



It All Starts with the Microphone

Bob Heil



\$10

Things you were never told...



Preface

Have you ever had the experience of using a very expensive sound system and the sound was still awful? Have you ever been at a concert and not been able to understand the singer? Or been at a football game and not able to understand the announcer? These are often examples of poor or improper use of the **microphones**—the source of all sound in modern sound systems. The microphone is the single most important piece of equipment in nearly every audio chain. You can have a very expensive sound system and if you do not understand how to use a microphone, the sound will be terrible. The quality of sound at the end (your ears) depends on the quality at the beginning.

If you work with sound, it is essential that you have a thorough grasp of how microphones work, the different types of microphones and what they do. How a microphone sounds and behaves in a particular situation will significantly affect your success in achieving “good” sound. This publication is targeted at educating those of us who use microphones every day yet may not be technical whiz kids. While sound does involve physics, the basic understanding of microphones is not rocket science! We will bring new and informative light to the subject of mics, and also discuss and define issues that affect them and their surroundings. You will discover important information that will help you get the most from your microphones and improve the sound you work with. Our goal is to make your use of microphones, regardless of brand or type, easier, fun and more rewarding! ~Bob Heil

“To make a dynamic that sounds as good as a condenser, with absolute correct phase coherence, high output, fabulous build quality and ruggedness at a ridiculously affordable price... well... now you’re only talking about Bob Heil...period.”
~Taylor Johson T.H.E. Microphone Company

“I have known how great the new Heil dynamic mics perform for 2 years. Now it’s time for the rest of the world to catch up.”
~Joe Walsh

What is a Microphone?

A microphone is an amazing thing. It actually transfers energy—right in the palm of your hand! It takes an acoustical energy (your voice or instrument) and turns it into an electrical energy. This electrical energy can then be recorded, amplified or otherwise altered in ways that the original acoustic sound wave could not. Amazing!

A Basic Look at Microphones

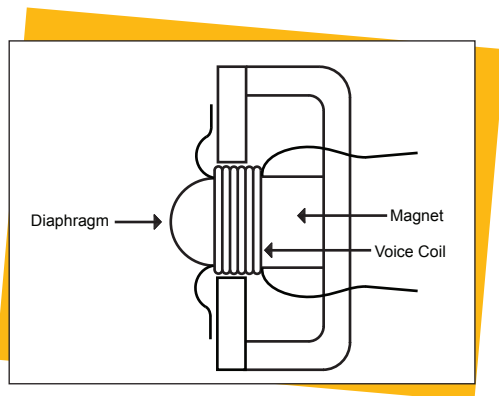
One of the most asked questions is, “What kind of microphone should I use?” It all seems very confusing: Dynamic, Condenser, Ribbon, Electret, large diaphragm, cardioid, omni—so many technical words! Think of a microphone as a “backward” speaker: a microphone hears sound and transfers it into electricity. A speaker sees electricity and transfers it into sound. The technical terms are not understood equally by those of us who use microphones. Read on. We will help you sort out some of the mysteries.

DYNAMIC MICROPHONE

Dynamic microphones work on the “moving coil” principle. A small diameter of thin aluminum or Mylar diaphragm is connected to a coil of very thin hair like wire that is suspended in a strong magnetic field. As the acoustic sound waves hit this diaphragm, the coil of wire vibrates in the magnetic field causing an electrical signal to be produced. The electrical signal is the same frequency as the original sound wave.

Tremendous mechanical durability, lower cost, no external power requirement and very high input SPL (Sound Pressure Level) capability were always the advantages of dynamic microphones. They are ideal for live events and concerts, in front of electric guitar cabinets, loud instruments (trombones, trumpets) and the like. They are ideal where rough treatment, such as at a school or church, is expected. Their lower cost makes it possible to own more mics so this is a big benefit to sound companies as well.

Typical dynamic microphone transducers are less than one inch in diameter. They have acoustical properties yielding frequency responses with peaks and dips in the wrong places, causing programs to sound either nasal or muddy or both. Excess equalization always had to be applied to electrically “fix” these poorly designed dynamic elements. The number one audio rule:



Dynamic motor diagram

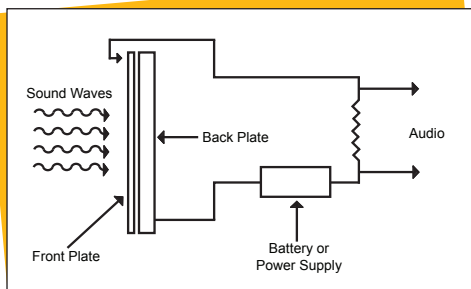
You Can't Fix Acoustic Problems With Electronic "Fixes"!



In recent years, Heil Sound has brought new technologies in materials, craftsmanship and design to the table for dynamics. In 2005, we introduced the new PR Series of “large diaphragm dynamic microphones”, addressing many of the inherent problems of previous dynamic microphones. They have dramatically increased the transient response and the frequency response of our dynamic to a point where it is possible to use a Heil PR mic instead of a condenser. This new technology uses huge Heil 1.5 inch diameter diaphragms, very different from the 1/2 to 3/4 inch diaphragms typically used in dynamics. These low mass large diaphragms allow much faster transient response, something never heard before in a dynamic. Precision location of the phasing plugs and a unique mixture of rare earth metals in our motors (Neodymium, iron and boron) have created the widest frequency response we’ve encountered in a dynamic. These new Heil large diaphragm dynamic mics offer a natural, smooth midrange response that has traditionally been the domain of ribbons. Heil mics are winning unique praise in the studio, the live event and the broadcast booth, something not readily seen or heard before. These new developments enable you to use a Heil Dynamic where previously you would have only used a ribbon or condenser. The Heil Dynamics are winning comparison tests everywhere so they are something you should try! We were pleased to hear that Heil PR 30 and PR 40’s are the lead vocal mic on major studio projects and this is certainly quite unusual.

CONDENSER MICROPHONES

Condenser microphones are typically found in the studio. The element is made up of a thin film coated with a conductive material such as silver or gold which is suspended over a polarized (powered) backplate. This condenser diaphragm is part of an electrical circuit that changes voltage with movement and this voltage becomes the output of the microphone. Sensitivity, wide frequency response and transient response were always the performance advantages of condenser microphones over ribbons, dynamics and all other types of microphones.



Condenser diagram

Unlike dynamics or ribbons, condensers require a power source to operate. This power is typically delivered via an external “power supply” or something called “phantom power”. Phantom power is a dc voltage fed back through the microphone cable from the console or mic preamplifier to the microphone to run its internal electronics. The term “phantom” was coined because there is no additional

wiring or connections to carry the dc power from the console to the microphone. Most all consoles or mic preamps have a built-in 48 volt phantom supply that can be sent to the condenser mic up the mic cable.

The phantom power situation is also something you must be careful of. These microphones are more susceptible to RF and electrical interference since you have dc voltage being fed on the exact same two conductors as the audio from the microphone to the console.

Because there is no heavy voice coil attached to the diaphragm, the diaphragm





Now Showing

The PR 40 was used to record the cannons and rifles in Clint Eastwood movies, "Flags of Our Fathers" and "Letter From Iwo Jima".



The PR 40's ability to handle incredible high SPL, huge wide frequency response and natural mid range articulation made it THE microphone of choice for soundman Charles Maynes shown at right with a PR 40 duct taped to the WW2 rifle!



“The PR 40 does handle loud sources remarkably well, and if it's off axis, rejection makes it a tremendous tool for my effects recording—I do *not* leave home without it.” ~ Charles Maynes

is exceedingly low in weight (low mass) and it puts up little resistance to being moved at higher audio frequencies. The trade off of this wider response is that the output of this light diaphragm is so low that it requires another amplifier inside the mic to boost its output up to a level that preamps can work on. We now need even more power and more electronics! Condensers are fragile beasts and require delicate handling, something you will never want to take on a long concert tour and rely on every night (without lots of expensive back up mics)!

The lighter diaphragm inside condenser microphones means they are extremely sensitive to sounds. It has always been the condenser's strength in a controlled environment but its downfall is in uncontrolled environments, such as live sound stages or commercial broadcast studios. While you may want every nuance of a quiet oboe or violin in the recording studio, on a concert stage you may *not* want the lady in the 5th row's sneeze to come through as clear as a bell. While you may want the subtle tone of a person's singing voice in the studio, the loud squeak of camera wheels on a TV news stage is not good! Picking up too much has always been the problem with condensers, especially in the hands of lesser experienced users or in less controlled environments. Even with a proper cardioid pattern, a bad room will make a condenser sound bad. Condensers are wonderful but environmentally critical.





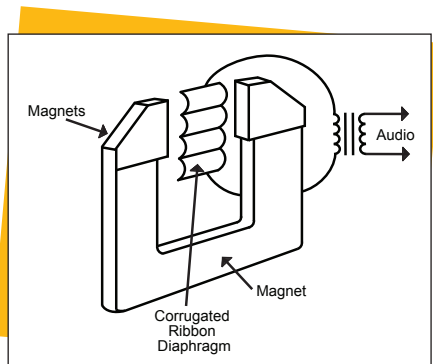
In recent years, there has been an avalanche of cheap condenser microphones from China flooding the market under many different brand names. Their frequency responses seem to look wide on paper, lots of lows and highs, but they lack midrange and are harsh and rumbly. They have variable or switchable patterns, but careful listening proves these patterns are at higher frequencies and mid to lower frequencies are often nearly omnidirectional! This causes the mic to be increasingly sensitive to the room acoustics and will not reject off axis (not in front) sounds. Beware of these cheap condensers! They look pretty, have a nice price, are common in stores but leave a lot to be desired in real applications. For many, owning a “condenser” microphone has become a great ego boost and has little to do with it's actual performance.

ELECTRET MICROPHONES

An Electret microphone is a small version of a large diameter condenser. Using an internal Field Effect Transistor, the Electret can usually be powered from an internal battery or phantom (console supplied) power. Their primary advantage has been size and you will find them on the lapels of TV anchors and news folk. They do not exhibit the extreme sensitivity of the large diaphragm studio condenser but they are still vulnerable when placed in and around high SPL situations. Care in handling the delicate Electret has to be taken since they do have sub miniature internal electronic components. They are best at voice, but expensive versions can offer wider response and wider applications.

RIBBON MICROPHONES

The ribbon microphone was popular in the early days of audio back in the 1930s, '40s and '50s. Using a metal bifurcated ribbon stretched between two poles of a large heavy permanent magnet, these microphones were noted for their wonderful midrange, warm tone and great bass response. Unfortunately they are *very* fragile and cannot take loud sounds (high SPL). The ribbon is easily broken if dropped or mishandled. Even blowing into them (“Hey, “whoooof” is this on?”) would often fracture early ribbons. The other issue with ribbons was very low output. Special high gain mic preamps were employed to get sufficient gain from the microphones. Ribbon technology was stagnant for many years but a few companies have brought some new technology back into this arena lately. The durability has increased and output has improved but these mics still remain best at recording applications.



Ribbon microphone

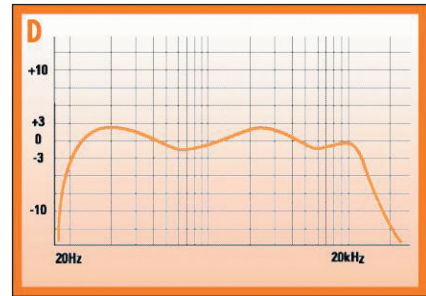
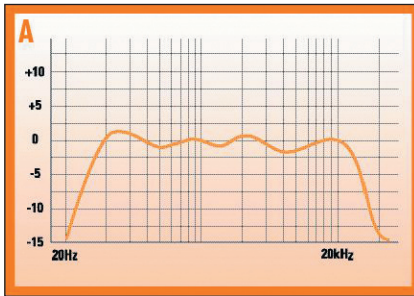


Microphone Characteristics

Here are some of the important characteristics that influence how a microphone will actually sound.

FREQUENCY RESPONSE

Of all the specifications, frequency response is the most important in determining how a particular microphone will behave. The band edges are set by where the lowest and highest response will be -3 dB. A graph of the response will tell you if the microphone is perfectly flat or has any coloration or shaped peaks or valleys. It is preferable to have a flat response but a response can be shaped to greatly enhance the performance of a particular microphone. The design engineer will shape the frequency response to give the microphone a personality or a very distinct sound which allows it to achieve much better performance for most applications. Flat is *not* always best.



PROXIMITY EFFECT

One of the most degrading effects to a cardioid microphone's frequency response is what's called "proximity effect". Proximity effect has to do with distance that a microphone is "worked" and can be a blessing or a curse. When a sound source gets closer to the cardioid microphone the bass frequencies can be boosted up to as much as 18 dB in some cases! The closer the source the "boomier" the bass! Singers often use the proximity effect unconsciously, bringing the microphone closer to their lips for a warmer, more intimate tone. But in large scale sound systems bass can be an enemy, making it harder to understand the words and having the levels change drastically as the performer unconsciously moves the microphone around in front of them. It also is a disaster when using a microphone with heavy proximity effect up close on an instrument, such as a piano, acoustic guitar or other "natural" sounding instrument. It will completely change the sound as though you turned the bass to "max" on the equalizer. No amount of bass cut will fix it, for the frequency "center" of the proximity effect is not where in the frequency "center" of your bass EQ is.

You will simply have to experiment with a microphone to actually understand each model's unique proximity effect behavior as it is not shown on a specification sheet. With proximity effect, close is not always better. Sometimes its best to place the mic back 6 or even 12 inches from the source to avoid proximity effects, but then you risk picking up everything from the 20th row to the back stage wall! The other damaging effect is that when using a microphone with your lips on it, the

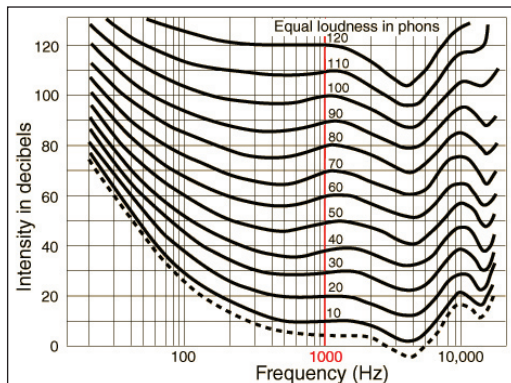
diaphragm will in many cases be overloaded, therefore the output will *not* be clean and articulate. No amount of EQ will help as it all starts at the microphone and when it comes to the mixer full of low end distortion there is little hope.

Remember: You can not fix acoustic problems with electronic “fixes”.

FLETCHER MUNSON CURVE

Humans don't hear all frequencies of sound at the same level. That is, our ears are more sensitive to some frequencies and less sensitive to other frequencies. In the early 1930's Dr. Fletcher and Dr. Munson, audio pioneers at Bell Labs discovered that the human ear hears differently at various loudness levels. At 130+ dB SPL we hear almost flat. But we hear lows and highs poorly at lower volumes

(lower SPL) and it gets worse the softer the sound. To complicate matters further we all lose our hearing above 14,000 Hz as we age! The important thing to understand about sound is the volume (in SPL) affects your perception of bass and treble response significantly. What sounds quiet one way, sounds different loud. The same thing is true for sources and microphones. A mic that sounds good at low level may sound terrible at high level! Fletcher-Munson also discovered that the dynamic range of the human ear was 120 dB!



WHICH IS BEST, FLAT OR SHAPED?

Choosing the right response profile depends on the sound source and the surrounding environment where it is used. Wide, flat frequency responses are most appropriate for music where a wide range of frequencies are being produced—classical music, symphonies, violin solos, etc. But a flat microphone usually is not what experts pick for sources that have a more limited frequency response. A “shaped response” with a boost in the response in exactly the correct place, is usually the best sound for voices. Most microphones do not have this shaping, or rise in response, in the correct place of the response curve.

Two of the most popular dynamic mics in the world are prime culprits examples of this. You will see these stuck in front of guitars, amps, drums and worse—pianos. The sound engineer has paid no attention to the fact these microphones have a terrible mid range peak in the *wrong* place. Couple this peak with the built in proximity effect and the instrument you are trying to amplify ends up sounding *nothing* like the original! Louder for sure but not pleasant to listen to. A popular dynamic on a snare drum has no “snap” and the snare actually become honky sounding because the microphone has a 3K response rise. This is over 30-year-old technology and its time things change.

After several years of experimenting and listening, the Heil Sound team

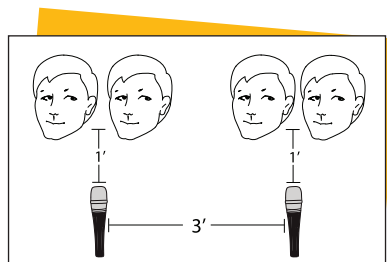


discovered that most of the old line favorites have their frequency responses in the *wrong* place. Just about every dynamic microphone has a mid range response peak that is in the *wrong* place. The peak is too low in frequency and therefore adds a nasal, hollow sound to the source it tries to reproduce. As a consequence, these popular microphones have to be equalized heavily to sound proper. The large diameter Heil dynamic mics have placed a small rise in *exactly* the proper frequency which gives it a perfect natural sound, *without* any equalization.

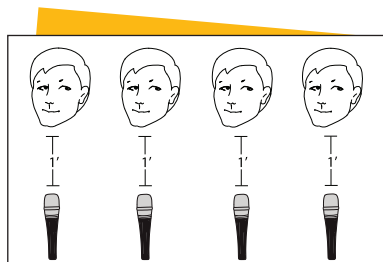
Multiple Microphone Use

Care has to be taken when using multiple microphones in the same location. Serious side effects occur when the sound of a single source arrives at two or more microphones. Sound travels at 1120 feet per second—very fast—so it is easy to understand that with one source and multiple microphones, sound will reach the closer microphone before the farther microphone. When these two signals arrive at the mixer, one slightly behind the other, you get a weird, hollow, “comb effect” sound or total cancellation! This side effect is called “phase cancellation” and is a condition that must be avoided because it will make good sound turn suddenly bad. So here’s the rule to memorize and never forget:

3:1 Ratio Rule

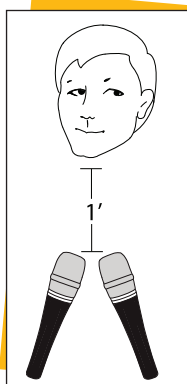


Good

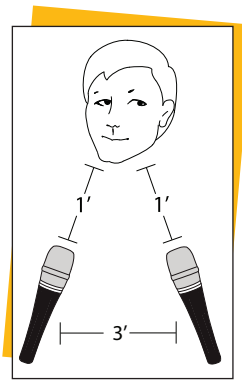


Bad

Whenever two microphones must be used in nearby locations and they can “hear” the same source, apply the **3:1 Rule**. If microphone A is 1 foot from the sound source, Microphone B should be at least 3 times the distance away (3 feet) from Microphone A. If you would have Mic A at 2 feet, the minimum distance for Mic B must be 6 feet from Mic A—a 3:1 ratio. The sound picked up by the more distant microphone is then at least 12 dB *less* than the sound of the closer one. Any closer and you get the dreaded phase cancellation that causes things to sound hollow and empty for no apparent reason!



Good



Bad





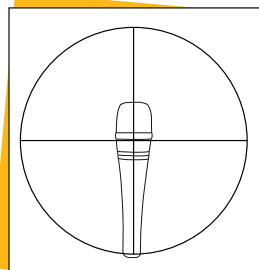
PICK UP PATTERNS

One of the more important things to know about a microphone is the area around the microphone that it will “pick up” versus the area it will ignore. Some pick up sound from all angles, others favor sound from just one angle—the front for example. These directional characteristics are classified as OMNIDIRECTIONAL, BIDIRECTIONAL, UNIDIRECTIONAL or CARDIOID. Just as a frequency graph will provide a useful indication of the microphones frequency response, a “polar” chart will provide a useful visual indication of a microphone’s directional characteristic. A polar chart is if you are looking down on the mic and seeing what “pattern” there is to the sound it will accept.

OMNIDIRECTIONAL MICROPHONE PATTERN

An *Omnidirectional pattern* or “Omni” mic will pick up sound equally well from all directions above and below, front and back. Omnidirectional microphones usually have a very flat response. This is ideal when you want to record everything in the room or you do not want the sound to change with location of the source. The most common application for an Omni is those “on location” TV interviews you see on the news. They are very useful where relatively inexperienced people are talking into and using the mic. Since the sound is picked up equally in all directions, you do not need to point the mic at one thing to “hear” it. There is no proximity effect with an Omni so you do not have bass boost changing the sound of the source.

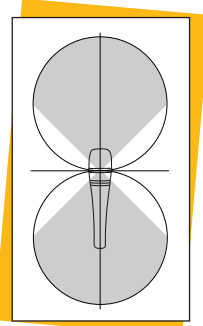
The Omni mic is not commonly used in live sound or recording for the same reason it works in TV news—it hears everything. You have no option of avoiding unwanted sounds and isolating the sound you actually want. If you are trying to record a single drum of a drum set, it cannot be done with an Omni. You need a mic that will isolate just the drum you want from the set of many drums.



In live sound, an Omnidirectional microphone is often a bad choice because it will pick up various reflections of the sound you want from nearby walls, floors, ceilings, etc. An Omni can produce a very hollow sound on a mic stand on stage, where the sound from a singer hits the floor and bounces back up into the same mic they are singing into, canceling some of the sound you want. In live sound applications, you are less likely to use an Omni because you have a much greater risk of feedback when the mic picks up the sound from the speakers as well as the vocals! Omnis are most often seen as condensers in the recording of orchestras in excellent sounding rooms.

BI-DIRECTIONAL PATTERN

Bi-directional pattern, also called a figure eight pattern, is most common with ribbon microphones which are inherently “front and back” mics. Some studio condenser mics still offer figure eight patterns. In the early days of radio, it was used for capturing the performer and a live audience simultaneously, or two people sitting facing each other at table. Not useful for live sound, this pattern is most useful in advanced recording techniques called Mid/Side. There is no proximity effect with a bi-directional microphone.

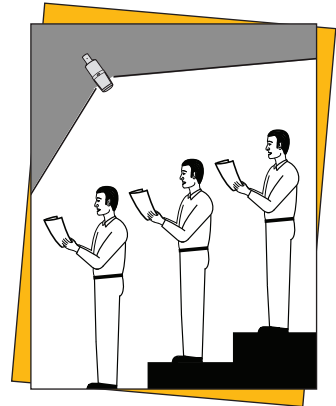
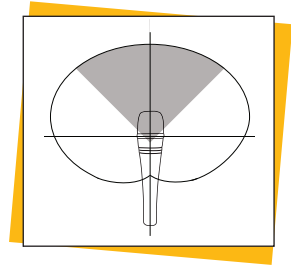




CARDIOID or UNIDIRECTIONAL PATTERN

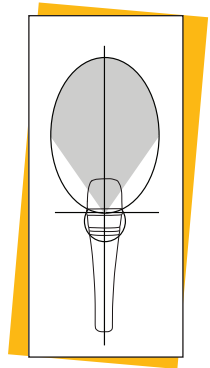
A Cardioid microphone is a microphone that picks up mostly from the front. Its pattern looks like a heart on a polar response chart, hence the name *cardioid*. The cardioid mic will focus its pick up pattern on things that arrive at the front of the mic, so you can point it at the sound you want and away from sound you don't want. This is the most popular pattern for live sound (it ignores the floor monitors and out front PA system) for it has greater "gain before feedback". This pattern allows you to eliminate the problems encountered with the Omni pattern because it can be pointed away from sounds you do not want. It is also the most important microphone for recording, for a user can focus the mic on just the instrument desired. It can also make a recording in a bad room better, because it "hears" less of the room and more of what is right in front of it.

Cardioids all have some form of proximity effect, which is an unavoidable by-product of eliminating sound from the rear. With careful application, this proximity effect can be used to your advantage.



SUPER or HYPERCARDIOD

The SUPER and HYPER CARDIOD pick up patterns have higher directionality and rejection of sound coming from the sides than Cardioids, but slightly more pick up of bass from the rear. They are very useful in isolating the desired sounds from the front and rejecting unwanted and ambient sounds from the rear and side. The caveat here is that the "acceptance angle" or pick up area is very small and the performer *must* stay directly "on axis" or directly in front of the mic to be picked up. Side to side movements can put a performer in and out of the pattern very quickly and cause significant problems for the sound system operator. The pattern is most useful in stable, non moving sources for live sound.



SPECIALTY PATTERNS

The SHOTGUN mic is a very hyper cardioid that has a very narrow pattern but has greater "reach", so the source can be further away than a normal cardioid or hyper cardioid. This mic can work a source that's 3 feet way. This mic is best used on location video, TV talk shows hung from a big boom and location movie work. It is used primarily to isolate sound in higher noise (high ambient noise) environments.

The PARABOLIC mic has a very narrow, pencil like far reaching pattern and is best applied on football field sidelines where the microphone will be very distant from the sound source (the football players). This mic works on sources over 30 feet way. This mic has very poor sound quality for you are using a dish to focus the sound. It is not used for any high fidelity applications.





MICROPHONES FOR LIVE SOUND

Most of the inputs for live sound systems are microphones with a few direct inputs from keyboards or guitars through a direct box. Open microphones in a live situation create a perfect path for feedback. So, it is important to choose microphones with excellent cardioid patterns and learn to aim the sensitive focus of the microphone away from the main system or floor monitor. Condenser microphones are highly sensitive and create feedback paths very easily. The new technology of large diameter dynamics solve that problem because the frequency response is good (or better) and the lower sensitivity solves the feedback problems.

USE AS FEW MICROPHONES AS NECESSARY

In setting a stage for a live group the thought has been to use as many microphones as possible. "The more the merrier". Nothing could be more dangerous! There are several good reasons. Number one is the phasing problems that occur when the same program source reaches two or three microphones at different times, due to their different distances from the source. This causes phase shift, phase distortion and phase cancellation. The same sound entering these microphones at the same time results in some very "weird" sounds: muffled lows, loss of mids and complete cancellation of highs can be heard. It is a monumental problem, but *few* engineers know about this horrible situation caused from using too many microphones.

Another ghastly open mic problem is system *gain* before feedback. Every time you open another microphone you will have to drop the overall system level by 3 dB (3 decibels) to avoid feedback. 3 dB is double your power so each time you open another microphone you loose another 3 dB of output level. If you think you need 40 microphones, you will have practically *no* output level! The answer is to use as few microphones as possible. Drum kits are usually the number one culprit of overly extended uses of microphones. Sound engineers like to use a microphone on every individual drum and cymbal. It is not uncommon to see upward of 12 to 15 microphones on a drum kit, especially if the overheads are highly sensitive condensers. Does this create a better sound than one with fewer microphones? No way. Experiment with DYNAMIC microphones that exhibit good cardioid patterns and you will discover a much cleaner, clearer, articulate reproduction.



The 100 watt guitar amp is less than 2' from the right PR 30 over the cymbal but with the incredible rear rejection of the Heil PR 30 that guitar was hardly detected in the overhead channel!





OVERHEAD CONDENSERS ARE THE CULPRITS

Overhead condensers present the largest problem on every stage. It has simply become “the thing” to do, but nothing could be worse than “hanging” several overly sensitive condenser microphones 3 feet above a drum kit. One reason for this happening is there has *never* been a dynamic microphone that had the wide response of the condenser—until the wizards at Heil Sound broke the barrier with their large diaphragm dynamic microphones, specifically the PR 30.



Condensers mounted high in the air hear *everything*—from the 5th row of the audience to the back stage door. But, of course, they *do* pick up the sizzle of the cymbals very well. Replacing these overly sensitive microphones with the new Heil dynamics will immediately clean up the sound and all you will have left in those mixing channels of the PR 30 microphones will be the sound of the cymbals—and cymbals only. A revolution has begun!

SNARE DRUM MICS

Choose your microphone carefully. An SM 57 or SM 58 is *not* a good direction. They have *no* mid range personality and no articulation. You have to “try” and equalize to get a decent sound and EQ is *not* the answer to “squeezing” mid range that isn’t there to start. Leading producers such as Joe Baressi, Russ Long, John Paterno and Kurt Ballou have all discovered the new weapon in their arsenal of microphones for snare drums—the Heil PR 20. Use *two* of them. One on top and one underneath near the actual snare. But make certain you reverse the phase on the mixing console of the lower PR 20 since that bottom snare is out of phase from the top. If you do not have a phase reversal switch, get the soldering iron out and physically reverse pins 2 and 3. This will give you the best snare drum sound you have ever heard. Guaranteed!



For the greatest snare sound ever, mount a PR 20 on the top head of the snare and a second PR 20 wired out of phase, close to the actual snares on the bottom.





TRANSIENT RESPONSE

One of the most important factors in a microphone is its ability to respond to rapidly changing sound waves. This is known as “transient response”.

The acoustic sound wave physically moves the diaphragm. The amount of time it takes for this to happen depends on the weight of the diaphragm material. Of course, the response time is longer for the heavier diaphragm material of the dynamic to react over the lightweight, thinner condenser element.

One of the new and important technologies of the new HEIL PR series microphones is a larger diameter of much lighter weight materials. The wizards at Heil discovered that if they fused two different types of metals for their new large diameter diaphragms it would keep the weight down and bring the transient response of their new dynamics close, or equal to, many of the inexpensive condenser microphones. This changes the way many producers and leading sound engineers think about dynamic microphones.

We now can use the new technologies of Heil dynamic microphones for overhead cymbals and other instruments with sharp fast attacks. This new dynamic does not bring the baggage of overly sensitive condensers that pick up sounds and instruments from across the stage. The new Heil dynamics can be much better controlled, with very fast transient responses similar to the condensers. The new Heil PR series finally brings overhead cymbal microphones that hear *just* crystal clear sounds—never before attainable with old technology dynamic microphones.

ELECTRICAL IMPEDANCE

Another important characteristic of a microphone is its output impedance. This is a measurement of the ac resistance-to-current flow that would be observed looking back into the microphone. Source impedance determines the size of the load that the microphone can comfortably drive. It is important to recognize that the impedance of a microphone should not be matched to the impedance of the device to which it is connected. Doing so will cause a significant loss in signal level. Ideally, a microphone should be connected to a mixer's input whose input impedance is higher than the output impedance of the microphone.

Microphones are usually divided into two basic classes: low impedance 50-1,000 ohms (also called Low-Z) and high impedance 10,000+ ohms (also called High-Z). Most professional microphones designed for long cable runs are low impedance devices. This means their source impedance is below 600 ohms. Properly connected, they are far less susceptible to extraneous noise pickup in the cable and can be used with long cable runs (over 1,000 feet) with very little loss in sound quality. High impedance mics are limited to about twenty feet before degradation.

High impedance microphones require a buffer amplifier or transformer when using low impedance inputs and/or long mic cables.

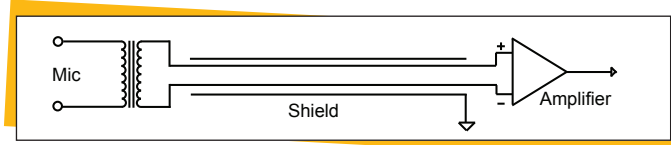
A microphone's impedance is not necessarily an indicator of quality or performance. It is simply a factor that must be weighed for any given application and the characteristics of the input to which it will be connected.

WIRING: BALANCED or UNBALANCED?

Microphones can be balanced or unbalanced. An unbalanced connection uses two wires. The center conductor carries the audio signal while the shield carries the ground wire.

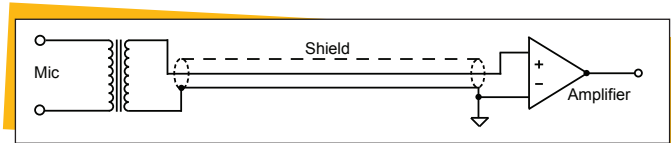


A *balanced* connection uses three wires. Two separate signal wires inside the shield carry the plus and minus signals (opposite polarity). The shield is connected to ground. It encases the signal wires and protects them from outside interference. This makes the system more immune to noise from poor lighting equipment, electric motors, computer hash and RF interference because they hit the shield and are directed to ground.



Balanced output

With an *unbalanced* configuration one of the signal wires is the shield, the other is the + signal. Any noise picked up



Unbalanced output

on the shield will be fed directly into the amplifier or mixer input. Balanced configurations are the preferred method, especially over long cable runs and noisy environments. The added bonus is that noise induced on the microphone cable will cancel since the two signal lines are out of phase from each other and the shield is not connected to *any* of the signal input lines.

MICROPHONE TECHNIQUE

■ **P POPS** — Talking directly into a diaphragm of a microphone will cause a nasty side effect called “P-popping”. P-popping is a horrible explosive bass “thump” you hear when a speaker uses certain letters (P’s and B’s) and speaks right into the mic. You cannot remove P-pops from the audio once its there. When speaking into a microphone, you should talk “across” or just over the microphone rather than directly into the diaphragm. This will eliminate a good part of this problem. Another solution to P-popping is the use of a Pop Filter; these are large circles you place in front of the mic and are not visually acceptable in live situations. To help reduce (or in many cases eliminate) this low frequency distortion, simply roll off the low frequency response of the microphone in use. Keep in mind that the human voice has little (if any) energy under 120 Hz, so rolling off the equalization of that microphone will not loose any program response but certainly will eliminate the P-pops and handling noises. This is a trick used by the leading front of house mixing engineers.



Talk across your microphone.



Heil PR 40 in the SM2 shock mount shown with the BSW “pop” filter.



■ **LEVEL** — It is very important to keep a source at the same distance from the mic so the volume of the source does not change drastically over the PA or in the recording. It is critical in vocals to keep the lead singer “out front” and at a relatively constant level. If a singer moves his head around a lot in front of the mic, the level will go up and down, making the singer loud and then soft, understood and then not understood. So practice keeping your mouth at the same position relative to the mic as much as possible, except when you really belt it out and need to back it off a bit. One *huge* change in the level and pattern of the microphone will occur if you cup your hand around the ball or where you speak into. Hold the mic on its *handle*, not the ball.

■ **HANDLING NOISE** — Nearly all microphones make noise when you rub your hand on them or tap them when they are amplified on PA. This rumble or handling noise is impossible to remove. Cardioid mics can be a problem especially in the low frequency area. Professional sound engineers solve this by reducing the low end response of the vocal mic at the mixer. Most handling noise is in the 30-80 Hz region and since the human voice has little content there, rolling off everything under 80 Hz reduces the handling noise.

■ **MIC PLACEMENT** — Mics sound different depending on how they are pointed at the source. Sources also have different response depending on whether you are directly in front of them or not. We spoke about “on and off axis” before, which refers to whether you are directly aimed at the center (on axis) or off center (off axis) of something. Pointing a mic directly (on axis) at something sounds very different than pointing it to the side of something (off axis). If a trumpet is pointed directly at the mic it sounds different than if it is pointed to the side of the mic. Same is true for acoustic guitars, pianos, singers, etc. Experiment!

Important Extras

- **Shock Mounts** are very useful and necessary accessories that float the microphone in a neoprene rubber band “cage”, thus mechanically isolating the sensitive microphone element from vibration or thumps transmitted through a mic stand or desk top. This is vital for studio and broadcast applications where people might be hitting the table with their hands, walking on a wooden floor, etc.



- **Windscreens** are necessary in some applications. Made of acoustically transparent foam that fits around the head or windscreen of a mic, they help to reduce the noise created when the wind “blows” on the mic element while in





use. If you know you will be using microphones in a windy location, make sure you prepare for this possibility.

- **Mic Stands** are an often neglected issue. “We just need enough stands to hold all of our mics” is a phrase often heard. Many will grab some of the 50 year old stands and if it holds the microphone, excellent. There are a number of very clever and high tech mic stands and booms available today. Pay attention to some of these. They will make your job easier *and* position that microphone *exactly* where you need. The new Heil SB 2 is one of these tools. They are perfect for getting microphones into tight places around drum kits and guitar amplifiers.



Listen, Listen!

It is surprising how many folks work in sound but don't *listen*. When you set up a PA or recording system, budget the time to listen to each microphone univocally during set up to be sure it works correctly and sounds good. This is where you can spot a bad cable, connector or defective mic. Try different mics on different instruments and vocals. Each model has a unique tone and sound to it and “fits” with a particular source better than other mics. One singer may sound better with one mic than another. The sax may sound better with the mic that doesn't work so well on vocals. A good mixing engineer is an artist too and the microphones are the instruments—colors on the palette to build the sound he or she wants to achieve. Determine for yourself which sound is the best for your particular situation. Learn to classify the sounds and audible characteristics of each microphone you own and know where to put them before you get to the gig to get the most out of them.

Remember this important audio fact:

Hearing is a physical process...

Listening is a mental process.

Make certain you are always listening to your work!



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- vocal
- horns
- talk show host

- vocal
- talk show host
- kick drum
- horns
- cannons and rifles

- vocal
- broadcast
- big band

- vocal
- snare
- guitar
- horns
- piano

- vocal
- guitar
- overhead
- cymbal
- choir
- piano
- condenser replacement

- vocal
- guitar
- piano



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