Sound is an essential element of movies and should be given much thought and care. If you need proof, watch your TV set with the sound off for a while and see how well you understand what is happening. Then turn the sound up, cover your eyes, and listen without seeing the picture. You probably will be able to understand what is happening much better without the picture than without the sound.

Nevertheless, student (and even some professional) moviemakers often become so absorbed in setting up proper picture composition that they forget to leave time for proper microphone positioning. They hastily place a microphone in front of the actors and then fret over the poor sound quality during postproduction—when it is too late or very expensive.

Much of what is needed for good sound is the same for film and video. Recording equipment differs, but microphones, cables, and connectors are basic and the principles of sound are similar for all media.

The Nature of Sound

To select the right audio equipment and to record sound properly, you need to understand a number of characteristics of sound. These include pitch, loudness, timbre, duration, and velocity.¹

Pitch and Frequency

Sound waves travel in well-defined cycles. The number of times per second that the wave travels from the beginning of one cycle to the beginning of the next is its frequency, which is measured in hertz (Hz). For example, a sound wave that goes from the beginning of one cycle to the beginning of the next at 200 times per second is said to have a frequency of 200 Hz. The sound made by the differing frequencies is the pitch. Bass sounds have lower frequencies
and lower pitch than treble sounds (see Figure 7.1). For example, a bass violin has a frequency of about 100 Hz, whereas a triangle has a frequency of about 13,000 Hz. Men’s voices generally have a lower frequency (hence, lower pitch) than women’s voices. People with exceptionally good hearing can hear a range of frequencies from about 20 Hz to 20,000 Hz.

Each microphone and audio recorder has its own frequency response—the range of frequencies that it will pick up. The frequency response needed depends on the type of sound being recorded. For example, the range of frequencies used by the human voice is from about 200 Hz for a deep male bass to 3,000 Hz for a high female voice. For recording speech, a mic and recorder with a somewhat limited frequency response will probably be adequate. On the other hand, for recording music, you would want a wider frequency response, perhaps as broad as 20 Hz to 20,000 Hz.

Microphones and recorders may not pick up all frequencies equally well. As a result, equipment manufacturers usually represent the ability to pick up various frequencies with a graph called a frequency curve (see Figure 7.2). Some mics and recorders do not pick up the very high and very low frequencies as well as they pick up midrange frequencies; therefore, the frequency curve will be higher in the middle. Sometimes this is because the equipment is inexpensive and not well constructed, but other times this is entirely intentional. For example, some mics have a speech bump; they intentionally pick up human speech frequencies better than they pick up other frequencies. Other mics have a switch with two positions, one for speech and one for music. When the mic is in the speech position, it records a narrower band of frequencies than when it is in the music position. Microphones and recorders that pick up all frequencies equally well are said to be flat because they have a flat curve.

You can manipulate frequency characteristics in other ways. For example, some mics boost the bass frequencies as a person moves closer to the mic. This is called proximity effect and is usually undesirable because it gives the voice a fuzzy sound. However, it can make some
male voices sound more mellow.

There is no universally correct frequency response or frequency curve. The choice depends on the use intended. Sometimes a very limited frequency response, perhaps 1,000 Hz to 2,000 Hz, is desirable to create a tinny sound similar to an answering machine. Obviously, all the equipment within a complete recording system should have a similar frequency response. A symphony orchestra recorded with high-quality, wide-frequency response mics should not be fed into a $50 recorder with narrow frequency response.

### Loudness and Amplitude

In addition to having a frequency, a sound wave has a height or amplitude. Amplitude is related to loudness. As the amplitude increases, the sound will become louder.

Loudness is measured in decibels (dB). A whisper is about 20 dB, conversation is about 55 dB, a rock concert can get well above 100 dB, and a gunshot blast is 140 dB. The threshold of pain starts at about 120 dB.

The range of quietness to loudness is called dynamic range. Different pieces of equipment can handle different dynamic ranges. If something is recorded louder than the system can handle, the result is distortion. For example, if a system has a 60 dB range, and you plan to record at 20 to 100 dBs, some of the sound will not record well. With analog equipment, the loud notes will become a muddy jumble, and the frequencies will not come out of the equipment with the same clarity with which they went in. With digital equipment, sometimes the sound will disappear or turn into pops. For recording speech, mics and recorders with a limited dynamic range are quite adequate. But for recording a rock band or symphonic music, every piece of equipment in the system should have a large dynamic range, in the neighborhood of 90 dB.

Another element related to loudness is the signal-to-noise ratio (S/N). Most electronic equipment has inherent noise built into it; it comes from the various electronic components, such as those used for amplification. One of the specifications provided for equipment is its signal-to-noise ratio, usually something like 55:1. This means that for every 55 dB of signal recorded 1 dB
of noise is present. A ratio of 55:1 is considered good, whereas one as low as 20:1 is considered poor. Generally, more expensive equipment has a higher signal-to-noise ratio. Digital equipment is more sensitive to self-noise because it picks up softer, subtler sounds better than analog equipment.

**Timbre**

Timbre (sometimes called tonal quality) deals with such characteristics as mellowness, fullness, sharpness, and resonance. It is what distinguishes a violin from a clarinet when both are playing the same pitch at the same loudness. It is also what distinguishes each person’s voice.

Harmonics and overtones contribute to the production of timbre. A sound has one particular pitch, called a fundamental, but it has other pitches that are exact multiples of the fundamental frequency (harmonics) and pitches that may or may not be exact multiples of the frequency (overtones). The way the fundamental combines with its harmonics and overtones is part of what creates timbre.

The room in which something is recorded can also affect timbre. All other things equal, a voice will sound more hollow in a large room than in a small room. Timbre can also vary for different mics. Although two mics may have the same frequency response and dynamic range, one brand may sound mellow while another sounds sharp. Choosing the right mic to enhance a given timbre is mostly a matter of trial and error and experience.

**Duration**

Another characteristic of sound is duration, the length of time that a particular sound lasts. Duration has four parts: attack, decay, sustain, and release. Attack is the amount of time it takes a sound to get from silence up to full volume; decay is the time it takes sound to go from full volume to a sustained level; sustain is the amount of time sound holds its volume; and release is the amount of time it takes to go from sustained volume to silence. These four parts add up to duration. [Au: This actually repeats info in the second sentence. Can we]
Clipped speech that occurs in certain dialects is largely the result of duration differences between that dialect and what we consider standard American speech. Much of the difference between the sound of a violin when it is plucked and when it is bowed is due to changes in duration.

**Velocity**

Velocity refers to the speed of sound. This speed is 750 miles per hour, but it is relatively slow. It is certainly much slower than the speed of light, as anyone who has experienced thunder and lightning can attest.

This relatively slow speed can cause phase problems. If two microphones pick up the same sound at slightly different times, they can create a signal that is out of phase; one of the mics is receiving the sound when the wave is going up, and the other is receiving the sound when the wave is going down. The result is that some or all of the sound is canceled and little or nothing is heard.

One way to avoid the phase problem is to follow the **three-to-one rule**. No two microphones should be closer together than 3 times the distance between them and the subject. In other words, if one mic is 6 inches from a person, the second mic must be at least 18 inches from the first mic. In this way, the mics will pick up very little of each other’s sound.

Another way to avoid phase problems is to place the mics head to head so that they receive the sound at exactly the same time (see Figure 7.3).

Phase problems can also occur when only one mic is used. If that mic is placed in the middle of a room that has perfectly parallel walls, the sound will bounce in such a way that some sound waves cancel each other out. This can be avoided by placing the mic so that it is at an angle to the walls and is not equidistant from the walls. One way to do this is to place the mic on a diagonal of the room, slightly off center (see Figure 7.4).
Microphones: Characteristics and Placement Techniques

In addition to differing in frequency response, dynamic range, and timbre-producing qualities, microphones have particular characteristics that relate to their directionality, construction, and positioning.\(^3\)

**Directionality**

**Directionality** in a microphone involves its **pickup pattern**. The main pickup patterns likely to be used in moviemaking are **cardioid** (picking up mainly from one side in a heart-shaped pattern) and **omnidirectional** (picking up from all sides).

If only one or two people are speaking and background noise is not desirable, a cardioid mic is appropriate. These mics are the workhorses in film because their pattern picks up sound from the front, where the talent is located, and not from the rear, where the camera and other equipment are operating.

Omnidirectional mics are best for picking up a large number of people and are excellent for gathering background noise. Because of their broad pickup pattern, they do not pick up distant sounds well. Usually, an omnidirectional mic must be closer to the talent than a cardioid mic to achieve the same volume as the cardioid.

Sometimes sound must be picked up from a great distance to keep the mic out of the picture. In these circumstances, more extreme cardioid mics, referred to as **supercardioid**, **hypercardioid**, and **ultracardioid**, are used. Their patterns are longer and narrower than those of the regular cardioid (see Figure 7.5).

Stereo recording requires at least two microphones or specially designed stereo mics that have several different pickup elements within them. One approach to stereo recording is called **M-S (midside) miking**. This uses **bidirectional** (picking up from two sides) and supercardioid microphones. The bidirectional mic picks up sound to the left and the right, and the supercardioid mic picks up sound to the front (see Figure 7.6a). The output of both mics is fed
through a circuit that makes use of their phase differences to produce left and right channels. This setup gives a strong center sound, which is compatible with monaural (mono) sound. In fact, sometimes a switch on an M-S stereo mic will disengage the bidirectional element so that the mic can be used to record monaural.

Another method of stereo recording is called X-Y miking. Two cardioid (or omni) mics are placed next to each other. One angles to the left at a 45-degree angle, and the other angles to the right at 45 degrees (see Figure 7.6b). This way, both mics pick up sound from the center, and sounds for each side are picked up primarily by one mic or the other. When the recording is played back through stereo speakers, it yields definite left and right channels, but the center sound is not as strong as with the M-S method. With both the M-S and X-Y methods, you can use two mics (which come packaged in kits), or you can use one mic with stereo elements (see Figure 7.7).

Surround sound, which can encompass up to 360 degrees, can be recorded with a number of cardioid and/or supercardioid mics, each pointed at a different spot around the circumference of the circle; however, there also are single-unit surround sound mics (see Figure 7.8). Frequently, surround sound is recorded in stereo and then mixed into six or more channels in post-production, a process known as upmixing.

Most microphones have a set pickup pattern, often written on the mic or the box it comes in; it is not easy to discern the mic’s pickup pattern simply by looking at it. Some microphones have interchangeable elements so that the mic can be changed from one form to another, for example, from cardioid to omnidirectional. In other instances, mics have a switch to change directionality, perhaps from cardioid to supercardioid. A more complicated variation is the zoom mic. It can be changed gradually from cardioid to ultracardioid so that sounds at different distances can be heard clearly.
<H2>Construction</H2>

The two main types of microphones used for electronic moviemaking, based on their construction, are dynamic and condenser. A **dynamic mic** uses a **diaphragm**, magnet, and coils of wire wrapped around a magnet (see Figure 7.9a) to generate sound signals. The diaphragm moves in response to the pressure of sound and creates a disturbance in the magnetic field that induces a small electrical current in the coils of wire.

A **condenser mic** (Figure 7.9b) has a diaphragm plus an electronic component called a **capacitor**, which responds to sound. A diaphragm moving in response to sound waves changes the capacitance in a backplate, which then creates a small electrical charge. Because charging the backplate requires a power supply, many condenser mics have batteries or some other external power source. Other mics, called **electret condenser mics**, have permanently charged backplates.

Dynamic and condenser mics are fairly rugged and have wide frequency responses. However, the dynamic mic is slightly more rugged because its sound element is sturdier than that in a condenser mic. The condenser mic, on the other hand, has slightly better high-frequency response. Dynamic microphones do not work well with some individuals because the mics have a tendency to exaggerate plosives and sibilance. In other words, p’s will pop and s’s will hiss.

<H2>Positioning</H2>

You can use many devices to position mics. The most common in moviemaking is the **boom**, a long pole with the mic on the end. The boom operator positions the mic above the actors and moves it as each person speaks. Sometimes these booms are elaborate devices with wheels, gears, and hydraulic lifts. Sometimes they consist of a pole (called a **fishpole**) held by the boom operator (see Figure 7.10). Often, they have a **shock mount** on the end to isolate the mic.
from vibrations.

Stands can also hold mics, but because these stands will show in the picture, they are appropriate only when a mic would naturally be present—a singer in front of a floor stand or a radio commentator sitting by a table stand. Sometimes people simply hold microphones. This is common for news and documentaries, but for dramas such an obvious show of the mic must be motivated.

You can also hide microphones on the set in or behind props such as flower vases. You must plant mics carefully, in part so they won’t show and in part so their pickup is adequate.

Hidden mics (also called plant mics) are not desirable if people in the scene move a great deal because their voices will fade in and out as they move close to and away from the mics. But they are useful if you need several areas miked and you only have one boom operator.

Mics can also be built in or attached to cameras, but camera mics are not advisable for recording dialogue because they are usually too far from the actors to pick up their sound well. What they do pick up well is the noise of the equipment, which is definitely undesirable in a narrative movie. Mics mounted on cameras can prove satisfactory for picking up ambient sound or news and documentary work, however. For example, a mic mounted on a camera is often best for an uncontrolled situation in which people are not able to take the time to talk into a properly set-up microphone.

Very small microphones called lavaliere (lavs) (see Figure 7.11) attach to clothing or hide in small areas such as car visors. Although lavs show in the picture, they usually will not be noticed because they are so small. If they are attached to a cable, they may limit the actor’s movement. Although you can hide the cable under clothes, it is likely to show in a long shot that includes the set. The sound from a lav may be inadequate when clothes rustle and when people turn their heads to one side or the other.

Some microphones—whether they are lavaliere or stand mics—do not have long
cables. They are **wireless mics**, and they operate on FM frequencies. The mic has a small antenna attached to it or to a transmitter pack that can be hidden in a pocket or clipped on a belt (see Figure 7.12). This pack sends the audio signal to a receiver, which can be located a considerable distance from the mic and attached to recording equipment such as a digital audiotape (DAT) (see the section on types of recorders, this chapter). Because the mics do not have cables, the actors can move about freely and quickly (often with a miniature lav totally out of sight under a costume), and cables do not need to be hidden on the set. One problem with wireless mics is that they can experience interference from other equipment using FM frequencies. Some higher-end mics have built-in elements to avoid this interference.

***Figure 7.12 here.***

Another way to pick up distant sound for a movie is to use a **shotgun mic** (see Figure 7.13). This mic has a very long but narrow pickup pattern, usually super-, hyper-, or ultracardioid.

It can pick up from a distance, but it must be pointed carefully and re-pointed if the sound source moves because of its narrow pickup. Unfortunately, this narrow area can include sounds reflected from an object, such as a building. **In one instance, shotgun mics have been known to pick up** the noise of a trash truck not in the immediate area; the sound had bounced off a building in the background that was in the microphone’s path. A shotgun mic also tends to pick up some sounds to its rear, so its rear portion should be pointed toward something that is silent. Shotgun mics are almost always covered with a **windscreen**, a metal or foam cover that cuts down on small noises such as wind. Other mics often have built-in or added on windscreens, especially if the recording is being made outdoors.

***Insert Figure 7.13 here.***

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### Cables and Connectors

Most microphones (wireless excluded) use cables and connectors to carry the electrical impulses from the mic to other equipment. These are actually the elements most likely to prove troublesome during recording sessions. Connectors that are not soldered properly and
cables that contain broken wires are common causes of audio failure.

**Balanced and Unbalanced Cables**

Cables consist of wires protected by a shielding, usually made of plastic. These cables are referred to as **balanced** or **unbalanced**. A balanced cable has three wires—one for the positive, one for the negative, and one for ground. Unbalanced cable has two wires, one for the positive and one that acts as both the negative and the ground.

Balanced cables are better because a separate ground wire means they are less susceptible to extraneous interference. Unbalanced lines are usually used for consumer-grade equipment because they are cheaper, but professional equipment uses balanced lines. Always take care to avoid placing audio cables (balanced or unbalanced) parallel to power cables because this can induce **hum**.

Both analog and digital can use the same cables, but digital signals are less likely to travel well in low-quality, inexpensive wires, such as ones that mix aluminum and copper rather than being **comprised** primarily of copper. Because digital mics pick up subtle sounds, digital technology needs high-quality cables to carry the sounds.

**Connector Types**

A variety of connectors attach mics to mixers and recorders, and recorders to headphones. A **phone plug** is a long, slender connector with a sleeve and tip, and the **miniphone plug** is a smaller version of the phone plug. The **RCA connector** (also called the **phono plug**) has a short prong and outer covering and is very common in consumer equipment. It can be used to carry either video or audio, but not both at the same time. The **XLR connector** has three prongs and an outer covering. It also has a guide pin and lock so that it remains firmly in place.

For many years, it has been the professional standard because its three prongs accommodate the three wires of a balanced line. The **BNC connector** is a twist lock that has been used for video and is now starting to be used for audio. All of these connectors have male plugs and female jacks. Usually, the male connector is at the end of the mic cable and plugs into the female connector built into the recorder. A cable-connector combination that is used with computers is
Firewire (or IEEE 1394). It enables both video and audio digital signals to be copied into a computer with a FireWire input or to a hard drive (see Figure 7.14). As computer and audio/video fields converge and as HDTV becomes more widespread, new connectors, such as USB-2, will come to the fore.

***Insert Figure 7.14 here.***

Phone and miniphone connectors can be either monaural (mono) or stereo. Monaural versions have one ring (as does the phone plug in Figure 7.14), and stereo versions have two (see the miniphone plug in Figure 7.14). RCA, XLR, and BNC connectors are always monaural. If you want stereo, you need two connectors, one to the left channel and one to the right channel. The BNC connector is used for digital signals but not for analog. XLR and RCA have also been adopted by the digital world, but phone and miniphone remain analog. Firewire is only digital.

Adapters are available to convert the more common connectors from one form to another. For example, an adapter fitted on the end of an RCA plug can change it to a miniphone. This adapter consists of a female RCA jack and a male miniphone plug. Most production facilities have a variety of these adapters on hand because the connectors needed usually change as microphones and recorders are changed. In general, professional, high-quality equipment uses balanced lines and XLR connectors. When cost is a factor, the combination is likely to be unbalanced lines and miniphone connectors.

### Recorders

Sound travels electronically from a microphone through cable and connectors to recording equipment. In recent years, many new types of recording equipment have become available, mainly because of the advent of digital recording.

Sound for movies used to be recorded only in analog fashion, which, like its video counterpart (see Chapter 3), produces a continuously variable electrical signal with a shape defined by the sound wave it represents. Each time the analog signal is re-recorded or
processed, it is subject to degradation because the signal changes shape slightly. Digital recording converts the audio information into an electrical signal composed of a series of on-and-off pulses. These do not degrade when they are re-recorded, so sound kept in digital form can be dubbed numerous times without losing quality. Digital audio also has a clearer, sharper quality than analog sound. Some sound technicians feel that digital sound is overly sharp and prefer the more mellow analog sound.

When planning sound recording, the director and sound recordist must take into account the concept of single system versus double system. Then they can select the exact equipment they want to use for the recording. The sound recordist must have a thorough understanding of how the equipment actually records to ensure that the type of recording will be compatible with the equipment used for editing.

**Double System and Single System Sound Recording**

**Double system** sound records the picture on one piece of equipment and the sound on another. **Single system** sound records both within the same piece of equipment.

Double system sound recording has its roots in film production, which traditionally recorded sound on an audiotape recorder, totally separate from the film. One reason film traditionally used double system recording has to do with editing—film was physically cut when edited. This meant the sound for each frame had to be adjacent to it if the cut were to be made properly. But placing the sound at the same point as its accompanying picture was impossible because taking a picture is an intermittent process. The film stops in the camera momentarily to be exposed. If sound were recorded intermittently, it would be unacceptable. As a result, if sound was recorded in a film camera (and sometimes it was back when news was recorded using film), the sound recording equipment was usually placed ahead of the picture by about one second. In this way, the film was running at a more uniform pace by the time the sound was recorded. However, this made for difficult physical editing. If the editor made the edit at the appropriate point for the picture, some of the sound needed was lost. If the editor made the edit to accommodate the sound, too much picture showed. The solution was to record sound and picture...
separately and then match them at a later time.

Single system sound became the norm in early video production because from the very beginning videotape recorders were made to capture both sound and image. The audio and video heads of a VCR cannot be at the same place either, but because video editing involves electronic manipulation rather than physical cutting, the sound and picture can be kept together. Most material shot on film today is not physically cut. It is transferred to video and edited electronically. However, the trend in recording sound, whether with a film camera or a video camera, is to record double system. This seeming contradiction comes because double system recording allows for greater control than single system recording. A person operating a camcorder is preoccupied with framing a proper picture and usually cannot, or does not, pay proper attention to what is being recorded aurally. If the sound is recorded on a separate piece of equipment, one crew member can give the sound full attention—even to the extent of closing his or her eyes while the recording is taking place to concentrate on listening for sound problems or imperfections. In addition, separate audio recorders often yield higher-quality sound than the sound track on many video recorders.

Of course, when the dialogue and picture are recorded separately, they will need to be put in sync at some time in the future. When double system was first used in film, a cable connected the film camera to the audiotape recorder and sent a pulse to the tape recorder as each frame passed through the film camera. In effect, this created electronic sprocket holes on the audiotape. Another method of maintaining film–sound sync was to equip both the camera and tape recorder with a special crystal sync control unit that governed the speed of both units so accurately that sync problems did not occur. Both these methods required the use of a slate with a clapper on the top (see Figure 3.14 in Chapter 3). The closing of the clapper was filmed, and the sound of the clapper closing was recorded on tape. In editing, the two were matched, and so from then on the sound would be in sync with the picture for that particular shot.

Video equipment did not incorporate these cable or crystal methods and at first used
only single system recording. When time code became available, it became possible to record the
time code frame numbers on the videotape, the slate, and the audiotape simultaneously. A little
later, magnetic stripes[Au: strips?] were added to film stocks, and time code numbers could also
be recorded next to the frames of film. In other words, a signal that will translate to 2 minutes, 5
seconds, and 15 frames (00:02:05:15) can be recorded on the audiotape at exactly the same time
it is recorded on the videotape or film. During editing, the time code numbers are lined up, and
the material is kept in sync. Time code is the primary method used today for keeping double
system material in sync, whether the picture is recorded on film or on video.

Types of Recorders

For many years, sound for film was recorded on a separate reel-to-reel analog tape recorder. The brand name that became synonymous with film audio recording was Nagra. This
company’s recorder was sturdy and contained the features most needed for recording good film
dialogue. Nagra (and other companies) now manufacture digital recorders that record on a hard
drives (see Figure 7.15). These recorders have many of the features of older recorders, but they do
not use tape. Sometimes the hard drive can be removed from the recorder and placed in a

nonlinear editing system so that the sound can be transferred directly. Other times, sound can be
recorded onto or transferred to a CD or DVD recorder.

Another recorder that is now often used to record film sound is the digital
audiotape (DAT) recorder. This is much smaller than the Nagra and uses cassette tape. It is not
as rugged as a Nagra, but it is more portable and less expensive. Some of the least expensive
DAT machines are not capable of recording time code, but they hold sync fairly well without
time code. Professionals do not use the DATs without time code, but students may use these less
expensive DAT recorders (with and a clapper and slate) [Au: OK for meaning?] in the same
way they have been used traditionally in film production to establish the beginning of
picture and sound recording. If the shot is not too long, the sync will usually hold through the
editing process. Any time you are using a tape recorder, buy high-quality tape.
Tapes are plastic bases coated with metal oxide, and some of the oxide may fall off cheaper tapes, creating **dropouts**, a loss of signal because there is no oxide to record it or because the oxide dropped off after the recording was made.

### Recording Methods

Camcorder formats and audio recorders have different ways of placing sound on the recording medium (videotape, audiotape, hard drive). Some editing systems do not recognize all the recording methods in existence and may not be able to play back the sound properly. You may record beautiful sound, but later find it difficult to edit.

Two things to note in digital recording are **sampling rate** and **bit depth**.

Sampling rate is how many times per second the information is converted into the 0s and 1s of digital technology.

The two most common sampling rates are 44.1 kHz (44,100 times per second) and 48 kHz (48,000 times per second), although some recordings are now made at 96 kHz. The standard for **DVD and HDTV** is 48 kHz and 44.1 is the standard for CDs. Bit depth is a quality of sound that is related to signal-to-noise ratio. The higher the number of bits, the higher the signal-to-noise ratio and the better the quality of the sound. Each bit yields approximately 6 decibels of signal; so in **12**-bit audio, the signal is 72 dB louder than the noise. The bit depths used most often are 12 bit, 16 bit, and 24 bit. Sometimes a recording system will use 12 bit for stereo and 16 bit for monaural.

On many recorders, sound can be recorded on different channels, which are different places on the tape or disk. This capability can give you additional control when you are recording. For example, you can record two people at opposite ends of a room by recording one person’s mic on one channel and the other person’s mic on another channel, a method that permits you to adjust each person’s volume separately. Or, the multiple channels can be used for stereo or surround sound.

Anyone recording audio should know how the particular machine is recording and should make a careful list of what methods (sampling rate, bit depth, and mono or stereo) were.
used so that the production sound can be matched within an editing system.⁹

**Features of Sound Recorders**

The video recorders and the audio recorders used for moviemaking have the same function controls as most recorders—play, record, stop, pause, fast forward, rewind. Some tape recorders allow you to hear the sound as it is rewinding or fast forwarding so that you can cue it easily.

Audio and video recorders usually have two types of inputs—mic and line. **Mic inputs** are for microphones, and **line inputs** are for other equipment, such as tape recorders and CD players. The difference between mic and line inputs is the amount of **amplification** that the signal is given. Tape recorders and similar equipment usually have some means of amplifying the audio signal. Microphones do not, so they need the extra amplification provided by the recorder. Therefore, you should always make sure the mic is plugged into a mic input, not into a line input. If you make a mistake, the sound will not record at a level high enough to be useful.

High-quality recorders have a **VU (volume unit) meter**, a device that shows how loudly the sound is being recorded. Sometimes, this is an actual scale that has a red area at one end where the needle indicating the volume level should not linger. In other cases, the VU meter is a bar of flashing diodes that change color from green to red when the signal is too high. In either case, **peaking in the red** (also called **overmodulation**) is undesirable. As already mentioned, for analog the signal will be distorted and for digital it may pop. Sound that regularly rides at the low end of the meter (**riding in the mud**) will not be loud enough. See Figure 7.16 for examples. Ideally, audio should ride between 20 and 100 percent on the VU meter.

Another feature often found on higher-end recorders is **equalization**. This function enables you to cut out or emphasize certain frequencies, such as treble or bass. Sometimes unwanted noises in the high frequencies, such as whining from equipment, can be filtered out through equalization so that they are not recorded. Of course, anything else at that frequency range will be filtered out too. You definitely should not use equalization to get rid of frequencies.
in the voice area when you are recording dialogue.

Some recorders have **automatic gain controls (AGCs)**. When this control is on, the gain is automatically adjusted so that the recording is neither too soft nor too loud. If the control is not on, an operator must adjust the volume control manually to change the degree of loudness.

The counter on a recorder can be valuable for finding your place. Most counters display the minutes and seconds into the recording and can be reset to zero so that new counting can begin whenever you want. Some have an option that allows you to see the time remaining on a tape or disk. Digital recorders often allow you to give different recordings names (for example, fire take 1, motorcycle take 4). These names are visible in a little window on the recorder and can be cycled so that it is easy to access the one you want.

A connection for earphones, a headset, or a speaker is also necessary. The only way you can really tell whether you are recording the sound properly is by listening to it as it is being recorded or just afterward. Some digital recorders allow you to back up and listen to passages while continuing to record.

Some recorders, especially consumer camcorders, have very little in the way of audio recording features. Not only do they **may not have** features such as equalization, but they don’t even **and may not** have a meter, making it difficult to know if sound levels are set properly.

Before using (or preferably before purchasing) a video system for moviemaking, consider carefully the audio features available. Many users (and salespeople) become so enamored with the video features that they forget about audio and end up with something that is unacceptable and difficult to edit. ¹⁰

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**Audio Mixers**

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Audio mixers are not absolutely essential in a production shoot. When they are used, they are between the microphones and the recorders. Sound from microphones is routed into a mixer, where the volume can be adjusted and sound can be altered in other ways (for example, it can be equalized) before it is sent on to the recorder. If there is only one microphone being directed into a high-quality sound recorder, there is no overriding need for the sound to go
through a mixer. In fact, the mixer can get in the way of other production equipment. But if there are several microphones, or if the sound is only being recorded on videotape that is in the camera, or if the audio is complicated and the person recording it wants optimum control, then a mixer can be valuable. Often for digital moviemaking, the sound recordist will use a mixer but not a separate recorder. He or she will adjust the sound in the mixer and send it (via cable) from the mixer audio out to the camcorder audio in. Many companies make portable mixers (see Figure 7.17), and most of them contain the same features discussed for sound recorders.

***Insert Figure 7.17 here.***

**<H1>Care of Audio Equipment</H1>**

Although most audio equipment is manufactured to hold up under fairly rugged conditions, it should be treated as gently as possible. Microphones should always be carried in their cases, most of which are foam-lined with foam. Carrying mics in their cases also helps prevent the loss of accessories such as clips and batteries. You should never blow into a microphone to test it; such puffs of air can damage the sound element. Always telescope mic stands, such as a fishpole, down to their smallest size for carrying. If they have cases, use them for carrying and storing.

Never pull cables out of their sockets by tugging on the wire; remove the connector gently with your hand. Some connectors require that you push a lever to release them. Always do so; don’t just yank. Be sure to coil the cable properly. One way, called the over-under method, involves making repeated circles with the cable, giving the cable a little twist with each circle. Another way is to lay the cable on the floor in a figure 8 and then double the top half of the 8 over the bottom half. Connect the two ends of the cable to keep dust out of the connectors (see Figure 7.18). Then put tape or specially made cable holders over the wire so that it stays in place. Treat cable gently because the small wires inside the cable break easily. The breaks are difficult to find and difficult to repair. Also, cable that is not coiled becomes snarled, and the next
time you try to use it you will find yourself spending precious time untangling it.

***Insert Figure 7.18 here.***

Handle recorders carefully so that their internal electronics do not become damaged. Clean video heads and audio heads frequently with special head cleaners. It doesn’t take much time to treat audio equipment properly, but malfunctioning audio equipment can waste enormous amounts of time during the production process.

Notes


2. Another method for minimizing phase problems is referred to as the 8 and 8 method. The mics should be placed either closer together than 8 inches or farther apart than 8 feet.

3. A good way to study microphone characteristics is to look over the specifications provided by manufacturers. These are readily available on websites such as: www.sennheiser.com; www.electrovoice.com; www.shure.com; and www.audiotechnica.com. See also “You Can Never Have Enough Mics,” *Mix*, August 2002, pp. 38–40.

4. There actually are several types of X-Y miking, all using two microphones. Sometimes the mic heads are overlapped, with the one on the left pointing right and the one on the right pointing left. In this way, the sound hits each mic at the same time. Sometimes the mics both point forward, but they are spaced apart. See “Two Ears, Two Mics: Stereo Micing for TV,” *TV Technology*, 24 March 1999, p. 58.


9. You should always read the manual for any recording system thoroughly. Not only will it instruct you in the basic operation of the equipment, but it will provide recording methods and give technical information you may need to pass on to others.

Chapter 7 Captions

<FN>Figure 7.1 <FC>A low-frequency sound has fewer cycles per second than a high-frequency sound. PICKUP ART. Old 7.1

<FN>Figure 7.2 <FC>These drawings show three common frequency curves for microphones and other electronic equipment. The curve in drawing (a) is often referred to as a flat curve because the equipment it represents reproduces all frequencies with about the same accuracy. The curve in drawing (b) represents equipment that produces middle frequencies better than it produces high or low frequencies. Drawing (c) represents a mic that best reproduces frequencies in the human speech range. PICKUP ART. Old 7.2

<FN>Figure 7.3 <FC>The two main methods of preventing multiple microphone interference. The three-to-one method (a) shows how to place the mics so that they are at least three times as far apart from each other as they are from the subject. The head-to-head method (b) shows the placement of mics facing each other. PICKUP ART. Old 7.3

<FN>Figure 7.4 <FC>This placement of the microphone (a) is likely to cause phase problems because the mic is parallel to the walls and the same distance from all of them. Position (b) would be preferable because the mic is at an angle and slightly closer to one wall than to the other. PICKUP ART. Old 7.4

<FN>Figure 7.5 <FC>The most common pickup patterns are cardioid (top), omnidirectional (bottom left), and supercardioid (bottom right). (Artwork by Michael Swank) PICKUP ART. Old 7.5

<FN>Figure 7.6 <FC>Two methods used for stereo recording. The M-S method (a) uses a bidirectional and a supercardioid mic. The X-Y method (b) uses two cardioid mics. (Artwork by Michael Swank) PICKUP ART. Old 7.6

<FN>Figure 7.7 <FC>Microphones for stereo recording. Photo (a) shows how two cardioid mics might be set up on one stand to record both left and right channels. Photo (b) is an AKG C522 stereo microphone that contains the elements necessary for X-Y miking. (Photo (a) courtesy of Shure Brothers, Inc.; photo (b) courtesy of AKG Acoustics, U.S.) PICKUP PHOTO. Old 7.7
Figure 7.8 A surround sound microphone system called the Holophone. (Photo courtesy of Holophone) PICKUP PHOTO. Old 7.8

Figure 7.9 The construction of the two most common types of microphones, the dynamic mic (a) and the condenser mic (b). PICKUP ART. Old 7.9

Figure 7.10 A fishpole in its collapsed (unextended) position. (Photo courtesy of Beyer Dynamics) PICKUP PHOTO. Old 7.10

Figure 7.11 A lavaliere microphone. (Photo courtesy of Audio-Technica) NEW PHOTO. Provided on CD-R as 07.11 lav

Figure 7.12 This photo shows a wireless microphone with its transmitter pack (right) and receiver. (Photo courtesy of Audio-Technica) PICKUP PHOTO. Old 7.12

Figure 7.13 A microphone case, a windscreen, a shotgun mic, and a shock mount. (Photo courtesy of Shure Brothers, Inc.) PICKUP PHOTO. Old 7.13

Figure 7.14 Commonly used audio connectors. NEW ART. Provided on CD-R as 07.14 connectors

Figure 7.15 A Nagra recorder (a) that records onto a hard drive; and Cantar-X recorder (b) that can record simultaneously on both internal and external hard drives. The Cantar-X also has an internal DVD burner and a Firewire connection to use for external CD or DVD burning. (Photo (a) courtesy of Nagra Audio Division, Magravision S.A; Photo (b) courtesy of Aaton.) PICKUP PHOTO. Old 7.16 b. NEW PHOTO. Provided on CD-R as 07.15b Cantar

Figure 7.16 The needle on the left VU meter is riding in the mud. The needle on the right VU meter is peaking in the red. PICKUP PHOTO. Old 7.17

Figure 7.17 A portable audio mixer. (Photo courtesy of Soundcraft USA) PICKUP PHOTO. Old 7.18

Figure 7.18 An example of properly coiled cable that has the connectors snapped together. NEW PHOTO. Provided on CD-R as 07.18 cable