More information on sound then you'd want.

Decibels:

The term *decibel* is often used but not often fully understood. If a level is stated in decibels, then it is comparing a current signal level to a previous level or preset standard level. A value given as decibels always has a reference, otherwise it is meaningless. If you are talking about sound pressure levels (SPL), the reference is considered to be the lowest level that can be heard by human beings. A one decibel change is considered to be the smallest change that can be perceived by the human ear. If a value is given as negative decibels (-dB), it means that the value is below the reference. You will notice that the "B" is capitalized in dB. This is because it refers to the last name of Alexander Graham Bell.

It's Just A Phase I'm Going Through

The term "phase" in the world of production sound usually isn't a reference to the mood swings of the producer. Not all of the time anyway. "Out of phase" or "phasing" are terms that come up when there is a problem. If you understand when audio signals are in phase or out of phase, you're well on your way to solving these problems before they occur on location.

Phases Of The Moon, Part 1 - Acoustical

A good example of a potential phasing problem is when two or more omni-directional microphones are used in close proximity to each other for a typical panel discussion. When guest "A" is talking his signal is picked up by microphone "A". The scenario is identical for guest and microphone "B". All is well until the excited guests start jumping on each others lines and both microphones need to be open at the same time. Now, when guest "A" talks his direct signal is picked up by microphone "A" and his reflected signal bouncing off the table is picked up several milliseconds later by microphone "B". The result is a "hollow" sound identifiable by reduced low frequency information and a "swishing" of mid and high frequencies. The phasing is actually the difference between the two signals.

Faced with this type of situation, you have several options; space the microphones (and guests) farther apart, utilize directional microphones (cardioid or hyper-cardioid), manually ride gain on the mics or use a microphone mixer that employs automatic mic mixing.

The important point to remember here is that multiple omni-directional microphones operating in close proximity can cause phase problems. Eliminate the problem in pre-production with the right equipment for the job, not on the shoot day.

Another potential acoustical phasing problem exists when you have one or more people in the shot on wireless lavalieres, and they engage in conversation with people miced with an overhead

boom mic. In a typical ENG situation, it is normal to split the tracks by sending the boom to one channel and the wireless to the other channel. If you are monitoring in the two channel or stereo position on your mixer, (i.e. wireless in the left ear and boom in the right) you've left yourself open for serious phase problems in post. Again, remember that when two microphones pick up the same signal at slightly different times the signals are out of phase. The rub in this ENG example is that because you are monitoring the signals discreetly, you wouldn't hear the phase differential on location. In post, it is typical for editors to sum the tracks to mono, and the two mics that sounded fine on their own, combine into one out of phase disaster.

What's the answer? If the situation dictates a boom and lavs used together, monitor in mono and ride gain as best you can. It's not perfect, but if you monitor in mono, there won't be any ugly surprises in the edit room.

Phases Of The Moon, Part Two - Equipment

OK, now we get into the fun stuff! In the perfect world we live in, everybody does everything right all the time. Anybody disagree? Can I see a show of hands please?

For the most part, the inputs and outputs on professional audio equipment utilize balanced interconnects. A balanced circuit is made up of the ground, the plus (+) signal and the minus (-) signal. To use a microphone as an example, a positive pressure at the diaphragm will produce a corresponding output voltage on the positive leg of the output. Balanced signals typically interface with three pin XLR cables and connectors. Standards exist to insure proper polarity for three pin XLRs. Both the AES and DIN support Pin 1 = Ground, Pin 2 = (+) and Pin 3 = (-). So for everything in our happy audio universe to co-exist perfectly, all that is required is for all manufacturers to agree which pin is (+) and which pin is (-). Well guess what? They don't agree.

When Will He Grow Out Of This Phase?

What this means is that if you own (or work regularly) with audio equipment, it is important to know what the polarity of the equipment is and to make sure that all interconnects maintain the same polarity.

The best place to begin this kind of operation is with your interconnecting cables. All (and I do mean all) of your XLR cables have to be checked for proper wiring. The easiest way to do this is with a cable tester, but any continuity tester or volt meter will do. Confirm that each pin on one end of the cable connects to the corresponding pin on the other end of the cable. Pay close attention to "Y" cables and adapter cables.

Once you have confirmed cable polarity it's time to determine if your microphones are wired to insure proper phase relationships. The best way to start is to check the specs in your owner's manual and see if the manufacturer refers to polarity. If not, check with an equipment vendor. Once you have confirmed one device's wiring and established it as your reference mic, it is a simple matter to compare all other mics in your kit. Plug your reference mic into channel one, and your mic under test into channel two. Make sure to monitor via headphones in mono. Pot up your reference to a comfortable level and slowly pot up the mic under test. If the test mic is out

of phase the signal will loose low frequency information and sound "thin". If the mics are omni, separate them until acoustic phase cancellation isn't an issue. If your mixer has phase reversal switches you can pot up your test mic as before however, if the unit under test sounds "thin" and out of phase, flip the phase reversal switch. If the unit under test now sounds OK, you know you have a mic with polarity reversed to your reference unit.

Go through every mic in your kit this way. Don't forget to check your wireless mics either. Bear in mind that it is not unusual to find mics from the same manufacturer phased differently! I'll leave it up to you to decide what this says about the manufacturer's quality control. I've spoken to several manufacturers about this and it's surprising that they don't understand the importance of absolute phase coherent wiring on a unit to unit basis.

If you find mics wired out of phase you can have the wiring corrected by a service technician or mark the offending mic with tape and use it with a phase reversal barrel or phase reversal adapter cable.

What is critical in all of this is not that your microphones meet an arbitrary standard, but that your microphones are all wired the same. Having said that, there is much to warrant a completely phase coherent recording and playback system where positive air pressure at the microphone yields forward air movement at the playback monitor. This would be a lot closer to being a reality if manufacturers' would recognize the established standards.

Phased Out

Don't wait for a phase problem to show up in post. Review your cables' wiring, check your mics and be conscious of the phase anomalies that can arise with multiple mics on location. Do all of this, and you'll go a long way to guaranteeing a great sounding final recording.

1. Keep your mike as close to your performer as possible. Distance allows echo and background noise to mix with your desired sound. Further, natural bass frequencies drop off quickly with distance. Exception: recording a choir in a church. Here you want the microphone to be near the group but not near a particular member of the group who will dominate the sound. Further, echoes in the room fortify the sound making it robust at some distance.

2. Choose the right mike for the task. Take into consideration whether the microphone needs to reject unwanted echoes and background noise (ie. a directional microphone) or whether the sound is coming from several directions at once, requiring an omnidirectional microphone. For a person speaking, a tie clip or lapel microphone is best. If wires are a problem, a wireless mike may do. Or maybe a directional microphone on the end of a

fish-pole can follow the performer or reach into a tree to catch the hoot of an owl. Shotgun microphones are excellent for rejecting extraneous noise, but may give unpredictable fidelity depending on other surfaces near the performer.

3. Use balanced lines, the kind with three wires and XLR plugs on the end. Unbalanced lines, one wire and a shield terminated with a phone or RCA plug pick up hum and other electrical interference easily, especially if the wires are longer than eight feet. Balanced lines, on the other hand, cancel out interference, transferring a clear and quiet signal over distances of 30 feet and more.

4. Bring adaptors and transformers. You never know what you are going to have to connect to what. Transformers will allow you to interface unbalanced equipment (ie. consumer tape recorders, CD players, and PA systems) with professional gear having XLR plugs. Radio Shack sells balancing transformers (part #274-016 or 017) for about $13. Higher quality varieties are available from professional audio distributors such as Shure of Evanston, Illinois and cost about $45.

5. Also use ground lifters and pads. Audio ground lifters permit your audio mixer to take a feed from someone else's mixer or PA system without picking up hum.

Pads are resistors used in audio to reduce the strength of a signal. The powerful audio from a public address system, for instance, can be fed through a pad and reduced to a tiny voltage appropriate for a mixer's microphone input.
Radio Shack sells pads or line attenuators (part number 274-300) for about $3.00.

6. Always bring high quality headphones (with muffs to seal out ambient sound) and check the sound going into the mixer, and the sound going into the recorder. If the sound is good in one place

and bad in another, at least you've narrowed down where to look for the trouble.

10. Train your ear to listen for background sounds such as motors, wind, fans, whirring disk drives, audio hum or buzzing, buttons rattling against microphones, creaking mike cords, chirping crickets, distance traffic or voices, or the beep beep of wrist watches chiming out the hour. These sounds are much easier to silence when recording than to filter them out while editing.

11. Record sound. Shut everybody up and record a minute of ambient background sound of the room, factory, party, or forest where you happen to be recording. Not only can you use this as filler between prepared audio segments, but it also serves as nice background for voiceovers you might decide to add later.

12. Attempt to get the highest level signal possible without distorting your sound. VU meters should ride consistently around 0 dB with occasional spikes going up into the "red" zone (+2, +4, +6 dB). This assures that your source sound is much louder than background hiss in your tape.

13. Use "manual" versus "auto" record levels. No machine can make decisions as wisely as you. Use automatic only when you don't have the fingers or time to twiddle the knobs.

Pickup Patterns -

This has nothing to do with how men introduce themselves to ladies in bars. A microphone's pickup pattern describes how well it listens in various directions.

An omnidirectional microphone listens equally in all directions. You would use it to mike a crowd or a group of singers. It works well on a podium if your performers tend to move around or turn to the side while speaking, or lean forward into the microphone. Tie-clip microphones are generally omnidirectional, allowing the person's head to turn without affecting the volume of the sound very much. They also pick up chest vibrations to fortify the bass frequencies. Because

tie-clip mikes are so close to the performer's mouth, they tend to pick up very little background sound.

A unidirectional microphone listens in one direction primarily and rejects sounds from all other directions. A shotgun microphone is useful when you need to pick one member out of a crowd or one bird out of a tree (something my cats can do). The shotgun microphone must always be aimed to be affective; if the talent walks off axis, their voice will diminish abruptly.

Directional microphones exhibit the proximity affect; if you get too close to the microphone, it boosts the bass in your voice thunderously. It also emphasizes the letters b, p, and t which sound like bombs bursting in air. Omnidirectional microphones don't manifest this problem until you are about an inch from them, but unidirectional microphones need to stay a foot or so from the speaker to avoid consonant bombardment.

Part way between the omnidirectional and the unidirectional microphone is the cardioid and hyper-cardioid microphone. Here the pattern of sensitivity, if you graphed it, would be in the shape of a heart, representing great sensitivity at the tip of the heart (the direction the microphone is aiming), and almost no sensitivity at the heart's cleavage, usually the handle of the mike. Cardioids and their more directional brothers the hyper-cardioids are somewhat sensitive to popping p's and b's, and need to stay some distance from the speaker's lips to avoid the proximity affect. They are good, however, at reducing feedback, from PA systems where sound emanates from the speakers and works its way back to the microphone causing a whoop, squeal or ringing sound. Aiming the microphone and speakers away from each other and increasing the distance between them also helps diminish feedback. Omnidirectional microphones are most sensitive to feedback.

Bi-directional or figure-8 microphones listen in two directions, the front and the back and hardly at all from the sides. They are used primarily in talk shows and certain stereo applications.

Pressure zone microphones, or PZM's, have a hemispheric pickup pattern listening omnidirectionally on one side of the microphone and not at all on the other. You would typically mount a PZM on a square of plexiglas or other flat surface. The mike would pick up all sounds on one side of the surface and ignore sounds on the other side. PZM mikes are often used on boardroom tables to pickup the voices of people around the table. The mike also tends to pick up the sounds of papers and pencils rattling. If your guests like to fidget, ask them to do it with their feet; the mike ignores sounds from its opposite side. Mics with parabolic reflectors are handy for strengthening weak sounds such as woodland critters or distant outdoor conversations. Bass fidelity is poor (unless the reflector is huge) and the system easily picks up wind noise, as well as the snorts or sniffs of the person aiming the mic.

Although there are stereo microphones with two transducers built into the same body, most professional stereo recordings are the product of two monaural mikes used independently. Typically you set a pair of microphones in the shape of a cross pointing one 45° to the left of center and the other 45° to the right of center. The heads of the microphones should be only a few inches apart to avoid accidental phase cancellation.

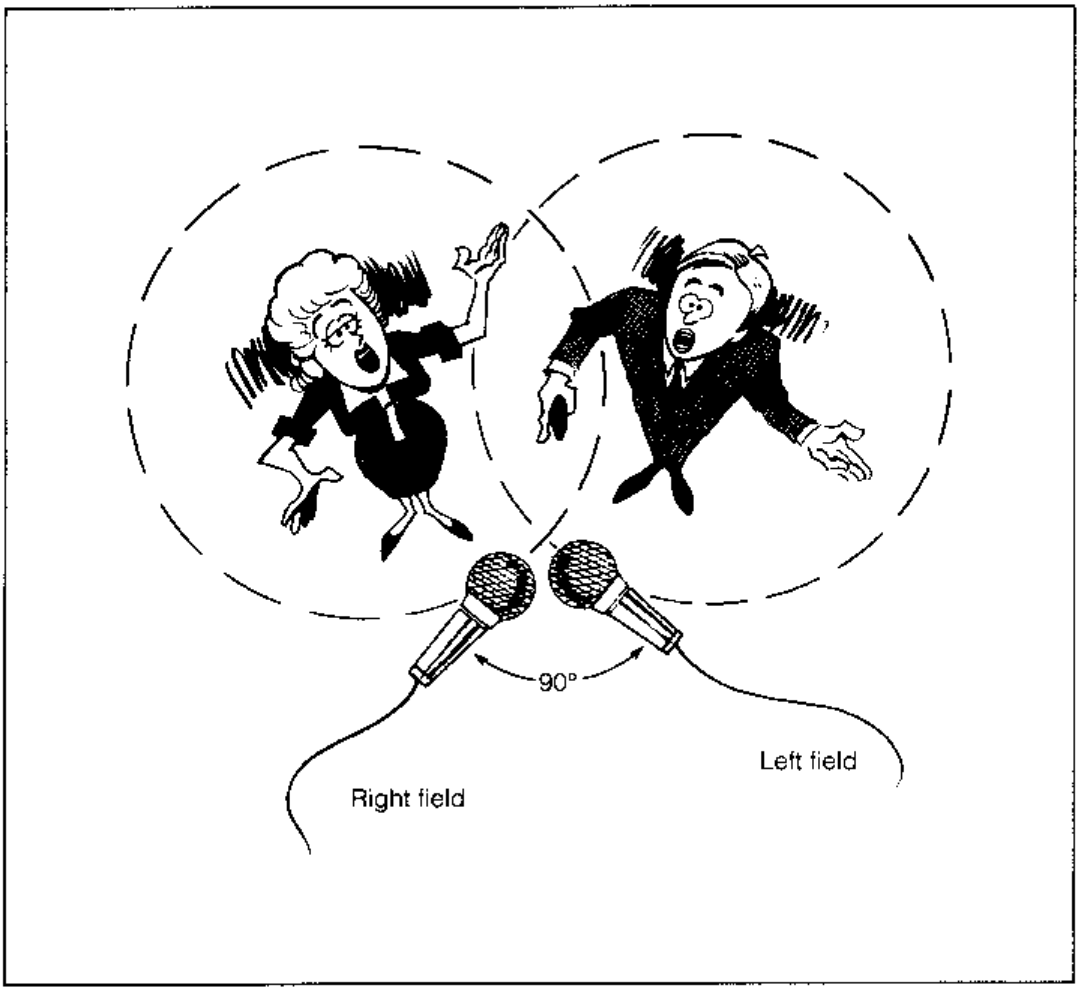

FIGURE 3-5 Stereo recording using two cardioid mikes

What is phase cancellation? Whenever two microphones (used for stereo or not) pick up sound, and the mikes are any distance apart, sound will reach one mike before it reaches the other. Certain frequencies of sound will have waves that are at their high point (compression of the air molecules) when they reach the first mike, while the trough between the waves (rarefaction of the air molecules) from the same sound is hitting the second microphone. In other words, the first microphone is vibrating inwards while the second one is vibrating outwards from the same sound. The two signals combine and equal zero, ergo phase

cancellation. Your ear will hear a weak or hollow sound or a flanging science fiction-like whoosh to the sound. Whenever recording stereo, you must avoid phase cancelling situations, and check your monaural mix to assure your program sounds good on monaural TVs and public address systems.

1. Keep the mike fitted within its foam windscreen, even when it's in transit. This keeps the mike clean and protects it from physical shock.

2. When conditions are really messy, you can assure great sound reproduction by covering the microphone with an unlubricated latex condom. This is a techniques that was used by audio technicians during Operation Desert Storm to keep the desert dust from clogging the mike ports or interfering with the diaphragm (the part that vibrates when struck by sound waves).
To install the condom, roll it onto the mike from the front pulling it tight almost to breaking. Secure it with gaffer tape or string below the XLR connector in the back.

This next tip will come as a surprise to you (like the last

You need two identical microphones with identical, same length cables and a phase reverser, an XLR to XLR barrel connector having the two signal carrying wires reversed. (As a substitute for the phase reverser, you can always unsolder the signal wires and swap them in the XLR connector for this experiment, as long as you change them back to normal afterwards.)

Position one microphone so that it picks up mostly the noise and send its signal through the phase reversed cable. The second microphone should pick up the desired signal. The two mikes should be close together but would naturally be aimed in different directions so that one hears primarily the source while the other hears primarily the noise. Back in post, you start with your source sound and mix varying amounts of your noise" channel with it. Since the noise is out of phase, it will subtract from the noise picked up by the first mike, diminishing the noise overall. The process requires a little knob twiddling but the results may be very satisfying.