



The vocal microphone: Technology and practice

Alexander Case

Evolving technologies for converting acoustic pressure into an electrical signal have driven changes in the performance practice and sound of pop singers.

When you listen to the vocal in a sound recording, you don't actually hear the singer. Usually what you hear is a loudspeaker illusion of the vocal, one so compelling that you think you know the voice of your favorite singers. But it's likely that they would sound very different singing to you in your living room or in your car. In fact, they might sound wrong. The discipline of pop music production includes the creation of sounds that are better than those in real life—exaggerated, unmistakable, and often unforgettable. And although that's true for all the members of a band, the vocalists get special attention.

Shouts and whispers

Sound recording and playback began in 1877 with Thomas Edison's tinfoil recording, and in less than a decade it advanced to the more durable, better-sounding wax cylinder. A horn coupled airborne sound to a flexible diaphragm whose motion pushed a stylus that cut into the recording medium; in that way, sound pressure oscillations in air were mapped to physical undulations of a groove. Playback reversed the process. The electricity-free, all-acoustic recording process was, not surprisingly, rather inefficient. Recording sessions dealt with that by favoring loud instruments. The quietest instruments were put closest to the horn of the recorder so that they had a fighting chance of projecting enough acoustic energy into the horn to alter the shape of the medium. Vocalists didn't so much sing as shout their performances. Recording with a microphone changed those practices; acoustic energy could be transduced into a changing electrical voltage that could be amplified as needed to drive the cutting head.

In the mid 1920s, the microphone began to see use in the recording studio. Two principal audio dimensions benefited from the new technology. First is dynamic range. Whereas screaming and shouting were originally the only ways vocalists could make themselves heard in a recording, with a microphone low-amplitude forms of expression could be captured, thanks to the electrification and associated processing and amplification of the signal on its way to the record. (Cylinders were called records in those days; they were the record of a performance.) Second, even the earliest microphones offered an improvement in frequency response; they reached both lower and higher in frequency than all-acoustic recorders.

Singers embraced those improvements so passionately that they evolved new styles of music. One musical style of the 1920s came to be known as whispering. Though marketed as such, the vocalists actually did sing, but they did so with what was at the time an ear-grabbing gentleness. Shouting was out; intimacy was in. Electronic recording could capture delicacy, detail, and understatement, and so give the listener a personal connection to the singer. The vocalist, singing close to a microphone, created a recording that made it sound as if the performer was in your living room.

The first technology empowering the whispering singers and other early adopters of the microphone was a carbon transducer. Granules of carbon packed into a cavity were made to compress slightly when air moved against a flexible diaphragm. The change in the density of the carbon granules caused a small change in electrical resistance. A fixed voltage applied across the changing resistance resulted in a variable current driven by the changing acoustic wave that compresses the carbon. The sound of the carbon microphone (shown in panel a of the figure) was part of the signature sound of the old analog telephone—characterized by narrow bandwidth, limited dynamic range, and a bit of noise. But it was a big improvement over the passive, mechanical, microphone-free records that preceded it.

Beautiful imperfections

An important advancement in transducer technology occurred in the early 1920s, when scientists and engineers at RCA invented the ribbon microphone. A thin, electrically conductive metal ribbon was suspended in a magnetic field. The motion of air pushed and pulled the ribbon through that field and thus induced a current in the metal. The ribbon, made as light as possible, reacted smoothly and quickly to the acoustic input. With the advent of ribbon technology, the frequency capability of the microphone at last spanned the full frequency range of the human voice.

But the ribbon microphone's sound, though improved, is still not perfect. In fact, the ribbon's slight imperfections are beautifully suited to the human voice. All microphones have a limited high-frequency capability—a ribbon, for example, can only move so fast. High-frequency oscillations moving too quickly for the ribbon to track are simply not transduced into electrical current. For ribbon microphones, however, the frequency attenuation is gradual, a property that creates a silky, never harsh tone. Whereas carbon microphones crackled a bit, ribbon microphones stayed smooth.

Audio fate smiled on the ribbon microphone, as a second imperfection in its design also proved useful to singers. The

**TO LISTEN TO
ILLUSTRATIVE AUDIO FILES,
VISIT
recordingology.com/PopVocal**



ICONIC MICROPHONES. (a) The Western Electric carbon microphone, from an exhibit at the Museum of Science and Industry, Chicago. (b) The Neumann U47, photographed by JacoTen. (c) The Shure 55s Unidyne, photographed by Holger.Ellgaard.

early ribbons, open to the air on both sides, possessed a property known in audio engineering as the proximity effect. As a microphone is placed closer to a sound source, the resulting signal, not surprisingly, gets louder. But the ribbon design caused the low-frequency portion of the signal to increase in amplitude more quickly as a function of distance than the high-frequency range. As a result, the tone of a vocalist up close to the microphone possessed a rich, velvety, bass emphasis. Singing so close also required breath control and performance restraint. No belting allowed.

The low-frequency lift, high-frequency cushioning, and mid-frequency clarity captured a larger-than-life, better-than-real vocal. From the ribbon transducer, the crooner was born. Nat King Cole, Bing Crosby, Rosemary Clooney, and others built their careers not only through musical talent, training, and practice; they also invented a dexterity around the microphone that enabled them to get the tone they desired. Musicianship now required a performance technique unique to the studio. The singer would lean in close for an exaggerated low end, while controlling breath and dynamics to prevent distracting artifacts that might otherwise become audible for someone so close to the transducer. The performance technique has no value to a singer alone. It is a singer-plus-microphone sound that makes a crooner croon.

Carbon and ribbon microphones weren't the only transducer types available to the earliest recording studios. In 1917 Bell Labs released the first condenser microphone, a technology that leveraged variable capacitance to create an electrical signal from an acoustic one. One plate of the capacitor is fixed; the other is a light, flexible diaphragm coupled to the air. Pressure waves displace the diaphragm, causing capacitance changes from which the electrical signal is derived. Used in broadcasts as early as the 1920s, the condenser microphone finally entered the studio for vocal recording with Georg Neumann's invention of the U47 (figure panel b) in 1949, and it dominates to this day.

Compared with ribbon microphones, condenser microphones offer greater accuracy in the highest frequencies; softened crooner tone is traded for heightened realism. The natural resonance of the capsule can enhance pockets of upper-middle frequencies. Sound engineers welcome that departure from flat frequency response. Fondly called a presence peak, it etches vivid detail into the vocal track, boosting intelligibility and

highlighting emotional expression. With the presence peak, the modern vocal sound was born. Frank Sinatra's recordings during his years at Capitol Records (1953–62) offer a representative early example of the larger-than-life pop sound heard on most recorded vocals today.

One for the road

Left out of the story so far is the humble moving-coil dynamic microphone, such as the Shure 55 Unidyne (figure panel c), which has been in continuous production since 1939. For live music performance, that type of transducer has ruled supreme. Since it picks up sound from just one direction, it can focus on the singer and reject everything else. The low-frequency power rises as the singer gets close, which gives a larger-than-life quality that is very much part of the pop aesthetic. However, the low end does not overwhelm the rest of the sound, and the hearty moving-coil transducer is forgiving of the breath, spit, and sweat that comes with a mouth so proximate to a transducer. With a far more durable capsule than the typical ribbon or condenser, the moving coil microphone is well suited to life on the road.

Offering a presence peak of its own but not reaching as high in frequency as a condenser microphone, the moving coil is a particularly good fit to vocalists with great intensity—blues belters and hip-hop poets, for example. Those performers work the microphones hard, knowing that the less-than-full-bandwidth capability of the microphone can lead to a sound with a distinct character suitable for stage or studio.

The evolution of microphone technology has not led to a single correct best practice for contemporary studio craft. Today audio engineers and singers are aware of the unique qualities of ribbons, condensers, and moving coils. Transducer type is a strategic choice, driven by the desired vocal timbre and the artist's performance style. Whereas once technology inspired artistry, artists now leverage technology.

Additional resources

► G. Ballou, J. Ciaudelli, V. Schmitt, in *Electroacoustic Devices: Microphones and Loudspeakers*, G. Ballou, ed., Focal Press/Taylor & Francis (2009), p. 4.

► R. A. Rayburn, *Eargle's Microphone Book: From Mono to Stereo to Surround—a Guide to Microphone Design and Application*, 3rd ed., Focal Press/Elsevier (2012). **PT**