

PSYCHOACOUSTICS & THE GRAMMAR OF AUDIO

(By Steve Donofrio NATF)

"The reason I got into playing and producing music was its power to travel great distances and have an emotional impact on people"
Quincey Jones

"The one good thing about music, when it hits you feel no pain"
Bob Marley

Sound Engineer : " How do you want this to sound?"
Producer: " I want it to sound better!"

PSYCHOACOUSTICS Is the subjective effect sound has on those who hear it.

LISTENING - is perceiving sound with careful attention, analyzing its quality, understanding its nuance, examining your reaction in mood and feeling. It is not playing your favorite CD while washing dishes or talking on the phone.

SOUND DESIGN - Represents the overall artistic styling of the sonic fabric in an audio production.

SOUNDSCAPE - Created by mixing different sound elements together forming a sense of time, place, motion, location, atmosphere and a point of view for the listener.

AMBIENCE - All the sounds contained in a given acoustical environment (space).

SOUND WAVE - Is mechanical energy, physical vibration of molecules transmitting energy from one place to another. It can carry information and convey emotion. Sound provides cognitive information related to mental processes of knowledge, reasoning, memory, judgment and perception, it also contains affecting information related to emotion, feeling and mood. It is wave form.

ACOUSTICS - The objective study of the physical behavior of received sound.

ACOUSTICAL SPACE - Where the sound takes place (large room, small room, cave, cathedral, bathroom, car , plane, dumpster etc...) Things that affect acoustical space: shape, dimensions, surfaces, objects, temperature, humidity, isolation of sound inside and outside the space.

AUDIO DRAMA - Basic elements include Music, Dialogue, Sounds (SFX , ambience) and Silence.

SIGNAL - A sound source represented by an electrical, magnetic, or digital form which is analogous to the sound wave .

NOISE - Anything other than the signal that is desired. It could be electrical hum and buzz, ambient noise Etc. Noise can be transient or steady state.

SIGNAL/NOISE RATIO - How much signal is generated for each dB of noise, Ex. 85dB signal to 1 dB of noise.

COMPONENTS OF SOUND - Include ; pitch, volume, timbre, tempo, rhythm, duration, attack and decay.

PITCH - Refers to the highness (treble) or lowness (bass) of a sound. This is dependent on the frequencies contained in the sound wave.

FREQUENCY - Refers to the number of cycles per second (CPS) = HERTZ. (Hz) at which the sound is vibrating. The audio range for human hearing is between 20Hz to 20,000 Hz. 1,000 Hz = 1 kHz (kilohertz)

AUDIO SPECTRUM - Low freq. is 300 Hz and below, Midrange freq. is from 300Hz to 3,500 Hz, and High freq. is 3,500 Hz and above.

SUBSONIC - Are sounds with frequency below human hearing .

ULTRASONIC - Are Sounds with frequency above human hearing.

OCTAVE - Western music is divided into octaves. There are 10 octaves between 20 Hz and 20 kHz.

LOW BASS - 1st & 2nd octaves (20Hz to 80 Hz) Gives sound fullness and power Ex: earthquakes, explosions, thunder, heavy traffic, dinosaurs.

UPPER BASS - 3rd & 4th octaves (80Hz - 320 Hz) Sound produced from instruments like drums, electric and acoustic bass, cello, tuba.

MIDRANGE - 5th , 6th & 7th octaves (320 Hz - 2,560 Hz) For many sounds the fundamental or primary freq. or the 1st harmonic falls in the 5th octave. The 6th octave gives the sound a horn like quality. The 7th octave gives sound a tinny quality.

UPPER MIDRANGE - 8th octave (2,560 Hz to 5,120Hz) Improves intelligibility and adds presence to speech.

TREBLE - 9th & 10th octaves (5,120 Hz to 20,000Hz) Adds sharpness and crispness to sound . Tape hiss is in this frequency range also electronic noise in equipment can be heard in this range.

EQUALIZATION (EQ) - Altering the frequency amplitude response of a sound source or a sound system.

EQUALIZER - A signal processing device that can boost, attenuate or shelve frequencies of a sound source or a sound system. Ex: graphic, full octave (9 band) , 1/2 octave(18 band) 1/3 octave (27 band) or parametric, paragraphic, notch filters, and band pass filters.

VOLUME - Refers to the amplitude of the sound wave , perceived as loudness. It is measured as sound pressure level (SPL) = decibels (dB). Apparent loudness can range from very faint to loud to deafening.

DYNAMIC RANGE - The range of volumes from the loudest to the quietest over a given length of time.

COMPRESSION - Reducing a signal's output level in relation to its input level to reduce dynamic range.

COMPRESSOR - A signal processor with an output level that decreases as input level increases. Four basic settings include the threshold, the compression ratio, the attack time and the release time. How all four settings interact is crucial in making a compressor work.

LIMITER - A compressor with an output level that does not exceed a preset ceiling regardless of the input level. When the compression ratio exceeds 10 to 1 it is referred to as limiting.

EQUAL LOUDNESS PRINCIPLE - Midrange frequencies are perceived with more intensity than that of bass and treble frequencies. Most home stereos have bass and treble controls because of human insensitivity in these frequency ranges. If you have three pure tones at a fixed loudness the 1st at 50Hz , the 2nd at 1,000 Hz and the 3rd at 5,000 Hz the tone at 1,000 Hz will sound louder to your ear.

MASKING - The covering of a weaker sound when they exist at different frequencies simultaneously. High frequency is easier to mask than low frequency. The masking effect is greatest when the frequencies are close together. The effect is less the further the frequencies are apart.

VELOCITY OF SOUND - Beside having amplitude and frequency sound has a component of speed. It travels at 1,130 ft/sec (sea level at 70 degrees F.) and 4,800 ft./sec. in water, 11,700 ft./sec in wood. 18,000 ft./sec in steel.

SOUNDWAVE -A series of compressions and rarefactions of molecules created by a vibrating disturbance. The motion of molecules transmitting energy from A to B. The number of molecules in motion = the amplitude loudness . Sound waves have physical force.

DISTORTION - Any change to the original wave form of the sound.

WAVELENGTH - Equals the velocity divided by the frequency.

Freq. (Hz)	WAVELENGTH (FEET)	WAVELENGTH (INCHES)
20	56.5	
31.5	35.8	
63	17.9	
125	9	
250	4.5	
440	2.5	
500	2.2	
880	1.2	
1000	1.1	
2000		6.7
4000		3.3
6000		2.2
8000		1.6
10000		1.3
12000		1.1
16000		0.07

Low Freq. waves are very long and non-directional.
High Freq. waves are very short and very directional.

Varying a sounds Freq. affects perceive loudness.

Varying a sound's Amplitude affects perception of pitch.

PURE TONE - a single freq. devoid of harmonics and overtones. Engineers use pure tone to set calibration of equipment for optimal signal transfer, recording and unity gain. Ex. 1,000Hz. at zero Vu.

Timbre - Is the tone color of a sound. That is why a trumpet and the human voice both making the same note sound different. Timbre is a multidimensional and consists of the entire sonic pattern created by the fundamental and the harmonics.

FREQUENCY RESPONSE - How well does a device respond or reproduce all the frequencies that exist in the sound.

RHYTHM - Refers to the sonic time pattern, it can be simple, complex, constant or changing.

THE SOUND ENVELOPE - Has three different parts Attack, Internal Dynamics and Decay. Attack is how a sound starts up. Internal Dynamics refers to initial decay & sustain and Decay or the time it takes for a sound to fade away.

ACOUSTICAL PHASE- refers to the time relationship between two or more sound waves at a given point in their cycles. Phase can be either constructive or destructive

Binaural - As human with two ears we use the intensity difference and the arrival time difference to give us location and dimension.

PRECEDENCE EFFECT - 1. The direct sound wave arrives first. 2. The indirect or reflected sound waves arrive later. If the arrival time is between 10 to 20 milliseconds the brain hears the sound as one sound, this is called temporal fusion. This is very strong between 1kHz and 5kHz. Beyond 20 milliseconds the brain starts to hear the sounds as reflections and beyond 50 milliseconds it is echo.

ACOUSTICAL LIFE CYCLE (in an acoustical space)

1. Direct waves - Reach the listener without bouncing off any surface.
2. Early reflections Bounces off 1 surface gives subjective information on room size.
3. Reverberation. (reverb) Latter reflections of, densely spaced reflections created by random, multiple, blended replacations of a sound. Reverb fills out loudness.

- A. Big Reverb & Long Decay - Concert Hall, Castle, Large Church.
- B. Big Reverb & Short Decay - Tiled Bathroom (singing in the shower)
- C. Little Reverb & Medium Decay - Living Room, Conference Room
- D. Little Reverb & Short Decay - Inside a Car.
- E. No Reverb - Out side in an open space or in an anechoic chamber.

DELAY - Is a time manipulation that changes how sound is heard by the brain. Delay has many special effects.

1. Flanging 2 to 20 milliseconds
2. Doubling - 20 to 40 milliseconds.
3. Chorus - 15 to 35 milliseconds recirculated
4. Echo - greater than 40 milliseconds
5. Infinite repeat.

50 millisecond = $1/20$ of a second.

MONO - Both channels, left and right, have exactly the same signal.

STEREO - The right and left channels have differing information.