DIALOG UNPLUGGED: THE ART OF WIRELESS MICS

by G. John Garrett CAS and Jay Rose

Don't let the name confuse you. A "wireless mic" is actually two different systems: a microphone to turn sound into electricity, and a radio link to get the mic's signal back to the camera. Many videographers concentrate their efforts on making sure the mic can't be seen. But to get a consistently good soundtrack, you also have to pay attention to the wireless part.

Wireless used to be a fairly scary way to do things, with battery-hogging transmitters and receivers that were prone to interference. But new technologies have made even low-cost wireless systems a lot more reliable.

WHY WIRELESS?

While booms are still preferred for dialog pickup (see "Boom Mic Basics", March '00), and a wired lav will almost always sound better than a wireless one, a radio mic can be a very important part of videomaking:

[bl] Wide camera angles and some lighting situations can force the boom too far from the actor for successful pickup. You have to use a lav. And if the actor is also moving around, a mic cable probably won't be practical.

[bl] Actors often turn from the camera and deliver a single line into a doorway, open window, or some other spot you can't reach with a boom. But plug a boundary ("PZM") or small cardioid mic into a wireless transmitter, and you've got a plant mic that can be hidden on the set for just that line.

[bl] You can also plug a boom mic into the transmitter. Wireless booming -- sometimes with a separate wireless return, so the operator can check placement and hear cues from the mixer -- combines the sound quality of a large condenser mic with the flexibility of radio.

[bl] Blocking can make other kinds of pickup impossible. If the talent will be walking from one room to another or around bulky set objects, a dangling cable from a wired lav will get in the way.
[bl] Booming often isn't possible at event or documentary shoots. A wireless rig on a competitor at a sporting event, or on the groom at a wedding, can capture sounds that would be lost otherwise.

[bl] If a location has a lot of video or computer wiring, or is near a radio or TV transmitter, interference can be radiated into mic cables. In these circumstances, a wireless connection may sound better than a wired one!

Multiple wireless mics, or a wireless on one character while a boom follows another, is often the only way to record complex dialog where the actors are moving around. They can also give the actors flexibility to ad-lib and overlap: if the mics are recorded to separate tracks, important lines can be brought up in post-production.

While wireless gives you exceptional flexibility, it has its own drawbacks. Good sound quality and reliable transmission isn't possible unless you adjust the transmitter and place the antennas properly. In some situations, you can do everything right and still suffer horrible interference. But if you want to do wireless right, the biggest drawback is the cost.

BUYING WIRELESS

Hollywood sound recordists pay as much as $5000 for a top quality wireless transmitter and receiver like the Audio Ltd TXU series -- and that's without the microphone. What they're buying is reliability and the ability to squeeze a signal through difficult circumstances, but mostly they're paying for the sound: when used properly, these units sound as good as a mic cable. Lectrosonics has a number of wireless systems for about half the price that are [ital]almost as good. These are the rigs to use if you're shooting 35mm film for theatrical release.

But if professionals pay that much to achieve the sound quality of a

$30 mic cable, what can a videographer expect from a system costing much less? Sony, AKG, Sennheiser, Shure, and Audio-Technica sell wireless combos in the thousand-dollar range, including microphone, that are good enough for television production. Azden, Nady, and Samson offer combos in the $300 - $500 range that are fine for corporate and event productions. What you're giving up is how natural the voices sound: as price goes down, bandwidth and dynamic range shrink, making dialog seem more "canned". If your goal is an educational or sales video that will be played through small tv speakers, the difference isn't critical.

If you want to hear these differences for yourself (or don't like the idea of paying more for a mic than you paid for the camera), consider renting. The highest-quality systems cost less than $80 per day in large production cities, and good ones are as low as $25. Larger rental companies will have a variety of brands to choose from, and can help you choose frequencies that will avoid interference at your shooting location.

Whether buying or renting, there are a few features you should definitely look for. They add to the cost, but are worth the investment:

[bl] Ultra-high frequency

Originally, wireless mics ran in the upper part of the VHF TV band, using standard broadcast channels 7 through 13. At the time it was very difficult to build small, reliable equipment for frequencies higher than that. This worked -- even if local TV stations broadcast on the same channel -- because wireless mics could squeeze into the hole between conventional television's separate audio and video signals. But that loophole in the spectrum is about to be closed (see "The DTV Squeeze"). A lot of other services also use VHF frequencies, so interference was often a problem from non-TV sources.

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THE DTV SQUEEZE

Even if you're not shooting anything more sophisticated than a VHS

wedding album, America's move to digital broadcast television will affect you.

The FCC has mandated that local stations turn digital within the next four years. Unfortunately, digital TV uses an entire 6 MHz channel -- either for a single HDTV broadcast, or for two separate standard-definition signals. Audio and video are part of a single data stream, and there's no hole between them where a wireless mic can sneak through. Even if a channel is nominally vacant where you're shooting, a nearby city's high-powered DTV can overpower your battery-operated rig. The competition is worse that it appears at first, because UHF is desirable for wireless mics and essential for digital TV. Conventional stations have to move to the UHF band to comply with the FCC's order... while staying on VHF to serve existing viewers. In the greater Boston area alone, 16 new digital UHFs are coming on line.

The best solution is to be flexible, particularly if you travel to multiple locations. Get wireless equipment that can support a number of different channels. If you know where you'll be shooting, check with your dealer or rental company to make sure the equipment you choose will be usable. The FCC keeps a city-by-city list of the new channels at http://www.fcc.gov/oet/dtv/start/dtv2-69.txt.

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Fortunately, modern circuits can easily handle the UHF range above TV channel 14. It costs a little more to build equipment for that part of the spectrum, but it's less crowded up there -- for now -- and each channel can support more individual wireless signals. The higher frequency means that manufacturers can use broader audio channels for better fidelity. UHF uses a smaller antenna, so it's easier to wire the actors, mount a receiver on the camera, or build special directional antennas for difficult pickups.

The disadvantage of UHF is that the signal is more fragile: it can bounce off light stands and girders in the walls, and even be absorbed by cast and crew on the set. There's no danger to the humans involved, but if things or people move around during a take you might

hear sudden dropouts.

[bl] Diversity reception.

Figure 00 shows how this problem could arise, even on a very simple set. The red dashed line represents the main signal path between an actor's transmitter and the camera's receiver. But the green line -- another path bouncing off a nearby light -- is almost as strong. Depending on the distances involved, the green signal may reinforce or partially cancel the red one. If anything moves, including the actor, these distances change and so does the cancellation effect. It will also change if the green crew member steps forward and absorbs some of the signal. The multiple yellow paths start to show how complicated it can get at a shoot: if anyone moves, the signal may fade in or out.
In this case, diversity truly is strength. Diversity receivers actually have two spaced antennas with separate radio-frequency circuits. They constantly compare signals and use whichever antenna is getting the best one. Because real-world paths are so random, it's highly unlikely both will be fading at the same time. Both VHF and UHF systems can use diversity reception, but UHF's higher frequencies mean the antennas don't have to be spaced as far apart and the receivers can be smaller.

[bl] Frequency agility.

Until recently, wireless equipment used fixed frequencies. Transmitters were controlled by stable crystal oscillators. Receivers used similar crystals along with carefully tuned resonant circuits. Changing the frequency required a trip to the service shop, but was seldom necessary.

Then things got busy. More feature and corporate crews started using wireless, often requiring frequencies for multiple mics. Media events started attracting news crews from around the country, and a city's wireless-mic population would swell by the hundreds overnight. While chapters of the Society of Broadcast Engineers have tried to bring some sanity to local usage, there's no official traffic cop and the FCC doesn't assign spectrum to individual producers. Wireless

collisions became common, where other voices would mysteriously drift into a shot.

Just like an agile athlete, frequency-agile wireless rigs are flexible and can change direction quickly. Instead of crystals, they have precisely controlled oscillators that can be set to several different operating frequencies. Good ones let you select among a few dozen, and the best offer more than a hundred frequencies spread over a number of UHF channels. They're a lifesaver if you're shooting near other crews. When DTV reaches your city, they may be the only wireless mics that remain useful.

[bl] Companding.

All wireless mics should include some form of limiter, which saves very loud sounds from being lost to distortion and prevents the transmitter from interfering with adjacent frequencies. The limiter is preceded by a volume control, so the transmitter can be adjusted for a particular mic and acting style. But higher priced wireless rigs also use companding, a system that uses a volume compressor on the transmitter that's precisely matched to an expander at the receiver. This yields more dynamic range with less noise, for a better overall track.

[bl] Physical form.

Wireless transmitters designed for dialog usually take the form of small body packs, slightly smaller than a wallet. There's a connector for the mic to plug into, which also provides power for the mic's internal preamp (see "Meet Mike", July 2000). Professional systems may be supplied without microphones; users usually order their favorites from other manufacturers, customized to plug into the transmitter. Low-cost systems often come with low-quality generic lavaliere mics, which are sometimes wired directly into the transmitter.

Transmitters can also be built into small metal cans with full-size XLR connectors. These are handy for plugging onto the end of a shotgun or the end of a boom cable, or for connecting to a standard

mic for hiding on the set. Hand-held wireless mics, with transmitters built into their bodies, are designed for stage vocal performance and rarely used in film or video.

Wireless receivers used to be fairly large boxes, but have shrunk to cigarette-pack size. Those with diversity reception tend to be slightly larger, to accomodate the extra circuits and spacing between antennas, but can still be small enough to mount on a camera. Multi-mic systems often combine four receivers into a lunchbox-sized pack, with arrangements to share the antennas and power supply. These "quad boxes" are most often found on the sound carts of feature film productions (figure 00).

[bl] Reach.

Depending on its design, a wireless transmitter may radiate between 10 and 250 milliwatts of electrical power. But while that number lets you predict how fast the battery will wear down, it doesn't say much about how well the system will perform in the field. Some of the best professional systems radiate less than 100 mW. You can usually ignore a manufacturer's "range" specification, particularly if it's just based on power. The actual usable distance also depends on the quality of the receiver, the frequency, reflective and absorbing surfaces on the set, and how you place the antennas. That's why it's important to learn how to use a wireless properly.

USING A WIRELESS

Hiding a mic on an actor is only half the battle (for some tips, see last January's "Got to Lav It" at www.dv.com). You also have to adjust the transmitter in a way that won't interfere with its operation.

Most transmitters have a small volume adjustment screw with a LED or meter to indicate when the limiter is activated. After the mic is in place, ask the actor to deliver a few lines in the voice they'll be using. Adjust the volume so the limiter just starts to turn on at the loudest part of their speech. If that results in too soft a signal at your camera, check the connections there or add some extra gain in a

mixing board. Cranking up the transmitter won't make things any louder, it'll just add more distortion.

Most transmitters have belt clips so you can hide them on an actor's back, if they're wearing a jacket or won't be turning away from the camera. A jacket or pants pocket can also work, though it might require cutting a small hole in the cloth for the cables. If you want pockets without the pants, audio supply houses sell little pouches with elastic or velcro straps. These can be used to hide the transmitter at belt, thigh or ankle level. In a pinch, you can tuck a transmitter into a dancers'-style ankle warmer or wrap it to a leg with an elastic bandage.

The mic cable absorbs radiation and should be kept as far away from the antenna wire as possible. In extreme situations, putting those wires together can feed some of the radio energy back into the system and cause bad distortion.

VHF transmitters have long wire antennas that should be extended in a fairly straight line. While you can dress an antenna into the actor's waistband, it's often better to let it hang down inside a dress or pants leg. A long rubber band, tied and taped to the end of the antenna and then safety-pinned to a stocking, can keep the antenna straight while providing some strain relief and flexibility. Some recordists assemble custom antenna stretchers for this purpose, with a small alligator clip and a length of elastic ribbon (figure 00). The clip pulls on the end of the antenna, and the ribbon is tied around the leg.

UHF antennas are short and stiff, making them much easier to rig. Just try to keep them away from the mic cable. If a UHF antenna sticks out so much that it shows when the actor turns, use some paper tape to attach it to the costume where it'll be out of sight. It's always better to attach antennas to wardrobe than place them directly against an actor's skin. People absorb radio waves. Perspiration makes the situation worse. A wireless transmitter's miniscule power isn't a health hazard, but it's so tiny you can't afford to squander any. If a lot of signal is being absorbed by the actor, there won't be enough to guarantee quiet pickup at the receiver.

Some transmitters don't appear to have an antenna at all. They actually use the mic cable as an antenna (a few extra components keep the radio signal from interfering with the audio). This limits your options: while the antenna wire should be straight, the mic wire often has to take a winding path from wherever the mic is hidden. If you're stuck with this kind of system, use long loops in the mic cable instead of abrupt turns and never coil it to eliminate slack.

A single antenna on a non-diversity receiver should be oriented the same direction as the transmitting one: for example, if the transmitting antenna runs down the leg of a standing actor, the receiving one should also be vertical. Single antennas work best when they're parallel to each other. If you're using a diversity receiver, angling the two antennas 90 [degree sign] can help you compensate for reflected signals. Try it with one antenna horizontal and the other vertical, or the two in a V configuration.

Reception is always best when the transmitter and receiver have a line-of-sight path and are close together. Mounting a receiver on the camera can satisfy the former, but a long shot may keep the units too far apart. This gets worse if there are things around that reflect or absorb radio waves. In most cases, you'll get a more consistent pickup by taking the receiver off of the camera so you can put it on the floor just out of camera range. Or mount the receiver high up on a ladder or grip stand near the talent (figure 00). Higher is better, because it usually provides a good line-of-sight path without too many reflections. If the actor is moving around, have a production assistant carry the receiver to match.

Low-cost receivers often have short cables with unbalanced miniplug outputs, designed to plug directly into a prosumer camera. Extending these cables can lead to noise and hum problems. If you want to move one of these units closer, plug it into a nearby mixer. Then run a balanced cable from the mixer's output to a transformer-coupled adapter (such as the BeachTek or Studio 1). Of course, the cost of mixer and adapter may be more than you saved by choosing a cheap wireless.

Professional-quality UHF receivers usually use removable short metal

or rubber antennas with standard RF connectors. These can be unplugged and replaced with more powerful antennas for better pickup.

LOSING A WIRELESS

If you follow the tips in this article, and are in a location without too much interference, a wireless rig will give you decent pickup most of the time. But because they're more complex than a simple piece of wire, things can go wrong.

If audio starts sounding funny in any way at all, check the batteries first. Depending on the model and the shooting situation, weak batteries will result in distortion, low volume, intermittent interference, noise, or other gremlins. Since you can't predict which symptom will appear, change the transmitter battery whenever you hear any problem with a system that previously worked. If that doesn't help, change the receiver battery as well. Always use high-quality, fresh alkaline or lithium batteries.

If it's not the batteries, look for user errors. Even audio professionals have been caught by receiver output levels that don't match the camera, mics that have come unplugged, or actors who've fiddled with transmitter controls. Then look for radio-frequency problems: many receivers have a meter to let you check the signal strength. If it's suddenly dropped and you know all the batteries are good, check to see if a mic cable has gotten wrapped around an antenna, a large reflecting object has moved near the set, or a performer's wardrobe has gotten wet.

Occasionally, two wireless won't work properly where one will. If you're using multiple systems for different characters, make sure they're on different frequencies. But also be aware that each receiver radiates a tiny signal of its own, which can interfere with other receivers nearby: try separating the units a few feet.
The most delicate part of a wireless rig is the mic. While some mics are rated as water-resistant, all of them rely on very tiny amounts of static electricity to generate their signal. Excessive humidity, as well as downright dunking, can interfere with this. Moisture around the transmitting or receiving antenna will also cause

problems. Most transmitters and receivers will survive normal on-set banging around, but physical shock can damage the crystal in single-frequency units. It can also knock fragile tuned circuits out of alignment in high-end receivers.

Wireless works. It's come a long way from the interference-prone, battery-eating, thin-sounding rigs of a decade ago. Hollywood crews use the technology to record good-sounding dialog under marginal conditions. For the videographer, particularly one working without a crew or shooting unrehearsed action, it can be the only way to get an acceptable track.

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