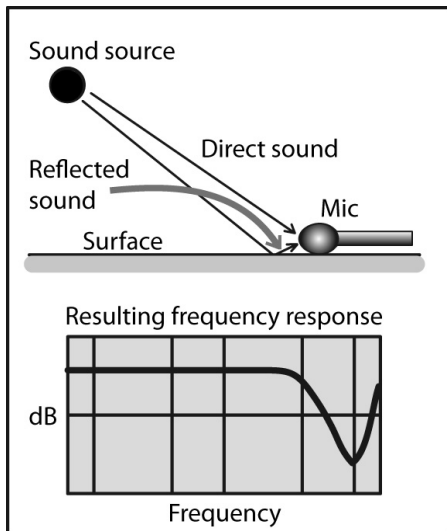


Figure 4. Conventional mic on the stage floor has phase interference at high frequencies.

[fig4-big mic on floor.jpg]

Solving the problem

I invented a new kind of microphone to solve the problem of phase interference from surface reflections: the directional boundary mic. This design uses a miniature mic capsule about 1 cm diameter. The microphone diaphragm is small enough so that any phase cancellations are above the audible range (Figure 5). This results in a wide, smooth frequency response free of phase interference.

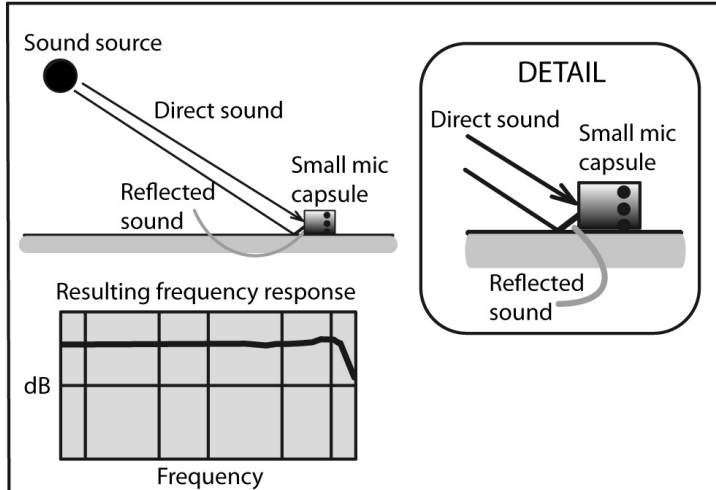


Figure 5. Small mic capsule on the stage floor prevents phase interference.

[fig5-small mic on floor.jpg]

Unlike the PZM which uses an omnidirectional mic capsule facing down, the PCC-160 or TM-125 uses a supercardioid mic capsule facing horizontally across the surface. Its directional polar pattern improves gain-before-feedback, reduces unwanted room noise and acoustics, and rejects sound from the rear.

Typical applications for the TM-125 are:

- Area pickup of drama and musicals
- Backup mic to use if an actor's wireless mic fails

- Conferences, videoconferences, boardroom
- Altar tables
- Pulpits and lecterns

Most pulpits and lecterns have a small surface area. Boundary mics need a large mounting surface to reproduce low frequencies accurately. So when you place a boundary mic on a small surface, you may need to boost the low-frequency EQ on your mixer to prevent a thin sound.

Benefits of the directional boundary mic

This type of mic combines the advantages of a directional mic with the advantages of a boundary mic:

- The miniature mic capsule eliminates phase cancellations in the audible range, giving a clear, natural sound.
- The half-supercardioid polar pattern reduces feedback and pickup of room acoustics.
- The half-supercardioid polar pattern rejects sound from behind the mic, such as a pit orchestra.
- Due to the coherent addition of direct and reflected sound, the mic's sensitivity and signal-to-noise ratio are up to 6 dB better than an identical mic that is on a mic stand or hanging.
- The tone quality does not change as the person speaking moves toward or away from the microphone.
- Because the mic capsule is small, the tone quality does not change as the person speaking moves left or right in front of the microphone.
- The mic is small and inconspicuous.
- The mic is less costly, more reliable, and simpler to use than a headworn wireless mic.

Disadvantages of the directional boundary mic

- Because it lies on the stage floor, it picks up footsteps more loudly than a hanging mic does. This might be controlled by putting rubber soles on the actors' shoes.
- It has less gain-before-feedback than a headworn wireless mic. But the gain-before-feedback might be adequate anyway.

Give the directional boundary microphone a try in your theater, house of worship or conference room. It's a simple way to pick up speech with a clear, natural sound.

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Bartlett Microphones Expands Work Force

Elkhart, IN (8-14-09): To meet increasing customer orders for the TM-125 and TM-125C stage-floor microphones, Bartlett Microphones has added skilled assemblers from the Elkhart, Indiana community.

"To help the local economy and the environment," says owner/engineer Bruce Bartlett, "we wanted our products to be made in the U.S.A. by local people, and using local parts and suppliers whenever possible. Having vendors in the States, and in Elkhart, also makes it easier to improve designs quickly and to communicate with the vendors."

Having others assemble the microphones also frees up time for Bruce to write articles on microphones and mic techniques. They are featured at the company's web site, www.bartlettmics.com.

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