Part 6

in our beginner's series

BY ALEX CASE

Nuts & Bolts

Microphones 3– specifications and controls

In the relatively straightforward case of recording a power trio, you might have to select maybe a dozen microphones. The trio: drums, bass, guitar and vocals. The mics: kick, snare, hat, three toms, two overheads, two out in the room, bass, guitar and vocal.

Selecting the right mic for the job is an ever-present part of the recording gig. The creation of an album involves making this small decision maybe hundreds of times.

In the last two episodes of 'Nuts & Bolts' we explored the inner workings of microphones. This month we tackle the meaning of the various specifications, and the function of the various controls that might appear on a microphone.

The goal is to convert microphone selection from a random, luck-of-the-draw process into an organized system built on total knowledge of all microphone technologies and parameters.

Frequency response

Selecting a mic really begins with its frequency response; we want to know how it sounds. A frequency response plot is the first view into this. This description of the microphone's output at different frequencies reveals any biases for or against any particular frequency ranges. Figure 1 offers a few samples.

The oft-cited 'color' of a microphone is very much determined by its frequency response. Try to have in mind a rough sense of the frequency response of every mic you use. You can store the data (in your brain, that is) visually, literally picturing frequency response plots in your mind.

Alternatively, you can store the data in words: warm, boxy, present, edgy, airy. As your experience grows, these words develop a very precise meaning. As time goes by and naturally you acquire more mics, you'll need to add new words to your lexicon to be more precise. It's not just warm—it's thick, tubby, big, phat, punchy, heavy, or some such. It's not airy; rather it's breathy, it shimmers, it soars, it sparkles....

So the frequency response plot is a good starting point for learning the 'sound' of the device. But your professional development will always—for the rest of your life—include refining your own internal sense of the sound of each make and model of microphone.

Each session will reveal ever more. A mic with a low end hump in its frequency response might sound punchy on congas, but murky on bass. This helps you zero in on the exact shape and location of that low frequency hump.

Warning: it is a hazard of this job that the words you use to describe a sound likely have a different meaning to someone else. Your sense of the sonic character of something that is 'thick' could be slightly—and sometimes very—different than someone else's internal conception of the sound.

Audio ear training (à la Dave Moulton's Golden Ears) in combination with professional interaction with others whose work you admire will help these descriptive words hover near a common definition. Just beware of the difficulty when you try to communicate with strangers on the topic, be it fellow engineers or a microphone salesperson.

The handy thing is, when it comes to the selection of a microphone by you, your own internal meaning for the words is correct and sufficient. Your descriptions of the sonic character of each mic are all you need to make a good guess at which mic will sound best on today's overdub.

So push yourself to develop a feeling for the frequency response of every mic you own or have access to. And constantly refine your internal sense of its frequency response toward an ever more precise meaning. The 'color' of a mic is a very personal, very detailed concept.

Off-axis coloration

Naturally, the frequency response plot that comes with the microphone and that lives in our head is an oversimplification of the complex behavior of the transducer. One frustrating point is that the frequency response of a microphone changes with the angle of the sound's arrival at the mic from the source.

While I encourage you (and constantly remind myself) to consider omnis and figure-eight patterns more often in the pop/rock recording studio, the fact is, cardioid patterns prevail. But there is a potential hazard to that cardioid pattern that needs scrutiny.

The idea of a uni-directional pattern is that the microphone is focused most on sounds directly in front of the mic. Sounds arriving from the side are attenuated. And sounds arriving from the rear are rejected. That's the theory.

The fact is, off-axis sounds aren't just attenuated—the off-axis frequency response of a microphone is often different from the on-axis frequency response. The result is that sounds arriving from anywhere but in front of the mic are spectrally altered. Specifically, most cardioid patterns are better at rejecting high frequencies off to the side and behind than low frequencies.

Said another way, the cardioid microphone is more of a true cardioid at high frequencies and more omnidirectional at low frequencies.

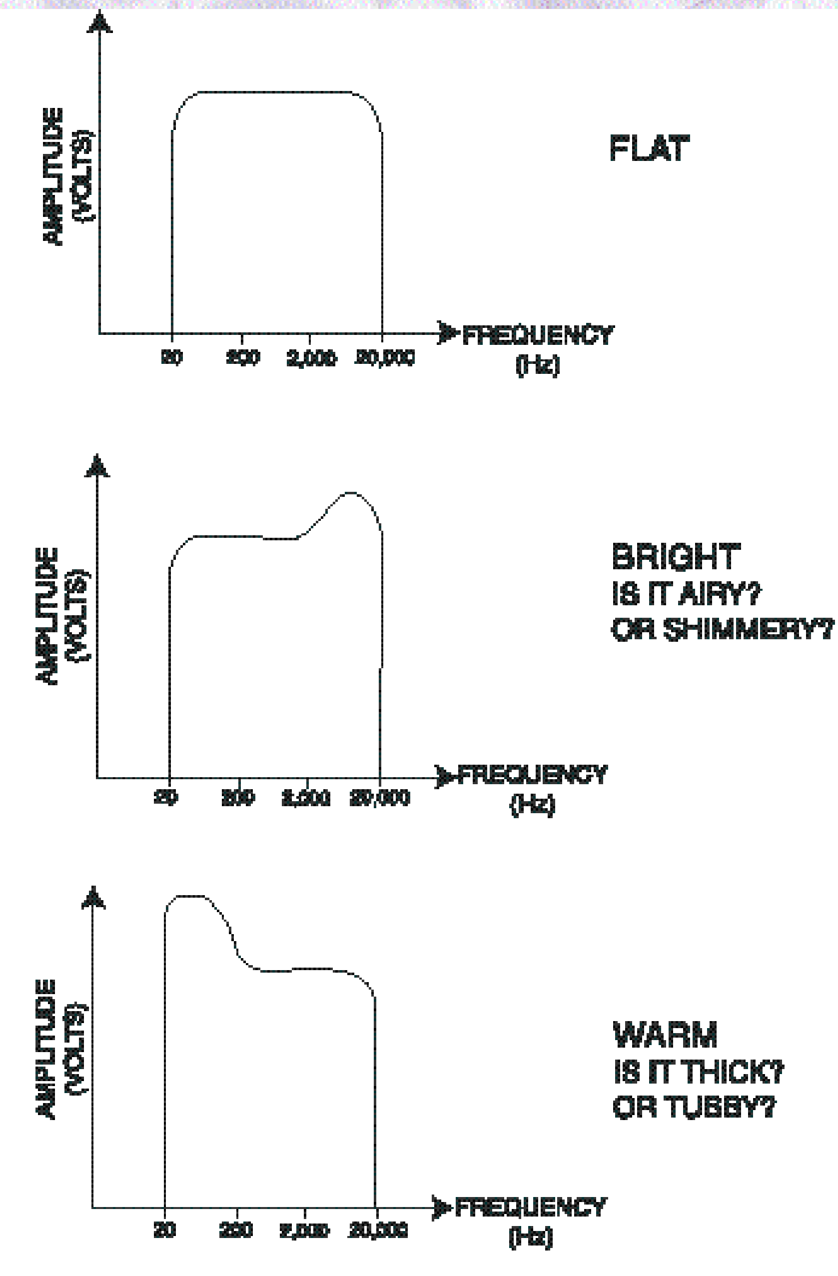

FIGURE 1: SOME FREQUENCY RESPONSE CURVES

Figure 2 (see p. 56)demonstrates a pretty typical frequency trend in cardioids. The response directly in front of the mic is consistent from low frequencies to high—a 'flat' frequency response, on-axis. But beside and behind the mic, the microphone attenuates the highs more than it attenuates the lows. This off-axis coloration means the mic is effectively acting like an equalizer for the sounds coming from all around it. It's rolling off the highs, yet hanging on to the lows and doing something in between for the middle frequencies.

The significance of this behavior cannot be overstated. When you place a directional microphone near a source, you still record sounds arriving from the sides. Sometimes that 'leakage' of other sounds into this microphone is inaudibly low, but other times you can hear it. When the instruments you are recording are required to be very near each other, you'll get an unavoidable amount of leakage from each instrument into the neighboring mics.

Close-miked drum kits are the most common situation where this occurs. The high-hat is always near the snare. The snare is often very near the top rack tom, and so on. Moreover, these instruments tend to be quite loud, forcing themselves on every microphone in the zip code. Leakage abounds.

> Which microphone shall we try? This question will sometimes fill you with dread and panic. ("I've never recorded a contrabassoon...")

But it's not just drums that require us to consider this acoustic leakage issue. When we work with loud instruments (e.g. horns, percussion, and the obligatory electric guitar) or in tight quarters (small booths, and most home or project studio recording situations), we get significant off-axis sound into our directional microphones.

In all cases, if that off-axis sound is dull or murky it will drag down the sound of the mix.

And another thing (this one seems more obvious but is all too often neglected): we often record off-axis sound on purpose. Drums, electric guitars, sections (of horns, strings, voices, etc.) and many other tracks welcome the placement of some distant mics for recording the ambient sound in the room.

In these situations, choose a mic that welcomes off-axis sound and doesn't impose an unappealing coloration onto the sound. These ambient room mics are supposed to be far from the source and are generally supposed to be picking up room reflections coming from all directions.

Choosing an omnidirectional mic is one solution. But it is perfectly acceptable to want a directional mic to achieve some rejection. Keep in mind the off-axis coloration the microphone might add. Choose one whose off-axis response enhances the ambient sound you are trying to capture.

A subtle part of microphone choice then has to do with the degree of off-axis coloration the mic imparts. As if you didn't have enough to memorize about a microphone, now you've got to learn its frequency response as a function of angle... Don't sweat it, though—it will come over time.

Proximity effect

Okay, so you've got the frequency response of a microphone thoroughly internalized, both on- and off-axis. What next? Proximity effect: the low frequency accentuation that occurs when a sound source is very close to a directional (i.e. non-omnidirectional) microphone.

Proximity effect represents another alteration to the frequency response of a microphone. Fortunately, it is easy to hear and easy to predict. Pressure transducers do not exhibit this frequency response-altering phenomenon at all; velocity transducers do. Therefore, the apparent frequency response of omnidirectional mics is unaffected by the closeness of the source to the mic.

Proximity effect is a property of velocity transducers alone. That means you can expect bi-directional mics to add an amplitude boost in the bottom frequency range whenever they are placed very near an instrument (within about one to three feet). Cardioid mics, being half pressure sensitive and half velocity sensitive, will also exhibit proximity effect, but with about half the bass boost of a pure velocity transducer.

How do you get rid of this bass boost? Well,first decide if you want to get rid of it at all.

Used with a little restraint, the enhanced low end can make a voice sound larger than life. This is helpful when advertising monster truck shows, announcing sports, or just plain ol' talking. DJs sound more impressive (and taller) when they are in close on their directional mics. Lead vocals in rock and roll and pop rely on this as well. Hit songs need to sound better than the original instruments, better than reality.

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Modern studio production techniques leverage proximity effect selectively for many tracks.

Roll-off

But bumping up the low end isn't always a good thing. Getting in close to a snare, a piano, or an acoustic guitar can lead to an overly boomy, annoyingly thumpy sound. When you hear this sort of problem, you are hearing an unwanted proximity effect. Know that backing the mic away from the instrument might be all it takes to solve the problem.

When the close mic location is just right except for some unwanted low end due to proximity effect, it is helpful to kick in a high pass filter. Allowing the highs through, the high pass filter attenuates only the lows.

Studio speak calls this 'roll-off,' and many microphones have a built-in switch that does exactly this. Engaging the roll-off circuit removes or diminishes a problematic proximity effect.

Additionally, it may be used simply to get rid of unwanted low frequency sounds that sneak into a studio. Air conditioning and traffic noise from highways or train tracks are typical low frequency headaches.

The roll-off switch is a good solution to these problems. And when the mic doesn't have a roll-off filter built in, you can often find one on the console or in an outboard mic pre or equalizer designed for the same purpose.

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Listen carefully when you engage a filter, because poorly designed filters can affect the higher frequencies audibly, even though they pass through the filter. If you've got the time, the gear, and the ear training, compare the highpass filter on your microphone to the highpass filter on your console to any other highpass filters your studio may have. You may find that all too common trend here: the more expensive filters sounds better.

Sensitivity

It's not just a New Age, politically correct term—microphone sensitivity describes how much output the microphone creates electrically for a given acoustic input. That is, if the assistant engineer screams at exactly 90 dB SPL into a microphone, what voltage will come out? When the assistant screams at exactly 90 dB SPL into another microphone, what voltage comes out?

The more sensitive microphone generates a higher amplitude voltage for the same sound pressure level input. The hotter output requires less amplification at the mic preamp, which can mean a lower noise floor will be recorded. This is a good thing. On the other hand, placing a very sensitive microphone near a very loud sound source can overload the electronics, causing distortion. This is (usually) a bad thing.

Think of sensitivity as a specification that really only needs to be worried about at its extremes. That is, if you know you must record a very quiet instrument (have you ever gathered sound effects like foot steps in sand or water dripping?), seek out a sensitive microphone. If you know the instrument is ragingly loud (trombone comes painfully to mind), perhaps look for a less sensitive transducer.

Otherwise, mic selection is more a function of polar pattern, frequency response, off-axis coloration, etc.

Pad

Sometimes the pairing of a loud sound with a sensitive microphone leads to distortion. Should the acoustic energy hitting a microphone overload the mic's internal electronics or the microphone preamplifier, a pad can be engaged.

The pad offers a fixed amount of attenuation, say 10 or 15 dB, to the signal just leaving the transducer. The lower voltage coming out of the transducer after the pad will (hopefully) no longer overload the electronics, enabling the microphone to be used even on a louder sound.

Many microphones have the ability to sound gorgeous on, for example, both acoustic guitar and snare drum. A mic close to a snare drum might encounter sounds well above 130 dB SPL. A subtle nylon string acoustic guitar might be a mere 40 dB SPL or less at the desired mic position. The pad enables the same mic to be used on instruments of such radically different loudnesses. The pad is turned on when recording the snare and turned off when recording the guitar.

Sometimes a pad isn't enough; acoustic signals can become too loud for the microphone. If the acoustic stimulation of the transducer forces the diaphragm into the extreme limits of its physical motion, it may become non-linear. That is, when the sound is too loud for the capsule, the motion of the diaphragm no longer follows the sound smoothly, rather it slams into the limits of its freedom to move—it distorts mechanically.

When recording very loud sounds like trumpets and space shuttles, look for a microphone with a very high rated maximum sound pressure level. This indicates the point beyond which the microphone cannot transduce without distortion.

Moreover, putting the mic in a soundfield greater than this rating could possibly damage the mic. The maximum SPL rating sets the upper amplitude limit for the device.

Session variables

Which microphone shall we try? This question will sometimes fill you with dread and panic. ("I've never recorded a contrabassoon...") Other

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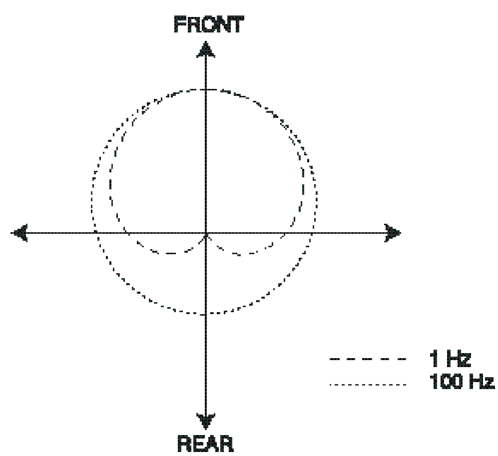

FIGURE 2: DIRECTIONALITY OF CARDIOID VARIES WITH FREQUENCY

times, this question will fill you with anticipation. ("This new mic sounded great on Amy's guitar. I can't wait to try it on yours.")

It is possible to break the mic selection process down into smaller decisions. You've got to get the best sound possible. Experience and ear training will help you match sound sources to complementary microphones.

Session requirements might narrow your options, forcing you into a given polar pattern. For example, you might need to use a mic with a cardioid pattern if you have to put the sax player next to the piano.

Given placements and pairings may or may not require you to switch in a roll-off or a pad, but your knowledge of what these switches do in combination with your reaction to what you're hearing make these decisions pretty straightforward.

The simplicity of the microphone technology requires that we master just a few concepts; the subtlety of recording acoustic sounds demands that we then proceed carefully, with our ears wide open.

Alex Case wants to know what you want to know. Request Nuts & Bolts topics via case@recordingmag.com. Thanks.