



# How Earthworks® High Definition Microphones™ Can Dramatically Improve the Quality of Installed Sound Systems

by Larry Blakely

## *Advanced Technologies in Earthworks High Definition Microphones™ overcome common problems inherent in conventional microphones.*

### **Common Problems with Installed Sound Systems**

Nearly every sound system designer and sound contractor typically faces one or more of the following problems with sound reinforcement systems:

- **Uneven Coverage of Conventional Microphones**

Conventional directional microphones typically have substantial off-axis high frequency losses that greatly reduce the intelligibility at the sides of the microphone. Therefore, when an orator speaks on either side, above or below the microphone this decrease in clarity and sound quality makes it difficult to hear or clearly understand the orator.

- **Insufficient Gain Before Acoustic Feedback**

One of the most common difficulties in sound reinforcement systems is obtaining sufficient sound level before acoustic feedback. It is often a significant task in manipulating sound system elements to obtain the desired amount of gain before feedback.

- **Leakage of Sounds from the Rear of the Microphone**

Another common problem is unwanted sounds at the rear of a directional microphone being picked up at the front of the mic, such as a conference table microphone picking up the sounds of people who are behind the microphone.

- **Sufficient Coverage with Multiple Microphones**

Conventional microphones have a narrow portion of the pickup pattern that will provide the full frequency response of the microphone. In multiple microphone systems, it often takes a large number of microphones to obtain the desired coverage.

- **Spotlighting and Highlighting**

Typically when conventional microphones pick up groups of people, such as ceiling microphones in a boardroom, people with voices in a certain frequency range will sound louder than the rest. This is normally caused by poor polar response of the microphone.

- **Lack of Pure Sound with High Intelligibility**

An excellent sound system will provide highly intelligible, pure sound that will accurately reproduce the sound of orators so the audience can hear every word clearly and distinctly. This is nearly impossible when using conventional microphones.

### **Goals in Sound System Design**

Sound system designers and installers strive to accomplish two main objectives: (a) capture and reproduce high quality sound and (b) have sufficient sound level without acoustic feedback. However, in most cases the results usually come out one of two ways: (1) either the sound quality was improved, or (2) there is more gain before feedback; but almost never both. Everything in sound system design is a compromise, and typically requires signal processing or other manipulations of the sound system components. In addition, other problems arise in attempting to keep from picking up unwanted sounds from the rear of the microphone(s).

### **Advanced Technology High Definition Microphones™**

David Blackmer, the engineering genius and founder of dbx® and Earthworks®, has developed a number of advanced technologies in microphone design, which overcomes most of the problems typically experienced with conventional microphones. These advances include near-perfect polar response, extended high frequency response, significantly improved impulse response and ultra-fast diaphragm settling time. Other benefits include a remarkable improvement in the rear rejection of directional microphones and the ability to feed long cable lengths up to 100 meters without loss of high frequencies.

### **These Problems Can be Solved Using Earthworks High Definition Microphones™**

Earthworks High Definition Microphones™ incorporate David Blackmer's advanced microphone technologies and are made differently than any other microphones. They reproduce sound with far greater accuracy and fidelity, while overcoming many of the obstacles typically encountered when using conventional microphones.

The following pages will outline each of the previously listed problems that are typically encountered when using conventional microphones, and show how the use of Earthworks High Definition Microphones™ can solve them.

## Uneven Coverage of Conventional Directional Microphones

Directional microphones are typically used in sound reinforcement systems. In theory, directional microphones will pick up sound at the front and sides, and reject sounds at the rear. A textbook perfect microphone would behave as shown in Figure 1a, which illustrates the microphone's pickup area in pink, and the blue area is where the mic rejects sound. In Figure 1b, the numbered circles in the polar chart are used to indicate the sound level of specific frequencies (at different positions shown in degrees) around the microphone.

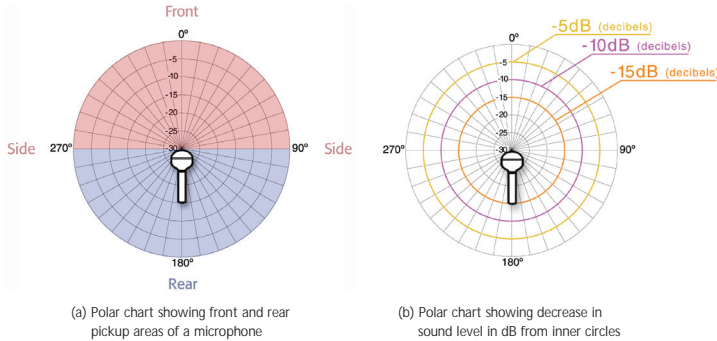


Figure 1. A Basic Polar Chart

All of this will become more relevant when you see a microphone's performance indicated on polar charts (graphs) in the following examples.

## Three Orators on a Conventional Directional Microphone

Anyone who has tried pick up three people on a single directional microphone quickly discovers that the person at the front of the microphone has the best sound quality, while those on each side have a dramatic reduction in sound quality, like having their hands over their mouths. The reason for this is illustrated on the polar chart in Figure 2. The person directly at the front of the microphone (0°) is the only one enjoying the full frequency response of the microphone; notice that all four indicated frequencies (500Hz, 1kHz, 4kHz & 16kHz) are mostly on the 0dB circle line (indicating a flat frequency response), while the people on the sides of the microphone have a loss of -20dB at 16kHz (indicated with the dotted blue line). The pink shaded area indicates where the microphones' pickup pattern provides full frequency response, and outside the pink area there are significant losses of high frequencies.

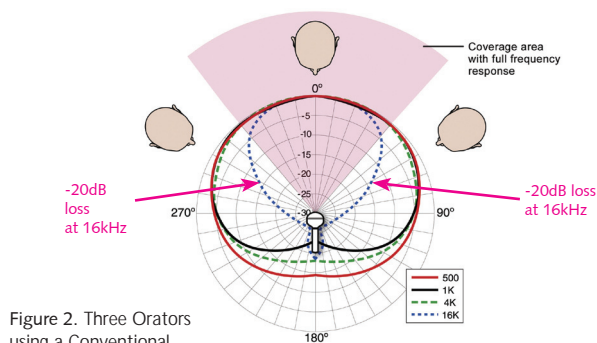


Figure 2. Three Orators using a Conventional Directional Microphone

## At Last, Uniform Coverage using Earthworks Microphones

Earthworks High Definition Microphones™ utilize advanced technologies that prevent the loss of high frequencies at the sides of a microphone. An Earthworks directional microphone will provide full frequency response at both the sides and front of the microphone. When orators use an Earthworks directional microphone, they will enjoy the same high quality sound at the front and the sides of the microphone. Figure 3 indicates that the high frequencies have no loss of level at the sides of the microphone (shown with the blue dotted line). In contrast to Figure 2 above, the green shaded area in Figure 3 indicates the area where the microphone's pickup pattern provides full frequency response. On an Earthworks microphone, all three orators will have the same sound quality and all three will be highly intelligible.

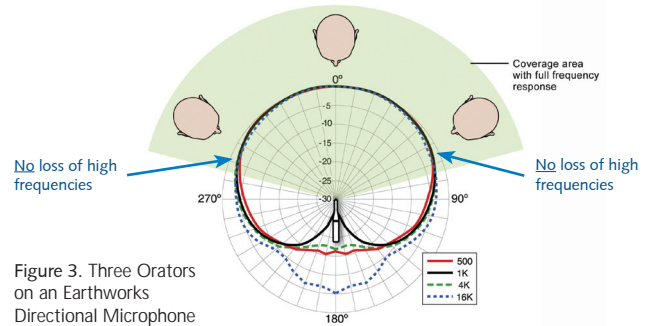


Figure 3. Three Orators on an Earthworks Directional Microphone

## Orators Using a Conventional Directional, Podium Microphone

While in a meeting or presentation you have probably noticed that when orators are speaking directly in front of the podium microphone, they are easily understood. But, as they move to the side of the microphone, their voices are softer with deteriorating sound quality. Yet, when they move back in front of the microphone, the sound quality dramatically improves. This is another version of the same problem of three orators on a conventional directional microphone. Again, the reduction of sound quality is due to a lack of high frequencies at the sides of the microphone as shown in Figure 4. Notice when the orator is speaking at the sides of the microphone, the high frequencies (i.e. dotted blue line) indicate a nearly 20dB loss at high frequencies.

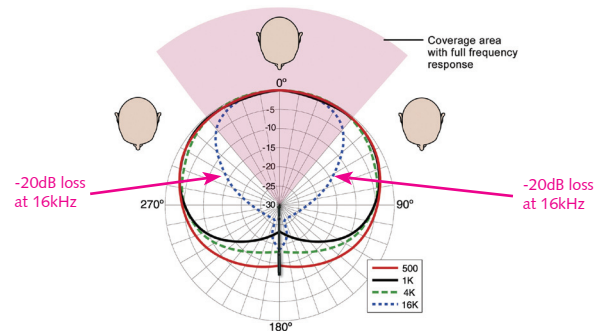


Figure 4. An Orator Speaking at the Front and Sides of a Conventional Podium Microphone

Now refer to Figure 5, which shows an orator speaking at the front, and the sides of an Earthworks directional High Definition Microphone™. Notice that there is no loss of high frequencies at the sides of the microphone (shown with the dotted blue line). So, when the orator speaks, no matter if they are at the front or the sides, they are enjoying the full frequency response of the microphone, and every word and syllable will be heard clearly and distinctly.

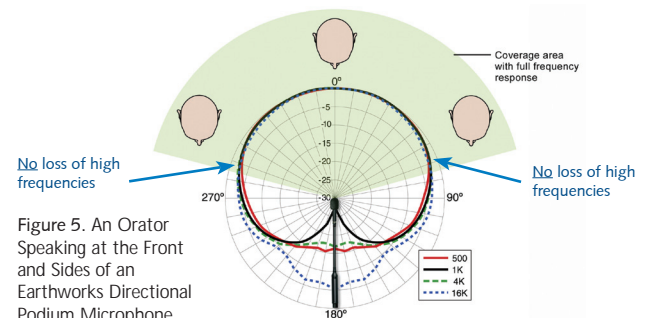
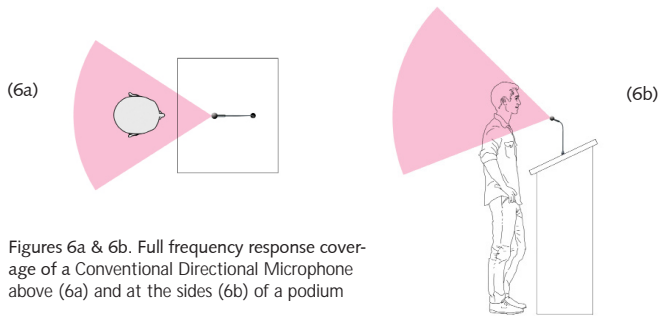


Figure 5. An Orator Speaking at the Front and Sides of an Earthworks Directional Podium Microphone

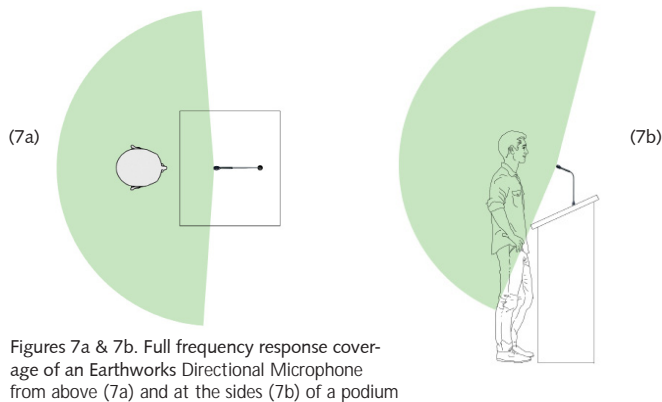
Up to this point, we have only looked at this situation from a top view of the microphone. On a conventional microphone, the high frequency losses on the sides are also the same above and below the mic. So, when an orator speaks under the microphone there will be the same loss of high frequencies as on the sides of the microphone. Likewise, when the orator speaks above the microphone the same high frequency losses will also be present. To il-



illustrate this, Figures 6a and 6b show a conventional microphone's pickup area (with full frequency response) from above and from either side of a podium.



In contrast, an Earthworks microphone will provide the full frequency response at any point around the microphone, out to nearly 90° on either side, and also above and below. So, regardless of what position the orator speaks, they will be covered with the full frequency response of the microphone.



In contrast, Figures 7a and 7b show the pickup area (with full frequency response) of an Earthworks directional microphone, both above, and at the sides of a podium. Notice the dramatic increase of the coverage area providing the full frequency response of the microphone.

### Insufficient Gain Before Acoustic Feedback

One of the main problems with sound reinforcement systems is the inability to have sufficient sound level (gain) before feedback. Acoustic feedback problems can be attributed to one or more of the following: (1) the microphone, (2) the loudspeaker system, or (3) the acoustics of the room. Conventional microphones contribute to acoustic feedback problems through the lack of uniformity in the polar response at different frequencies. For a directional microphone to be "perfect," all frequencies must exactly follow the textbook perfect, heart-shaped pickup pattern shown in Figure 8a.

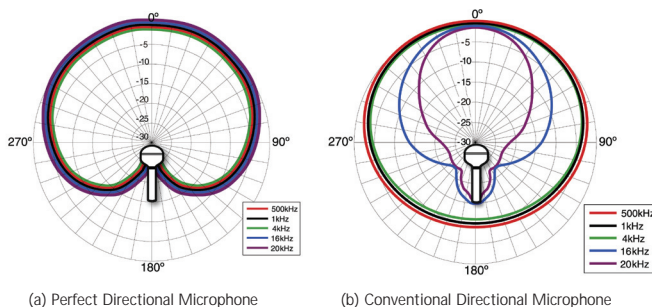


Figure 8. Differences Between a Perfect and Conventional Directional Microphone

Now, referring to the "Conventional Directional Microphone" in Figure 8b, notice that the different high frequencies vary significantly in level (i.e. 4kHz, 16kHz and 20kHz). These disparities in level between the various high frequencies correspond to significant peaks or dips (increase or decrease in level) in the microphone's overall frequency response, which also creates phase problems. These peaks and dips and phase anomalies contrib-

ute to acoustic feedback. Notice how the high frequencies track each other in the textbook perfect directional microphones shown in Figures 8a and 9a, which will cause no peaks and dips or phase disparities.

### At Last: More Gain Before Feedback

When comparing the textbook perfect directional microphone (Figure 9a) to the Earthworks microphone (Figure 9b), notice how close together the various high frequencies are from 0° to 270° and from 0° to 90°. See how close the Earthworks microphone is to the textbook perfect microphone shown in Figure 9a. Because of this very uniform polar response, an Earthworks directional microphone will provide significantly more sound level before acoustic feedback. Now, compare the Earthworks microphone

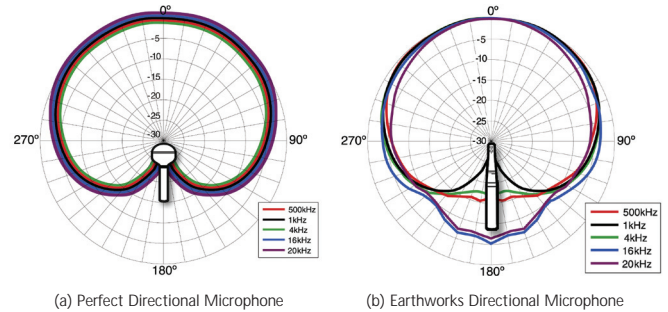


Figure 9. Differences Between a "Perfect" and an Earthworks Directional Microphone

shown in Figure 9b to the conventional microphone shown in Figure 8b. Those who have used Earthworks High Definition Microphones™ in sound reinforcement systems are always impressed with the significant increase in sound level before acoustic feedback.

### Conventional Microphones and Leakage of Sound from the Rear of the Microphone

In conference or meeting rooms it is important for a microphone to reject the sounds of other people speaking at the rear of the microphone. Conventional microphones exhibit this problem because they fail to adequately reject sounds at the rear of the microphone.

### The Earthworks Solution to Rejecting Sounds from the Rear of the Microphone

Earthworks directional microphones are designed to have significantly more rejection of sounds at the rear of the microphone than conventional microphones. Notice in Figure 10a that a conventional microphone will only provide approximately 18dB of rear rejection. In comparison, the Earthworks microphone (Figure 10b) will provide 32dB of rejection of sound at the rear of the microphone, which is 14dB more than the conventional microphone, or nearly twice as much.

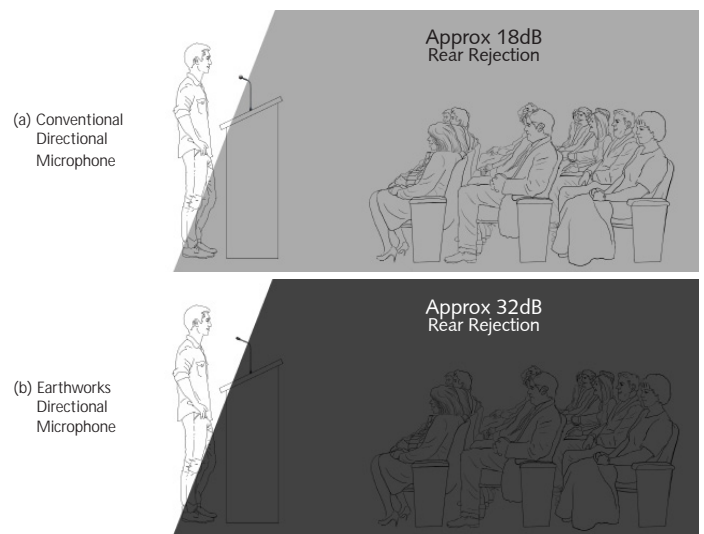


Figure 10. Differences in Rear Rejection of Sound Between a Conventional Microphone and an Earthworks Microphone

You can dramatically demonstrate this for yourself, by plugging an Earthworks directional mic into a mixer, and listen on headphones. Talk into the front of the mic to hear yourself, then turn the mic around and talk into the rear of the mic—your voice will disappear. The amount of rear rejection is very important in many applications, such as keeping sound of audiences out of podium microphones or in conference meetings, keeping your mic from picking up the sound of others who are located behind your mic.

## How Many Conventional Microphones Will it Take to Cover a Given Area

The narrow usable portion of a conventional microphone's polar response (with full frequency response) provides only a narrow area that will pick up sounds without high frequency losses at the sides of the microphone. Figures 11a through 11c indicate how many conventional microphones it takes to cover a room (with an 8 foot ceiling) and provide the full frequency response of the microphone at the head of a six foot man, in standing position. See Figure 11a, with two conventional microphones.

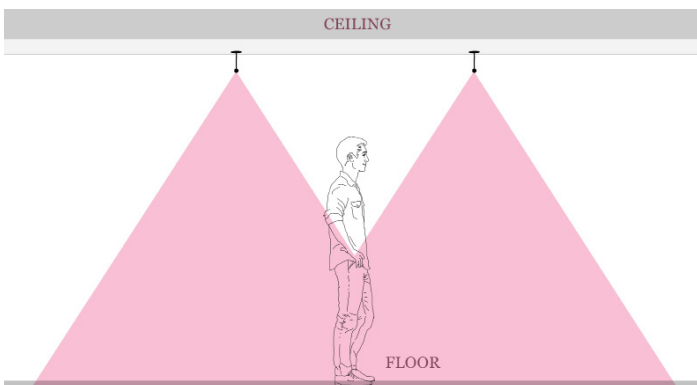


Figure 11a. Two conventional microphones covering a room with full frequency response

Figure 11b is the same room with 4 conventional microphones (instead of 2), and there is still a significant area that is not covered with the full frequency response of the microphones. Figure 11c shows 8 conventional microphones (instead of 4), illustrating that it takes 8 conventional microphones to adequately cover the room with the full frequency response of the microphones.

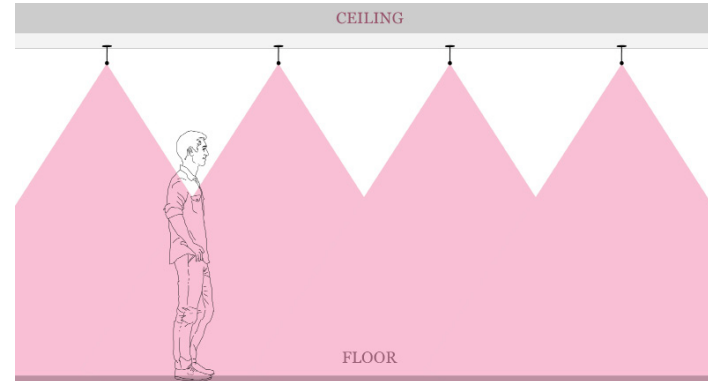


Figure 11b. Four conventional microphones covering a room with full frequency response

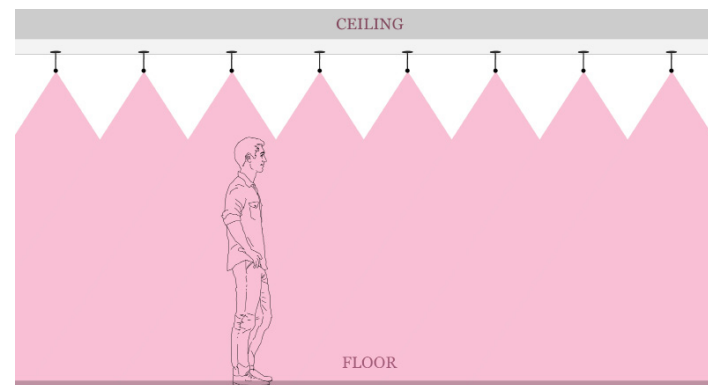


Figure 11c. Eight conventional microphones covering a room with full frequency response

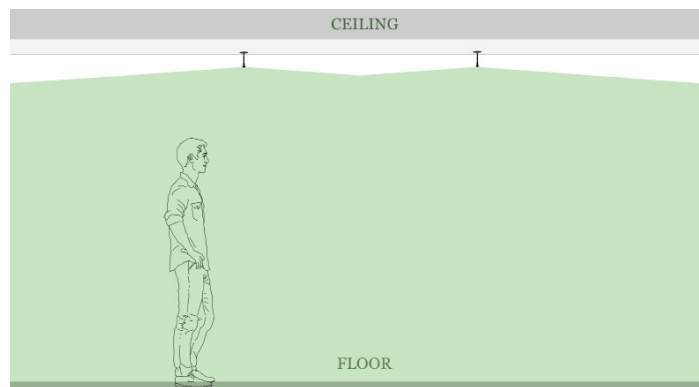


Figure 11d. Two Earthworks microphones covering the same room with full frequency response

## It Takes Fewer Earthworks Microphones to Properly Cover the Same Area

Figure 11d shows the much wider polar response (with full frequency response) of Earthworks directional High Definition Microphones™, requiring fewer microphones. In addition you also have more sound level before feedback, no spotlighting or highlighting, more rejection of sounds from the rear of the microphone, in addition to a vastly superior sound quality.

## Extended High Frequency Response

Recent scientific research has shown that music has high frequency overtones that can extend as high as 100kHz. Most humans can only hear pure tones to 15kHz or 20kHz. However, this research shows that overtones above 20kHz contribute to the sound quality, or timbre, of sound that we perceive. Some Earthworks microphone models have a frequency response as high as 50kHz. At first blush, one may say, "If sounds were at frequencies that high, there is no way I could hear or perceive the difference." However, thousands of audio professionals will confirm that they can perceive the difference between microphones with a high frequency response of 20kHz, 30kHz, 40kHz and 50kHz.

## Pure Sound with Accuracy and High Intelligibility

Earthworks® High Definition Microphones™ incorporate advanced technologies and will outperform any conventional microphones on the market, without respect to make, model or price. To describe the sound quality you will hear: "It is like comparing a standard television set to a high definition television set. The difference you see is like the difference you will hear when using an Earthworks High Definition Microphone." You will be astounded!

## The Proof is in the Listening

It is often said, "Hearing is believing". We are willing to back up our claims and prove it. We invite you to contact us and arrange for demonstration models of Earthworks High Definition Microphones™ to try out for your next installed sound project. This will allow you to hear our microphones in your own environment and experience the results and benefits for yourself. We know you will be impressed. Contact us by email at [sales@earthworksaudio.com](mailto:sales@earthworksaudio.com) or by phone at 603-654-2433, ext. 114. You will be glad that you did!

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