

Microphones



Learn to make the most of microphones, an essential in almost every recording set-up...

Before we switch our attention to the more practical matters of designing and building a suitable studio 'space' and the problems associated with wiring your recording system, there is one 'theoretical' area we need to cover.

Microphones

Though it's rapidly becoming something of a lost art, the selection and use of good quality microphones will never be completely abandoned as long as there are acoustic instruments and human voices to be recorded. Without downplaying the role of instruments such as the synth and the drum machine - both of which have played a major part in enabling musicians to move away from traditional miking techniques as a means of capturing the sound of 'real' instruments - basic microphone techniques are still an important part of the lives of most studio technicians. Even people who do not use an acoustic instrument often find themselves in need of a microphone.

Sampling, for example; some of the most creative samplers around do almost all of their work with a portable DAT machine and good quality mic. And, of course, if you're going to use any kind of vocals other than sampled ones, you're likely to find yourself in need of a reasonable mic and some knowledge of where to put it (...so to speak).

Inside info

As the vital link between the sound you hear and the sound that ends up on record, the importance of microphone design cannot be overstated. Anyone working in a studio needs to understand microphone technology and have a reasonable knowledge of the range of mics currently available.

Fortunately, there's nothing particularly complex about mic technology and, even though there is a vast range of models, for most practical purposes these break down into three or four basic types, with perhaps four different pickup responses - and this last characteristic is the one we'll look at first.

Pickup types

The pickup characteristic of a microphone refers to its ability to respond to sound coming from different directions. Microphones react in different ways: some pick up more or less equally in all directions; others respond to sound from some directions, but are virtually 'deaf' to others. This can be put to good use when it you're choosing the correct mic for the job.

For instance, when miking a vocalist performing on his or her own, it would be preferable to use a microphone which picked up only in one direction, limiting the possibility of noise entering the mic from the rear or the sides. This would also be of use in certain drum miking applications; where, for example, the sound of the snare drum needs to be picked up without spillage from other drums and cymbals.

By contrast, if we're using a single overhead microphone to capture the 'live' sound of a drum kit, we obviously wouldn't want to restrict the pickup area of the microphone to a narrow band. A microphone responding equally to sound from all directions would be called for.

The two types of microphones highlighted here are generally referred to as unidirectional (picking up sound in only one direction) and omnidirectional (picking up equally in all directions). But there are other types, too, as you'll see from the accompanying diagram, and all of them can be extremely useful in the right situation.

It isn't really necessary to know how a microphone exhibits a particular pickup characteristic - or 'polar response', as it is known. It's only important to know the different types and in what situations they're likely to be encountered. Take the example of the omnidirectional mic for recording the overhead drum kit sound (perhaps as one of a stereo pair). This could be mixed with the signals from individual cardioid mics placed above the snare and toms.

Incidentally, the word 'cardioid' in microphone terminology is used to describe the polar response of unidirectional

microphones. As you can see from the diagram, the pick-up area is roughly heart-shaped; this means it isn't exactly 'one directional', but it's reasonably close - particularly hyper cardioid, a more discriminating version of the usual cardioid. 'Rifle' microphones, such as those used for location recording and in TV studios for pinpointing particular sounds, are made from cardioid mics placed in a specially-designed 'interference' tube, which causes reflected (as opposed to direct) sound to be attenuated (reduced).

Common microphone pick-up response patterns:

- A - Omni-Directional;
- B - Cardioid;
- C - Hyper-Cardioid;
- D - Figure of Eight

A cardioid design would normally be the preferred choice for miking instrument amplifiers, but where a mic is placed within a sound field (rather than simply in front of it), it can be worthwhile using a 'figure-of-eight' type to maintain a fuller, more rounded sound. Where mics are in short supply, it is also possible to use a figure-of-eight pattern between two instruments (say, a hi-hat and a ride cymbal just above it) providing the mic is positioned correctly. Although you're producing only one signal, you are effectively covering two instruments which would seldom be played together, and which would in any case require similar EQ treatment on a mixing desk.

We'll look more closely at typical miking set-ups next month. I mention them here simply as a means of illustrating the different polar responses the mics offer. Remember, too, that a particular make and model of mic does not necessarily share pickup characteristics with other mics of the same make and model. Indeed, you'll sometimes find a model of microphone available with different polar responses or, in some cases, with different screw-on capsules that offer a variety of pickup patterns from the same mic.

Now let's look more closely at the most common types of mics currently available...

Dynamic microphones

The most widely-used type of mic - by a considerable margin - is the dynamic or moving-coil mic, which uses a lightweight circular diaphragm attached to a fine coil of wire which is centred in the gap between two cylindrical magnets (one cylindrical magnet inside the other). Sound waves pressing on the diaphragm cause the coil to move up and down within the magnetic field and this induces an electro-magnetic current across the coil, the voltage of which is proportional to the movement of the diaphragm.

In this way, sound energy reaching the microphone is turned into electrical energy which can be amplified and turned back into sound energy by the loudspeaker (a speaker effectively being a microphone in reverse).

Dynamic mics have several distinct advantages over other types; they are relatively cheap to manufacture and pretty robust, and they will work happily in areas of high sound pressure. This makes them useful for live work as well as in the studio, and it also means that dynamic mics are especially suitable for use with percussion instruments.

However, the internal mechanics of dynamic microphones tends to limit their polar response to either an omnidirectional or a cardioid pattern. Also, because of the inertia of the coil moving within a magnetic field, there is a limit to the high frequencies that most dynamic mics can pick up, and there is also a limit to their 'transient response' - the speed with which they respond to a sound.

Nevertheless, there is a massive choice of models available: so much so that many are designed for use in specific applications.

Capacitor microphones

A more recent innovation, the capacitor (or condenser) mic works on the principal of varying electrical capacitance. Simply put: the capacitance formed by two metal plates - one fixed and static, the other thin and flexible - varies in relation to the distance between the two plates. This distance fluctuates as a result of sound waves exerting pressure on the flexible plate or 'diaphragm'.

Because a voltage must be applied to the plates, capacitor microphones require a power supply. This usually takes the form of a 48V supply derived from a mixing desk or other amplification system, and is referred to as 'phantom power'. Being rather difficult to manufacture, capacitor microphones tend to be more expensive than dynamics. However, the improvement in performance is considerable.

Because the diaphragm can be made so thin, much less energy is required to move it. This means that sensitivity is increased, high frequency performance is better and transient response is improved. It is also possible to

produce capacitor mics with virtually any polar response, and this makes possible the design of the plug-on-and-off-able multi-head systems with variable polar responses that I mentioned earlier.

Capacitor microphones are used wherever serious recording work is carried out, but are sensitive to rough handling and so are not generally suitable for live work. In most applications, they reproduce sound much more accurately than dynamic mics do, and this makes them particularly suitable for 'difficult' instruments such as cymbals, which require good high frequency response and speedy transient response to cope with the high harmonic content of the sound.

That said, such accurate performance isn't necessarily what engineers - or indeed musicians - always want. Often, dynamic mics are chosen because their sound, though coloured, is actually flattering to a particular instrument. On the other hand, their accuracy does mean that capacitor mics can be used across a wide range of applications, so they make an excellent choice in the studio, where they can be put to work on anything from vocals to acoustic guitars to pianos.

Unfortunately their universal usefulness, along with their difficulty of manufacture, has traditionally put a premium on the price of capacitor mics. However, their cost has fallen considerably over recent years, particularly with the arrival of some excellent models from the former USSR at bargain prices.

Electret microphones

Though it works in essentially the same way as the capacitor microphone, the electret doesn't require an external power supply because it relies on the diaphragm being pre-charged during manufacture. Only a small battery (usually 1.5V) is required to power the mic; it's often inserted into the body shell.

Compared to capacitor mics, the diaphragm on electrets is significantly thicker, so overall performance isn't as good - particularly in terms of sensitivity and high frequency response. However, this has been improved considerably with the development of the back-electret design, where the electrical charge is applied to the fixed metal plate, making it possible to produce the flexible diaphragm from the thinner material used in capacitor mics.

Pressure Zone Microphones

The pressure zone microphone - or PZM - is a special type of mic mounted on its own flat plate and positioned on walls or other large surfaces. Its design is intended to take advantage of the fact that direct and reflected sound are picked up more or less equally if the mic is positioned at the correct distance away from the sound source.

Also known as boundary effect microphones, PZMs are commonly used to capture the overall sound in a room and may be positioned at a considerable distance from the musicians. This makes them useful as 'ambient' mics, where they contribute to the overall live feel of a recording.

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