SOUND TECH
and
PRINCIPLES

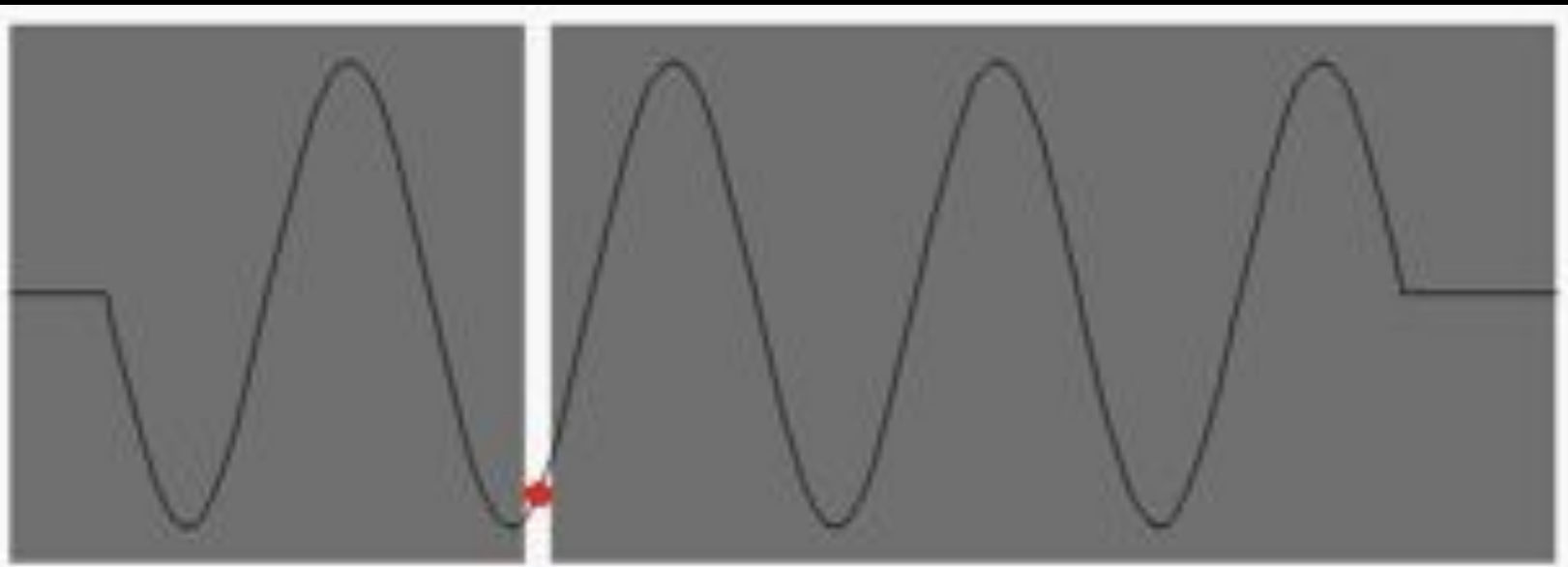
Sound may be the most powerful tool in the filmmaker's arsenal in terms of its ability to seduce. That's because "sound," as the great sound editor Alan Splet once said, "is a heart thing." We, the audience, interpret sound with our emotions, not our intellect.

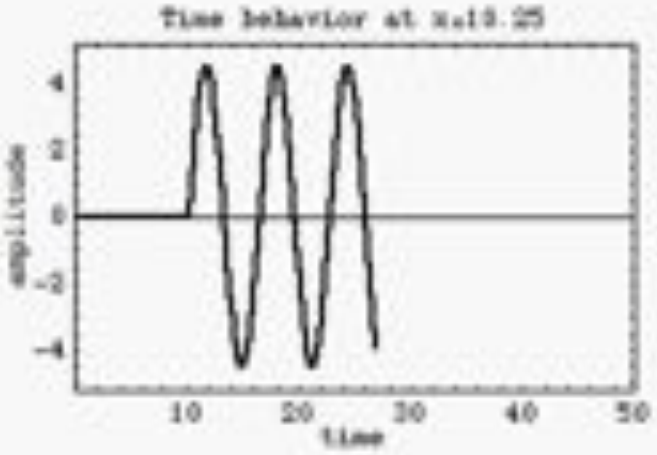
Randy Thom (sound designer, *Wild at Heart, Forrest Gump, The Incredibles*)

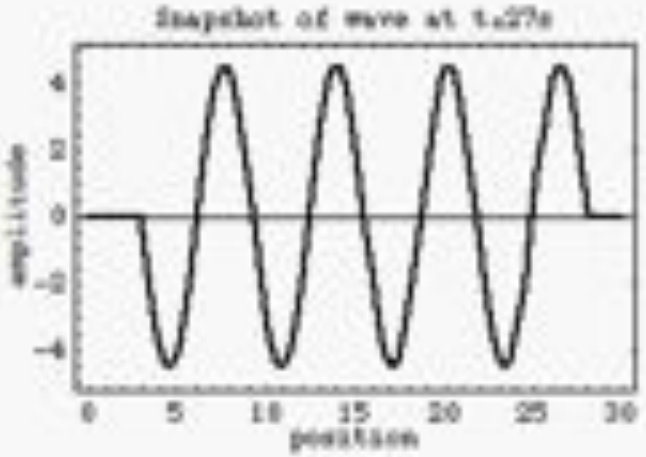
Sound is a wave:

Sound is produced by some vibrating source creating pressure and displacing air molecules. Much like the ripples in a pool of water when a pebble is thrown in, the displacement of the air molecules create acoustic sound waves, which move through the air.

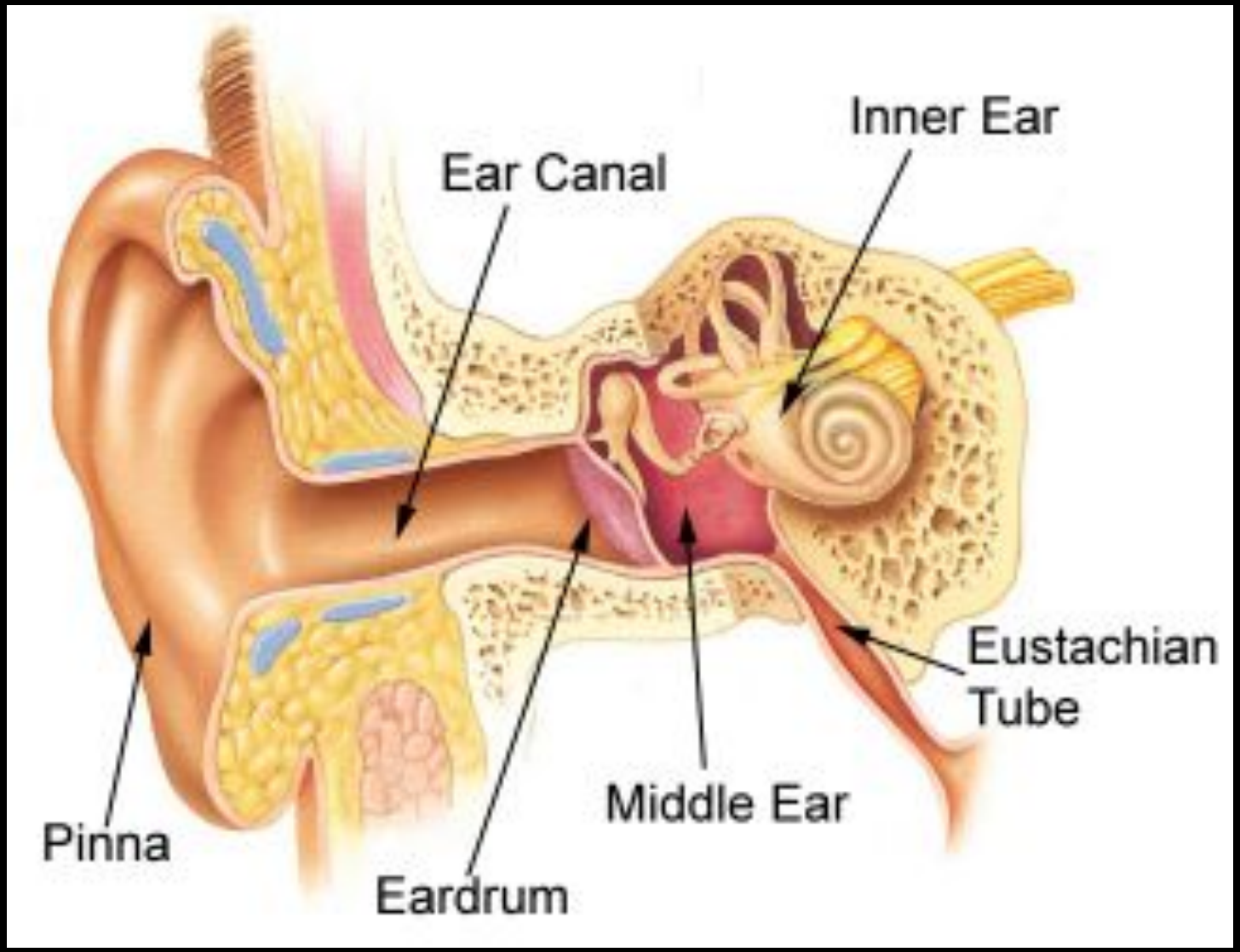
A **sound wave** is in fact a pressure wave, consisting of an alternating pattern of high pressure (compression) and low pressure (rarefaction), traveling through the air. The vibrating source of this pressure can be a guitar string, a tuning fork, the contact between a baseball and a bat, or human vocal chords.




Time behavior at x=10.25
amplitude
4
2
0
-2
-4
10
20
30
40
50
time

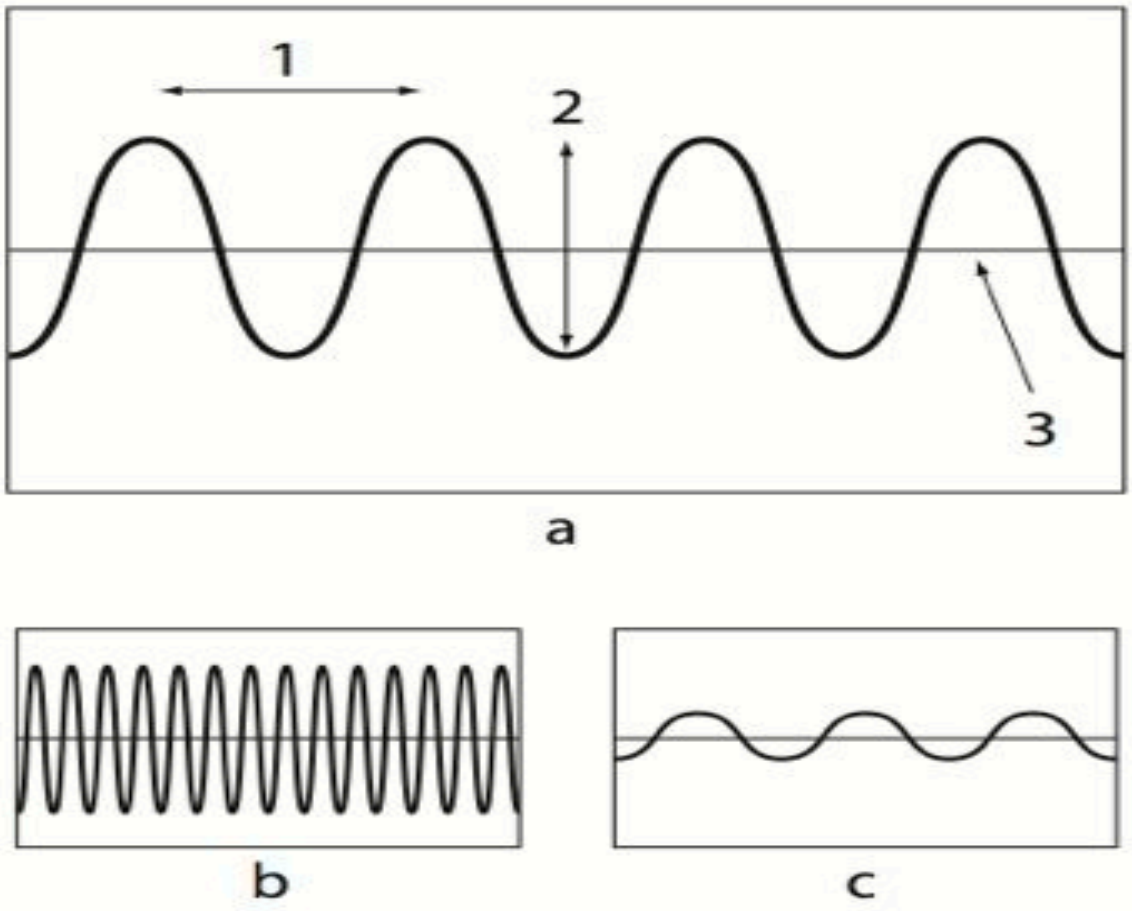

Snapshot of wave at t=27s
amplitude
4
2
0
-2
-4
0
5
10
15
20
25
30
position

Acoustic sound waves are eventually received by some sensitive membrane, like an eardrum or microphone diaphragm.


Inner Ear
Ear Canal
Eustachian Tube
Middle Ear
Pinna
Eardrum

Four basic qualities of sound (applied to a graph)

1) Frequency (pitch
2)Amplitude (loudness)
3) Timber (sound color)
4) Velocity (speed of sound)


1
2
3
a
b
c

Frequency (pitch)

Sound waves travel in consistent wave cycles. One wavelength is the length of one cycle, from peak to peak, which then repeats itself (#1 on graph). The number of these waves that pass a fixed point over the course of one second is the measure of the frequency of the sound wave. This measure of cycles per second is referred to as Hertz (Hz) and is measured along the graph's x-axis. A sound that generates 10,000 wave cycles every second has a frequency of 10 kHz.

Frequency is actually measuring the **pitch** (high pitch and low pitch) of that particular sound. The fewer cycles per second, the lower the pitch of a sound; the more cycles per second, the higher the pitch.

On Graph: b = high frequency and c = low frequency

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On Graph: b = high frequency and c = low frequency

Frequency range = the range of pitches that a sound source can produce

5200 Hz

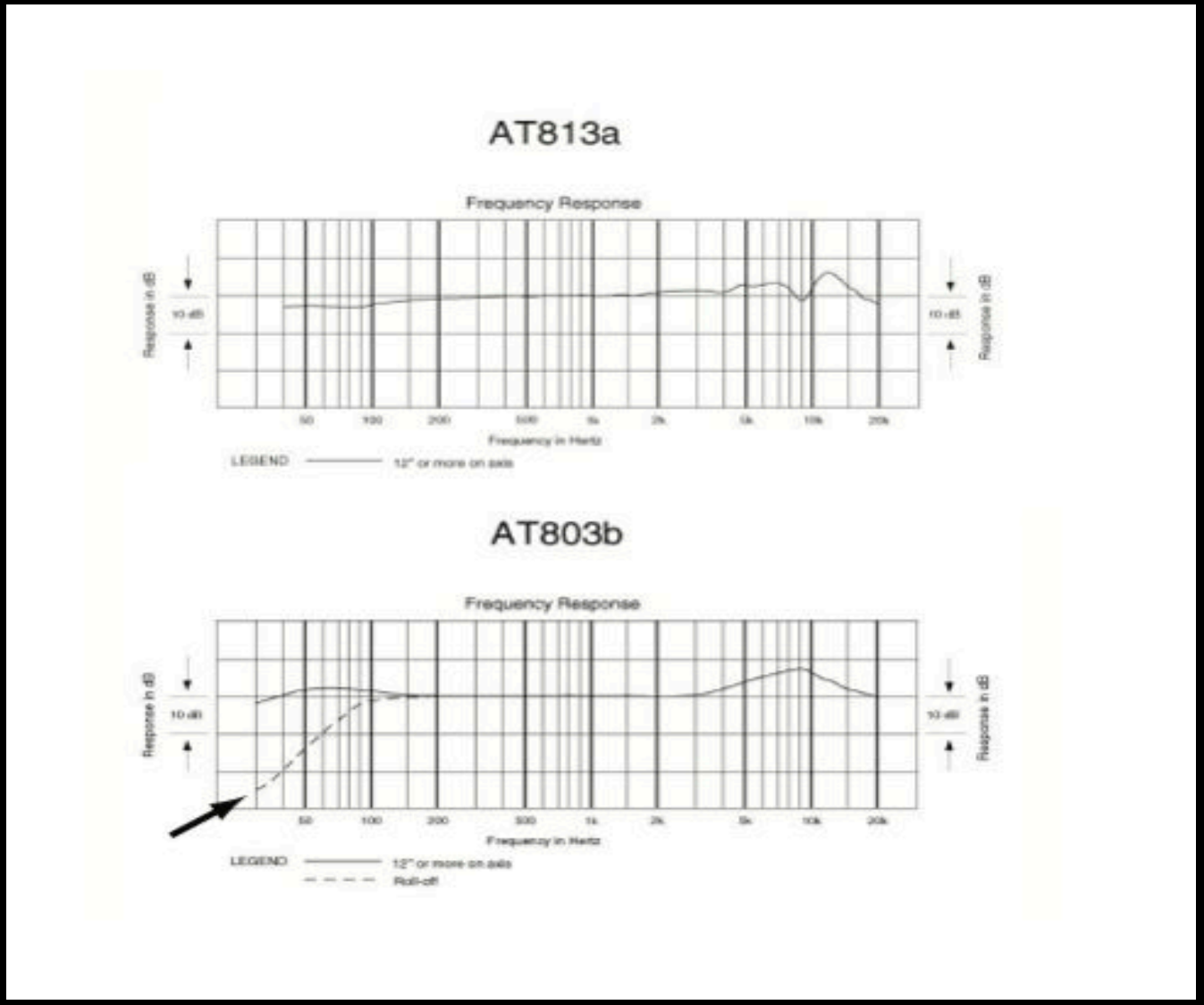
150 Hz - 2000 Hz

45 Hz

Frequency response= the range of detectable pitches for a given apparatus.

- Healthy human ear can hear: 25 Hz to 20 kHz.
- Dogs can hear beyond 20 kHz.
- Old cassette decks = 30 Hz–12 kHz
- Professional digital audio recorder = 20 Hz–40 kHz.

Microphone frequency response graphs



Amplitude (loudness)

Each peak high and low pressure point along the graph's y-axis (see #2 on graph) has a specific height or **amplitude,** which is a measure of the **loudness** of a sound. The higher the amplitude peak, the greater is the displacement pressure of the sound wave and the louder the sound. Loudness is measured in **decibels (dB)**.

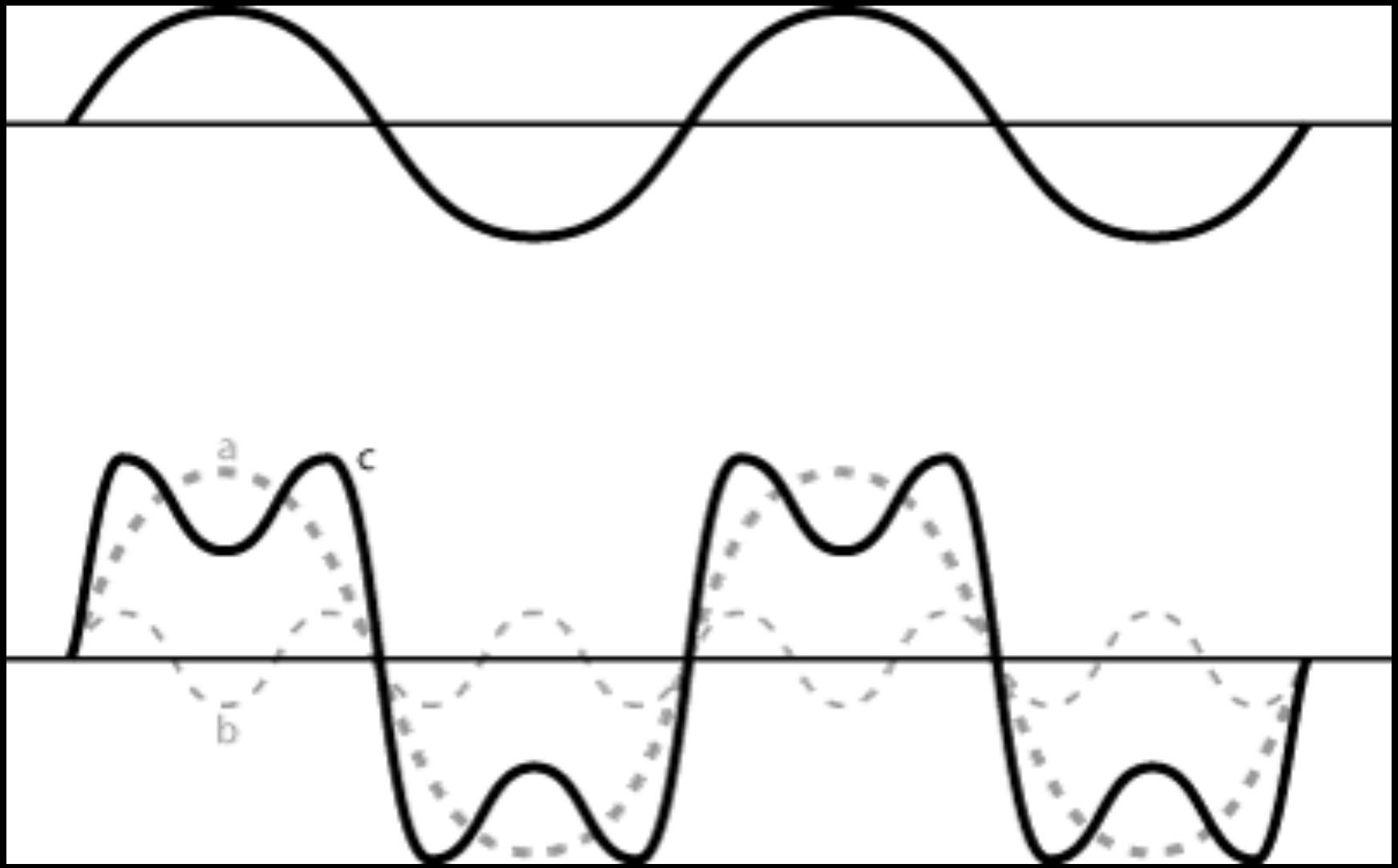
On the graph b has a higher amplitude (is louder) than c

The loudness range that the human ear can distinguish falls between the **threshold of hearing** (0 dB) on the low end, and the **threshold of pain** (120 dB) on the upper end. A normal conversation tone is approximately 55 dB. A whisper is around 25 dB and a scream comes in at around 75 dB. At 150 dB, eardrums will rupture.

Healthy eardrum – Ruptured eardrum

Timber (sound color)

Every naturally produced fundamental sound wave resonates with a series of imperfections and coinciding waves that represent **overtones** and **harmonics.** Therefore, most naturally occurring sound waves include characteristic irregularities and are accompanied by other waves of lower amplitude and various frequencies, all of which reflect the particular quality of that sound.


a
c
b

These elements comprise **timbre,** which is the unique tonal composition and characteristics of that sound (i.e., richness, harshness, resonance). Timbre allows us to easily distinguish different instruments playing the very same note. For example, middle C on a piano sounds quite different from the same note played on a trumpet, or on a guitar, or when sung by a human voice.

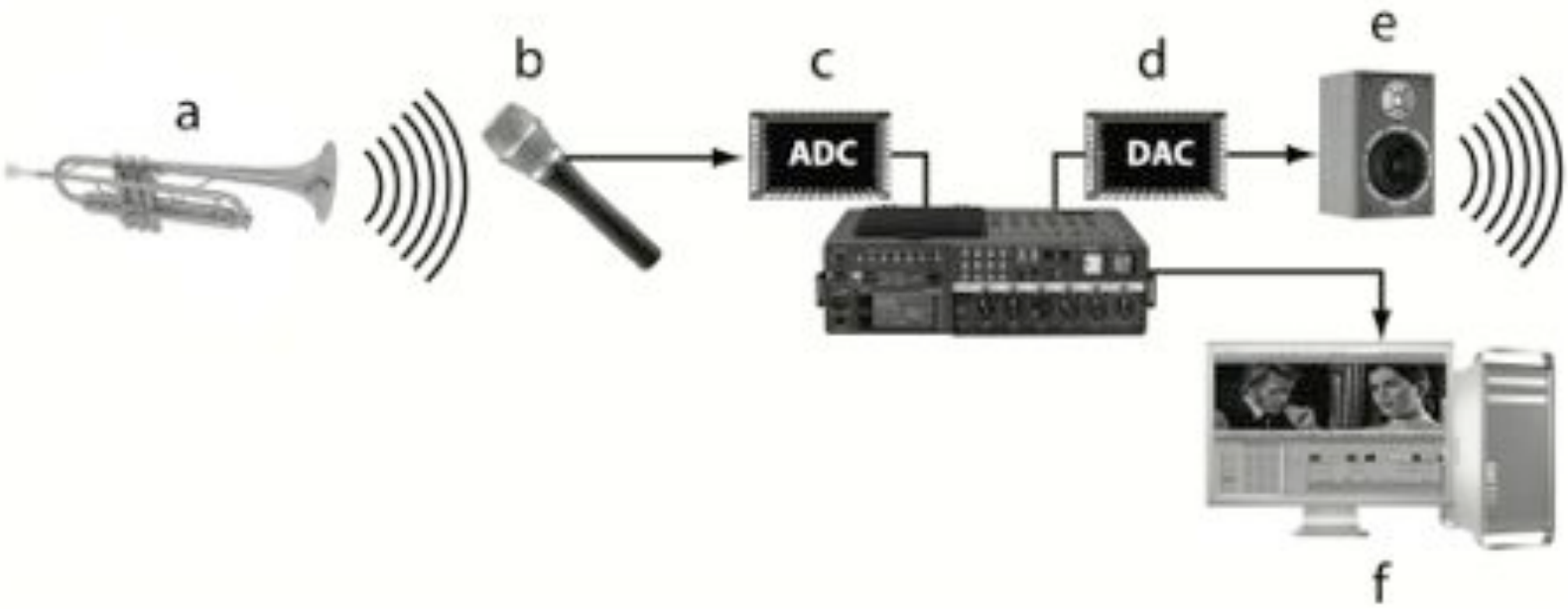
Velocity (speed of sound)

Sound is a wave that travels through space, so it has directionality and speed.

The **speed of sound** is 1,086 feet per second. (very slow compared to the speed of light which is 983,571,056 feet per second).

Super sonic jet breaking the speed of sound at the moment of creating the characteristic sonic boom

The basic signal path for sound recording



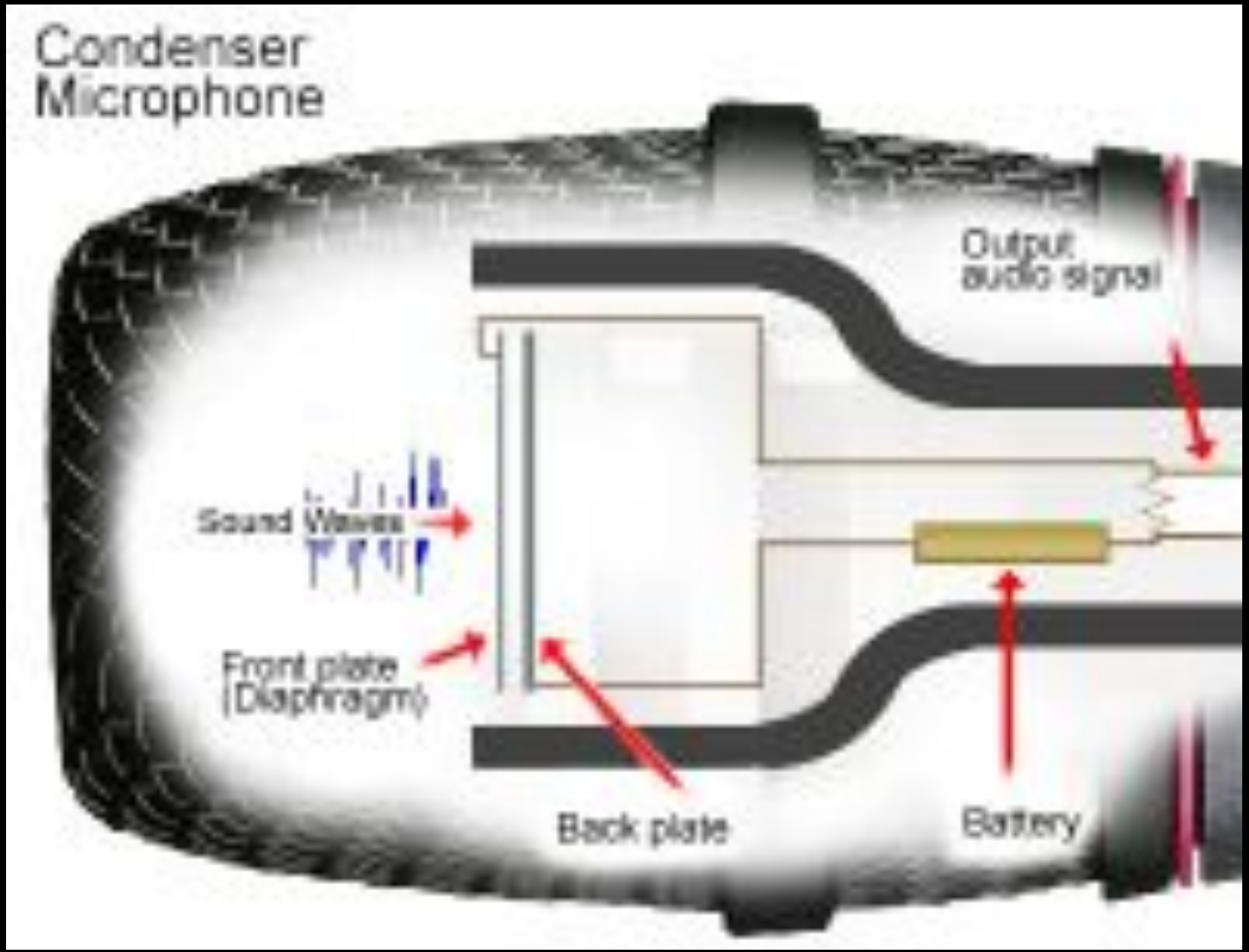
The signal path:

a. Begins with the source of sound, which emits acoustic energy (sound waves).
b. Sound waves enter the microphone, where a diaphragm, magnets, and coil convert the acoustic energy into fluctuations of electrical voltage which is sent to the digital audio recorder.
c. The electronic (analog) signal goes to an analog-to-digital converter (ADC), which samples the audio information and translates it into binary code (a series of 1s and 0s) and is stored on record media (e.g. hard drive, flash drive)

The signal path (cont'd):

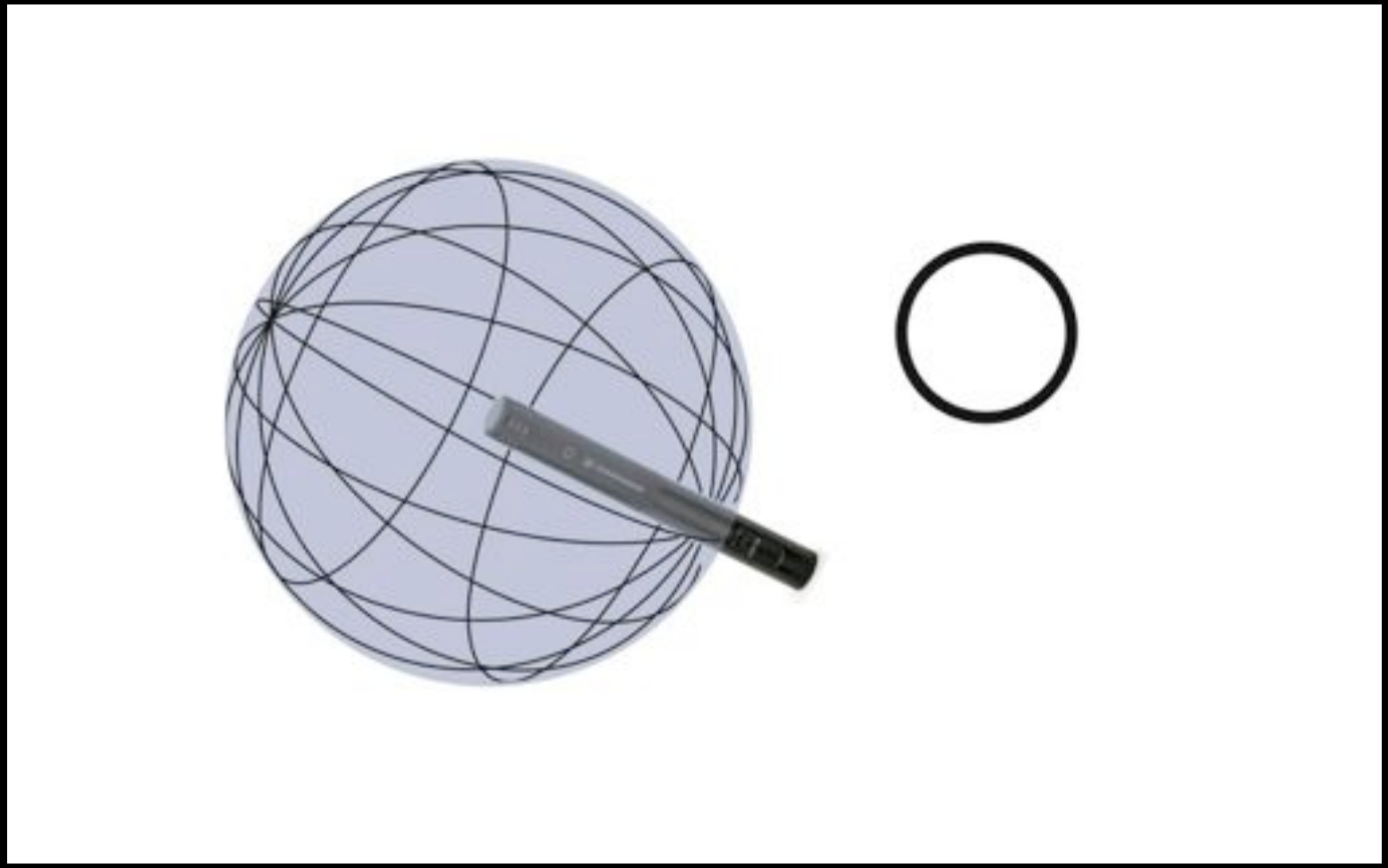
d. d. To play the audio, the data is sent to a digital-to-analog converter (DAC), which changes it back into electronic energy.
e. The electronic signal can then travel to speakers or headphones, where magnets, sound coils, and cones convert the electronic energy back into acoustic sound waves that travel through the air and are received by our ears.

The sensitive microphone diaphragm is buffeted by acoustic waves. The movement of the diaphragm against a charged backplate creates voltage fluctuations analogous to the original acoustic waves. Thus, analog sound.


Condenser
Microphone
Output
audio signal
Sound Waves
Front plate
(Diaphragm)
Back plate
Battery

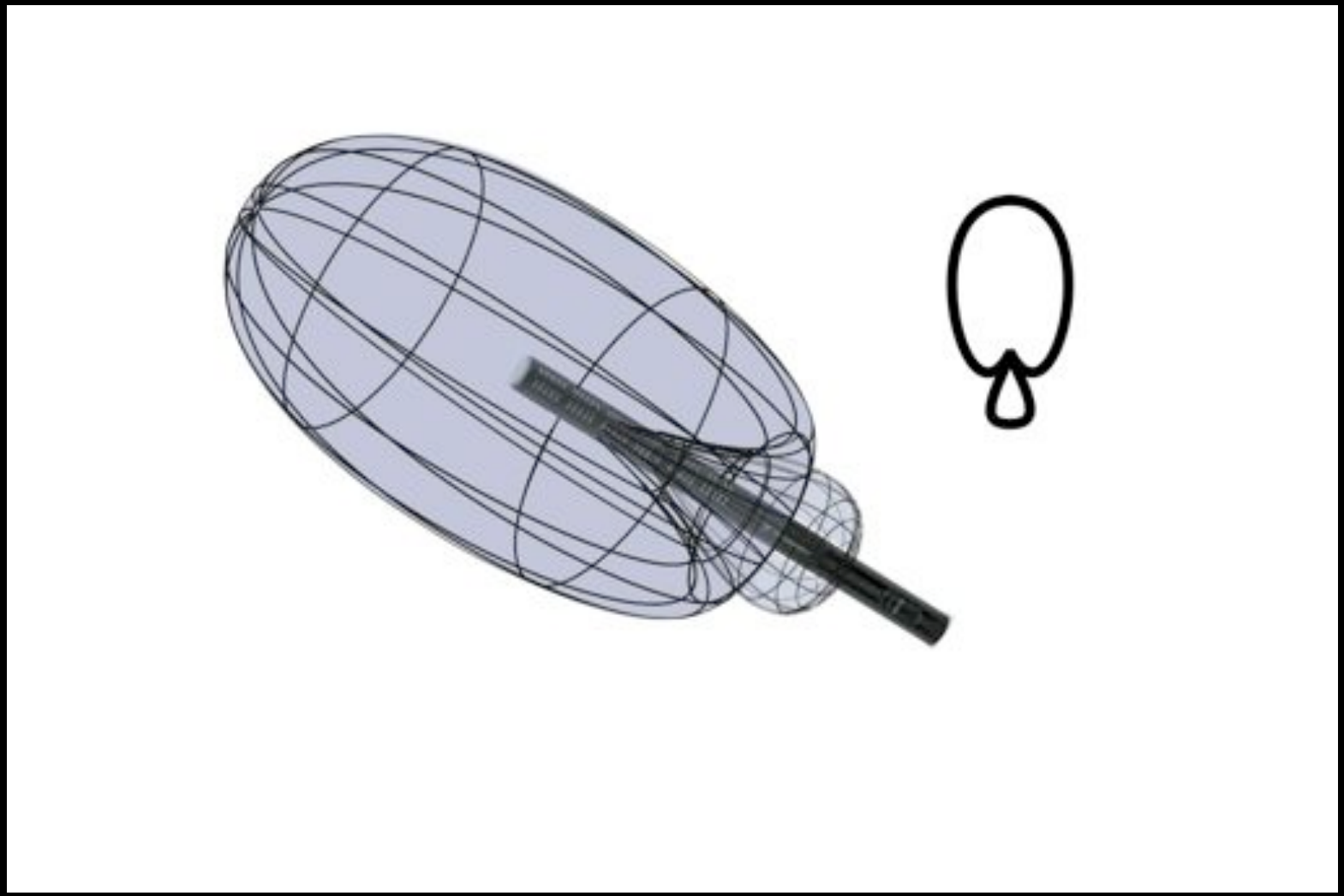
Microphones are manufactured with a variety of pick-up patterns for use in different recording situations

Omnidirectional mics. pick up sounds from all directions equally



Cardioid mics pick up sounds mostly from the front and sides

Super-cardioid mics pick up sounds mostly from directly in front

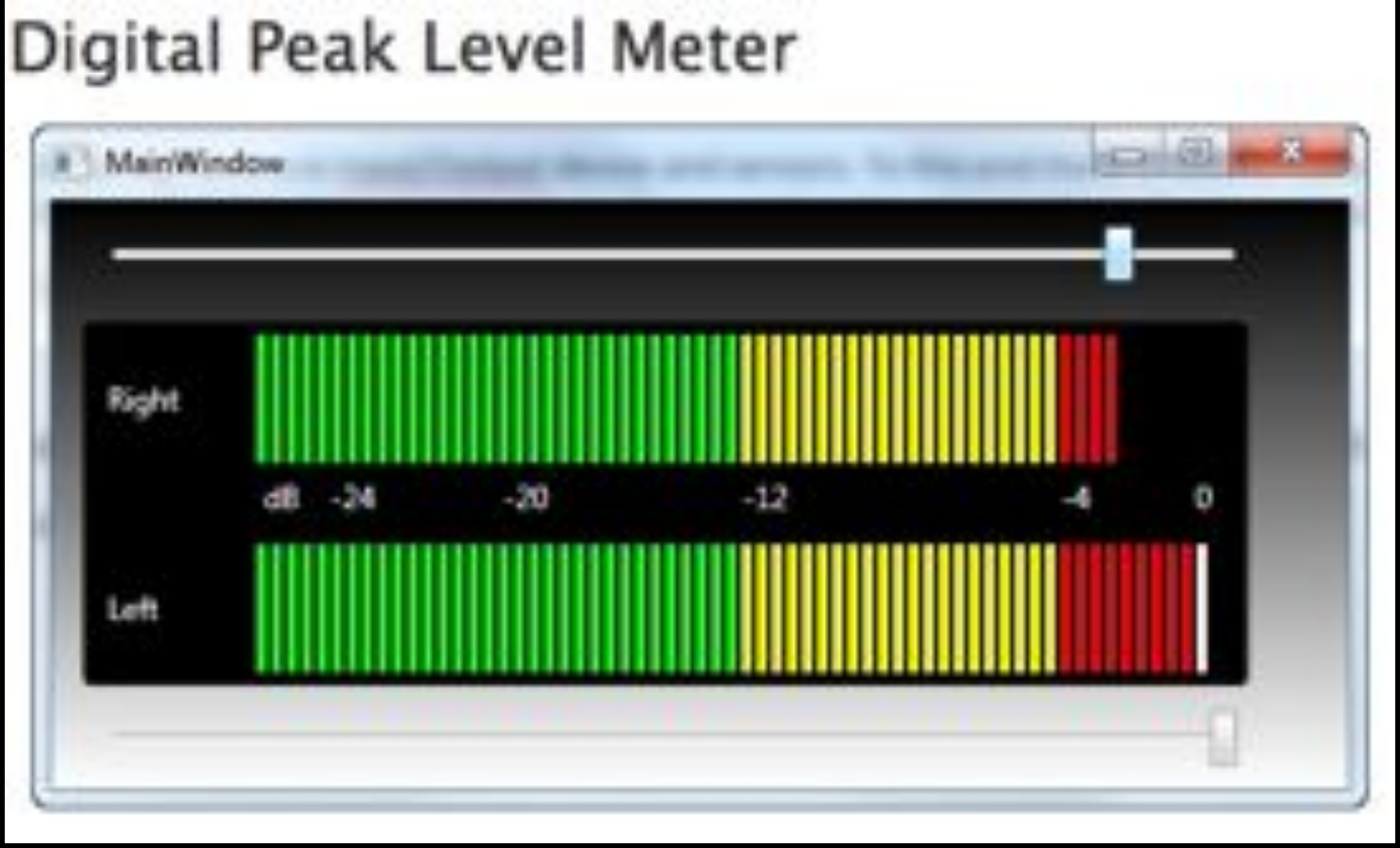


The typical sound team:
1) Sound recordist
2) Boom Operator

For simple sound situations a talented sound person can fly solo

The Boom Operator's job is to get the mic. "on-axis" and as close to the sound source as the framing of the shot will allow.

The sound recordist's job is to monitor audio on the recorder's meters and record the strongest possible signal (without over-modulating).



The peak meter and VU meter have slightly different scales but their function is similar – to measure the strength of the audio signal being recorded.

The peak meter measures sound directly while the VU meter averages the strength of the signal but their function is similar – to measure the strength of the audio signal being recorded.

The best way to set levels is to set the loudest sounds first (a strong signal but not overmodulating, or “into the red”)

In most recording situations the loudness of your source fluctuates. Sometimes the range of loudness levels, from the lowest to the loudest, is minor and other times it can be extreme.

The range of different loudness levels is called the **dynamic range**.

Wide dynamic ranges can be very challenging for both the sound recordist and the equipment

Room acoustics

also have an effect on sound recording:

A “live” room has a lot of reverberation (reflected sounds) and a “dead” room has a flat acoustic

TYPES OF SOUNDS WE RECORD IN THE FIELD

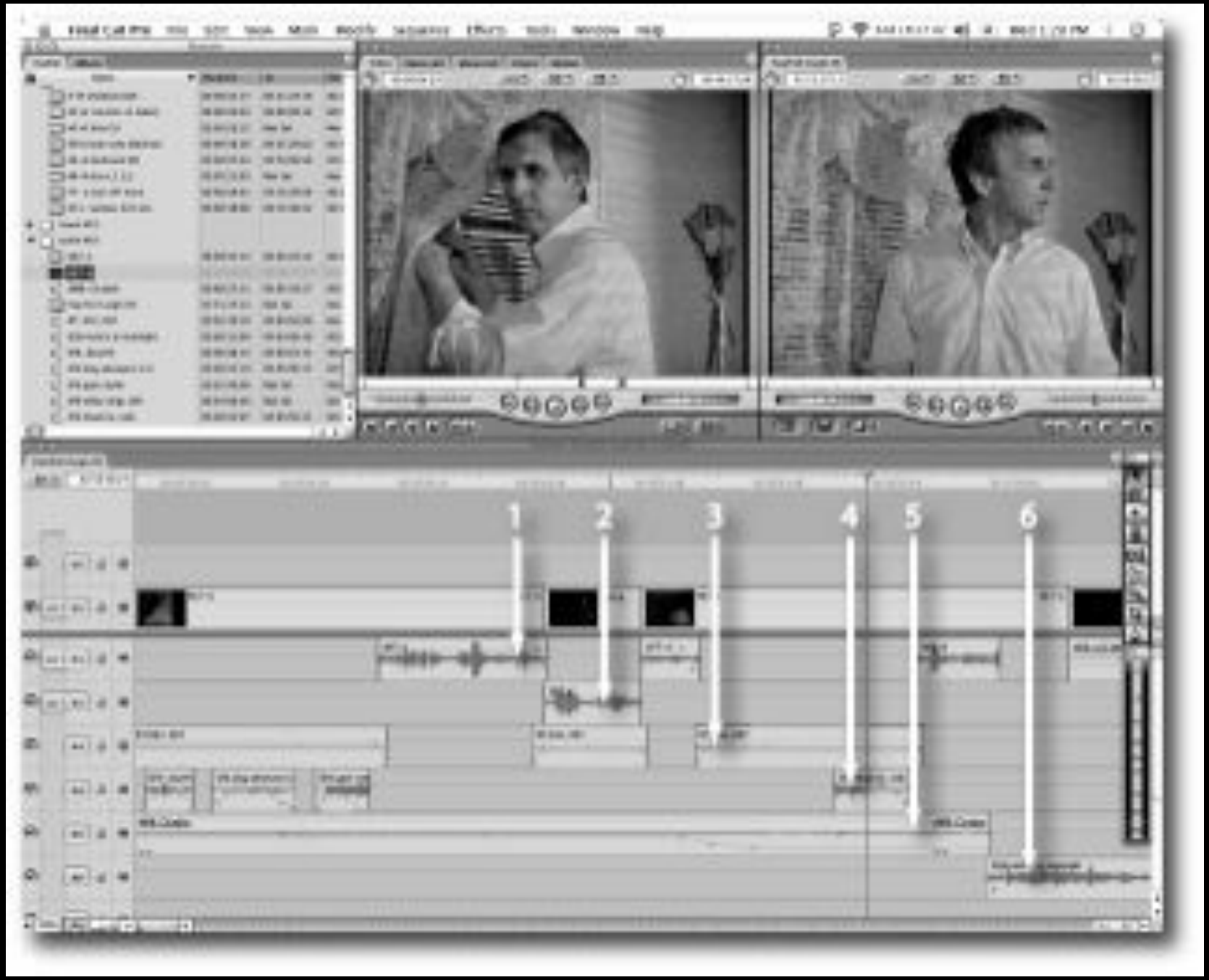
- **Sync sounds** (sound that has a frame to frame correspondence with the picture)
Dialogue, sound effects, ambience

- **Wild Sounds** (no correspondence with picture)
sound effects, ambience

TYPES OF SOUNDS WE RECORD OR FIND IN POST- PRODUCTION

- **Sound effects** (Hard effects or foley)(post synchromously dubbed)
- **Ambience**
- **Music** (prerecorded or scored)
- **ADR**

Sound Design:
The final form of a movie's total aural impression.
A film's sound design consists of layering multiple tracks of sound, anywhere from two to two dozen. The creative manipulation, placement, layering, enhancing, composing, juxtaposing, and mixing of these audio tracks is done in the postproduction stage.


1
2
3
4
5
6

Each track layer is dedicated to one type of sound (sometimes more thsn one track)

1 & 2 : **Dialogue**

3 & 4: **Sound Effects** (hard effects, Foley effects

5: **Ambient Sound:** Sync environmental sounds, post-synced sounds

6: **Music** (pre-recorded or scored)

Psychoacoustics:

This term refers to an audience's psychological perception of sound and sound's emotional and cultural connotations.

Four Basic Sound Design Strategies
(can be mixed in a single film)

Naturalism:

establishes the verisimilitude of the environment. Sounds represent what we would expect in real life. Adds truthfulness, even though carefully constructed.

Heightened Moments:

Elevate, underscore or heighten critical narrative or emotional moments.
Sound infuses extra emotions (usually covertly), like score music

Character Subjectivity:

Sounds used to bring audience into the subjective perspective of a character.

Commentary or self reflexive sounds:

Sounds designed to pull us outside of the world of the film to create commentary, or to make us THINK about the film rather than just FEEL the emotions in film.