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ABSTRACT

This paper describes the types of microphones that are available for use in media production. Definitions of 16 words and phrases used to describe microphones are followed by detailed descriptions of the two kinds of microphones as classified by mode of operation, i.e., velocity, or ribbon microphones, and pressure operated microphones, which include crystal, moving coil, carbon granule, and capacitor microphones. It is noted that microphones are also classified according to the way they respond to sounds emanating from different directions: the omnidirectional microphone picks up sounds from all directions, whereas uni-directional microphones are sensitive to sounds from directly in front of the microphone. The latter include cardioid, supercardioid, and hypercardioid microphones. Specialty microphones are also mentioned: the parabolic reflector, lavalier, machine gun, tie-clip, zoom, and pressure zone microphones. A description of a conference microphone--i.e., one that maximizes the clarity of speech around a table--concludes the paper. (DB)

Microphones and Educational Media

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My first educational media productions - a super-8 film, a slide/tape show and a video - all had audio problems. These problems included peripheral sounds, hums, whirring noises or inaudible, fuzzy or garbled parts. It is frustrating to spend a lot of time on a media production and have the effect weakened by the quality of the audio element. Without a background in science, trying to research and learn about audio functions, material and techniques can be overwhelming. As a beginning, and as a reference guide for myself, I have written this short summary on microphones.

Microphone vocabulary is the first problem, so, for my own benefit, I have included the words or phrases I need to know:

Cardioid - heart shaped.

Capacitance - the ratio of a change in quantity of electricity (in a conductor) to the corresponding change in potential.

Capacitor - a device for storing an electrical charge.

Condenser - same as capacitor - a device for accumulating and holding a charge of electricity. It consists of two conducting surfaces separated by a non-conductor and used for modifying the electrical capacity in a circuit and for blocking the flow of a direct current.

Diaphragm - a vibrating disc that makes or receives sound waves.

Field Pattern - the frequency and sensitivity response of a mic for 360 degrees (directional pattern).

Hertz - the international unit of frequency equal to one cycle per second.

Impedance - resistance.

Inphase - in synchronism.

Ohm - a unit of resistance - the resistance of a conductor in which one volt produces a current of one ampere (unit of current strength).

Phase - part of a cycle.

Pickup pattern - a graph of how a mic picks up sound.

Polar Pattern - a pattern in which the mic serves as the nucleus (pole) and the line surrounding the pole is delimiting the mic's direction.

Reverberation - reflected sounds.

Sensitivity - voltage output for given sound pressure and measure of the efficiency of the mic.

Transducer - a device that converts one form of energy to another (Bartlett, 27-28; hall, 74,76; Guralnik; Tremaine, 61).

A microphone is a transducer that converts sound, acoustical energy, into a signal, electrical energy. Based on

mode of operation, there are two kinds of mics - velocity and pressured operated. A pressure operated mic has a thin diaphragm with only one surface exposed to the sound source. Rapid pressure changes in a sound wave cause the diaphragm to move back and forth. The diaphragm is connected to some type of electrical generator - it may be crystal, a moving coil, a cup of carbon granules, or a capacitor. Most mics today are pressure mics (Hall, 77; Tremaine, 61).

Most crystal mics are made of Rochelle salt crystals. In a direct-actuated crystal mic, the sound waves strike the surfaces of the crystals and create mechanical strain. In an indirect-actuated crystal mic, sound waves strike a diaphragm and mechanical pressure causes the crystals to bend or twist. In both mics, crystals then give off electric voltages proportional to the sound striking them. Crystal mics are affected by heat and humidity, and any cable connecting the mic to preamplifiers must be short or hum and noise and loss of output results (Hall, 79-80; Tremaine, 64).

There are two kinds of dynamic mics - the moving coil dynamic mic and the ribbon dynamic mic (which is more delicate, but has smoother tones). The signal is generated when the sound pressure on the metal or plastic diaphragm causes either the conductive coil or the metal ribbon, depending on type of

mic, to vibrate in a magnetic field. The voltage produced is proportional to the sound pressure at the diaphragm. Dynamic mics are popular mics because they do not require separate power, have reliable signals, can accept very loud sound, and have slower transient response than condensers so can be used to soften the fine details condensers pick up. The coil dynmic is a rugged mic. Dynamics are used often for dialogues in movies and videos (Bartlett, 26; Bishop, 81; hall, 77; Tremaine, 66).

A capacitor or condenser mic has a conductive metal diaphragm and an adjacent metal disc which form the two plates of a capacitor. When sound waves vibrate the diaphragm, the capacitance between the diaphragm and the backplate varies and this produces the signal. The amount of electric charge that can be stored in a capacitor depends on the size and spacing of the diaphragm and the disc. Condenser mics have excellent response at high frequency, but need a high voltage source to work (Bartlett, 26; hall, 79; Tremaine, 69).

An electret condenser mic doesn't need the high voltage supply. The diaphragm in an electret condenser mic forms one half a condenser which is charged by a battery. Both condenser mics give smooth detailed sound with wide frequency responses. These are used also in video productions (Bartlett, 26; hall,

79; Tremaine, 69).

A carbon mic has a "button", or carbon-granule filled cup, attached to the center of a metallic diaphragm. As sound waves strike the diaphragm, the carbon granules are disturbed and contact resistance between their surfaces is changed. As the button's resistance decreases and increases, current flow, from a connected battery, changes. These changes are amplified as is the noise created by the constantly changing electrical contact between one granule and the next. The output voltage from a carbon mic is proportional to the displacement of the diaphragm. This mic has a lot of noise, high distortion and generally poor frequency and has a continuous frequency hiss. For these reasons, it is rarely used (Hall, 80; Tremaine, 62).

In a velocity mic, also called a ribbon mic, a crimped lightweight ribbon diaphragm is placed between two permanent magnets. When particles of air strike the ribbon, it moves. The motion of the ribbon generates an electrical voltage, corresponding to the velocity of the sound wave, in the ribbon itself. A ribbon mic responds to sound waves coming from the front and back, but for all practical purposes the sides are dead. A ribbon mic can be ruined by blasts of air which damage the crimp in the ribbon and cause the ribbon to hit the permanent magnets when actuated by sound. The contact of

ribbon and maynet produces severe distortion. A velocity mic is generally shielded by mesh under a metal shield to avoid this problem. These mics were used in the early days of radio, but now are used mainly in special situations (Hall, 77; Tremaine, 61).

Besides being classified by mode of operation, mics differ and can be classified by how they respond to sounds coming from different directions. Omnidirectional mics are equally sensitive to sounds arriving from all directions. These mics are less sensitive to "pop" - explosive sounds.
Uni-directional mics are most sensitive to sounds from one direction - in front of the mic. Uni-directional mics have cardioid, supercardioid, or hypercardioid pickup characteristics. The cardioid mic, which is a combination of velocity and dynamic type mics, is the most popular. It has a pickup pattern which is sensitive to sounds arriving from a broad angle in front of the mic. It helps reject unwanted sounds such as reverberations or sounds from other sources and has good isolation between recording tracks. Velocity mics are bi-directional and have a "figure 8" pickup pattern. They pick up at the front and back but are dead at the sides (Bartlett, 26-27; Hall, 76,78; Tremaine, 61).

There are many specialty microphones. A parabolic

reflector mic is valuable for recording sound from a distance. The parabolic reflector is a stiff, concave disk. If the mic's diaphragm faces the center of the disk at the focus of the parabolic curve, intercepted sounds will be reflected into the mic. To reflect sound adequately into the mic, the reflector must have a diameter longer than half the wave length of the sound (Hall, 81).

A lavalier mic is a small dynamic mic, worn around the neck, and designed for correct speech balance. It is pressure activated and is used mainly for T.V. studio and video work. A hydrophone picks up sound under water and consists of a mic or number of mics, generally crystal, inserted in a waterproof, oil-filled flexible compartment. The machine gun mic uses different lengths of tubes for highly directional use (Hall, 80-81; Tremaine, 83).

Tieclip mics are wireless mics which are attached to a small FM transmitter. If used with video, the receiver on the VCR picks up the signal and feeds it to the recorder. Tieclip mics are not entirely dependable and interference is often a problem. Zoom mics for video have a variable pickup pattern from uni-directional for telephoto work to moderately directional for close and wide angle work. A zoom mic by JVC attaches to the zoom control of the JVC video camera; as the

camera zooms, so does the mic. Switchable mics switch between two pickup patterns - narrow and moderate (Bishop, 81).

The PZM is a pressure zone mic, for home video and other uses, developed by Crown International. It can be placed on the floor for a 180 degree sphere that hears the whole room or can be placed in a corner or mounted on a plexiglass boundary board and be highly directional. Its special ability is to reject room echoes. The PZM receives direct and reflected sound inphase and has excellent clarity and reach. Also from Crown is the supercardioid surface mounted mic PCC-160 - which has the benefits of both the PZM and the supercardioid polar pattern. It is suited for lecterns and news desks (Bartlett, 28-30).

The 1070 Conference mic by Comprehensive Video was developed to mazimize the clarity of speech around a table. It also cancels out room echoes and resonances. The miniature condenser mic can be attached to instruments. A stereo condenser mic combnes two uni-directional mic capsules in a single unit for stereo recording (Bartlett, 28-30).

It's just a beginning!

References

Bartlett, Bruce. "A Buyer's Guide to Microphones." Tape Deck, 1986.

This article gives a thorough description of types of mics and when to use what. The article includes excellent selection charts for buyers.

Bishop, John. "sound Practices." Video, 1986.

This article describes the crucial link between sound sources and sound tracks. It concentrates mainly on mics for TV studios and video use.

Guralnik, David, Ed. Webster's new World Dictionary. Cleveland, Ohio: Collins Publishers, 1979.

Hall, Joel. "Fundamentals of Magnetic Sound Recording." Techniques of Magnetic Recording. New York: MacMillan Co., 1958.

This is Chapter 6 in an older book on the techniques of recording. This chapter describes many different kinds of mics and how they work. It is easy to understand.

Tremaine, Howard. "Microphones." The Audio Cyclopedia. New York: Howard & Sons, 1958.

This is section 4 in an encyclopedia type book on audio terms and equipment. Everything is written in the form of questions and answers and is easy to follow and understand.