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1) Name the three different types of microphones based on operation principle. Please explain how they each operate, and important sonic qualities they possess.

Microphones are a kind of transducer, a device that allows you to change one medium of energy to another. Microphones convert vibrations in the air into electrical signal through a number of ways. All microphones work similarly. At their core, they consist of a diaphragm, a magnet, and the electronics that go coupled with each individual microphone's design. How a sound is physically captured, though, depends on the kind of microphone. There are three different types of microphones that each have a different way of physically capturing sound: dynamic microphones, condenser microphones, and ribbon microphones.

Dynamic microphones function like a backwards speaker. As opposed to signal being sent through coils around a magnet to push a diaphragm, a diaphragm moves due to air vibrations and sends signal back from the magnet. These microphones are great for general-purpose use. They are generally cheap and incredibly durable. Unfortunately, though, these microphones are also insensitive, causing a low impulse response. The sonic effect of insensitivity is a lack of quick dynamic change. Dynamic microphones are not good for capturing sharp attacks. Two classic examples of dynamic microphones are the Shure SM58 and SM57. They are both nearly sonically identical. The SM58 has a resonance at the typical singers harmonic range that the SM57 does not.

Condenser microphones function as a variable capacitor. The main difference between this kind of microphone and other microphones is that condenser microphones require an outside power source, called phantom power, to function. This is due to how they physically function. They diaphragm of a condenser microphones is one plate on a parallel-plate capacitor. Condenser microphones have power so that when the capacitance of the diaphragm with the backplate changes as the diaphragm vibrates, a signal is sent from the diaphragm in accordance to the sound hitting the microphone. These kinds of microphones are sonically better then dynamic microphones. They are more sensitive, so can pick up transients better, unlike dynamic microphones. Also, they have a higher frequency response due to the higher sensitivity because small vibrations are detected more readily. The issue with condenser microphones is that they are fragile and more expensive then dynamic microphones. There is also a kind of condenser microphone called an electret microphone, which has a permanent charge stored on it's backplate.

The third kind of microphone is a ribbon microphone. Ribbon microphones are considered high-end due to their delicacy, fidelity, and price tag. They capture sound by having a small magnetic, flexible ribbon move inside of a magnetic field. As the metal ribbon moves through the magnetic field a produces a signal in accordance to the sound that is vibrating it. The ribbon is very sensitive and produces a silky sound. As said before, they are also fragile and delicate. One of their main hazards is accidentally activating phantom power the microphone, which would cause the components inside it to fry. Ribbon microphones are fantastic, but they need to be treated with care.

2) Name and discuss the seven main stereo miking techniques mentioned in class. Please describe the types of microphones used (polar patterns), and how they are set up.

The seven different stereo miking techniques we talked about in class are AB, XY, ORTF, Decca Tree, NOS, Mid-Side, and Blumlein.

AB stereo miking is set up by having two of the same omnidirectional microphones set facing the sound source and positioned 3 to 30 feet away from each other. This creates a very natural sound and is one of the best ways of capturing reverb.

XY miking uses two cardioid microphones whose heads are set at 90 degrees and are as close to touching as possible. This is used to capture the sound source with less reverb than AB miking.

ORTF style miking is a French originated miking technique that was created to simulate what is heard by the human head. It consists of two cardioid microphones set 17 cm away from each other and at an angle of 110 degrees. This gives more hall sound then XY miking, but not as much as AB miking. This was used to record classical music for radio in France.

Decca Tree miking is a technique developed to represent what a conductor would hear as their orchestra plays around them. It consists of three omnidirectional microphones, though they can be replaced by cardioids. Their set up is interesting. Imagine a square, whose center is centered on the conductor and whose corners face forward and to the sides. The microphones are placed at the front three corners of the square as though the square had a diagonal of 3 meters. This technique creates an authentic conductor sound.

NOS is a Dutch technique developed for recording classical music, just in the same way that ORTF was developed for classical music. It consists of two cardioid microphones positioned 30 cm from each other and at an angle of 90 - 110 degrees. This sounds sonically different to the ORTF style miking because of the increased space between the microphones.

Mid-Side miking is different from the rest of the miking techniques because it uses two different kinds of microphones. This is needed because two different patterns are needed in order for this technique to work. It uses a figure-8 microphone and cardioid microphone set on top of each other, where the cardioid is facing the sound source and the figure- 8 is perpendicular. This technique needs some processing due to phasing issues in the figure-8 microphone. This is fixed by splitting the signal due to the figure-8 microphone and flipping the phase of one of the signals. The sound comes out to be very directional and captures little to no reverb from behind the cardioid microphone.

Blumlein miking uses two figure-8 microphones. They are set up 90 degrees and on top of each other, where their front sides are both towards the sound source. This gives the presence of a single omnidirectional microphone. This technique is reserved for recording with ribbon microphones.

All techniques that require two of the same kind of microphone also require that both microphones are the same model. For example, having to random cardioid microphone models in XY miking will not reproduce a faithful sound.

Bonus: An eighth kind of stereo miking technique is using the Neumann microphone that looks like a head, used to try and recreate what a human would hear.

A ninth technique is called the Jecklin Disc. It consists of two omnidirectional microphones set up like the NOS technique and has a disc in between the microphones to stop phasing issues.

3) Name the two types of EQ and describe how they are different. Also, define the following terms:

Bandwidth, Q, Cutoff Frequency, Crossover, Low Pass, Band Pass, High Pass

The two different kinds of EQ are Graphical EQ and Parametric EQ.

The Graphical EQ consists of many fixed band and Q band pass filters across the human hearing frequency spectrum. They only parameter that can be adjusted in Graphical EQs are the gain. This gives allows for a very smooth EQ curve if done correctly.

Parametric EQs allows for control of Q, frequency, and gain. They are great for being able to target specific frequency ranges and treating them precisely. Unfortunately, they usually are not as smooth of an EQ as Graphical EQs, which may cause certain frequencies to be boosted or lowered undesirably. They usually do not consist of as many band pass filters as Graphical EQs.

Bandwidth is the frequency range of a band pass filter. It is defined by the frequencies where the filtering is -3dB from the center frequency boost or dip. This is a component of band pass filters.

Q stands for quality factor. It is the ratio between the bandwidth and the center frequency. This is also a component of band pass filters.

Crossover is the phenomenon that occurs when two filters are used in conjunction and their affecting ranges overlap. Their overlapping effects essentially add up to one total effect.

A low pass filter is a kind of filter that harshly attenuates the highs of a signal. They have many parts to them. They have a cutoff frequency which defines where the filtering starts. They have a slope that is defined by their rate of attenuation. Finally, they have an order, which determines the steepness of a slope. An order for a low pass filter could be -48dB/octave, where signals with a frequency higher then the cutoff range will be attenuated -48dB every octave above the cutoff frequency. This order is popular in most Moog low pass filters.

High pass filters function just like low pass filters, except in reverse. They attenuate low frequencies as opposed to high frequencies. They have a cutoff, slope, and order, just like low pass filters do. Both low and high pass filters have a resonance at their cutoff frequencies, whose severities are determined by the order of the filter.

Band pass filters are filters that only affect a certain frequency range. They have a Q, as defined above, a center frequency, a bandwidth, as described above, and a gain value. The center frequency is the value that the filter lines up one. The gain of a band pass filter determines how much boost will occur at the center frequency.

4) Define the following terms in regards to compression:

Input Gain, Threshold, Attack, Release, Ratio, Knee, Output Gain.

Input gain is the gain that is used on a signal as it enters a compressor.

Threshold is the level that a signal needs to pass in order for a compressor to start affecting the dynamics of a signal. It is rated in decibels.

Attack is the time that a compressor takes to begin to affect a sounds dynamics after it has passed the threshold level.

Release is the time it takes for a compressor to stop affecting a sounds dynamics after the source sound has dropped below the threshold.

Ratio is defined as the ratio between the how many decibels past the threshold the compressed signal is at and how many decibels past the threshold the original signal is at.

Knee is the rate that a compressor kicks in. It affects how hard the compressor attenuates the original signal in accordance to the ratio. A hard knee would have the original signal be attenuated fast and as soon as the attack time is over. A soft knee would allow the signal to be attenuated slightly slower.

Output gain is the gain given to the compressed signal on the way out of the compressor. This gain gives the most noise out of any of the steps in a compressor.

5) Quick Questions

a) 343 meters per second
b) 20Hz – 20,000 Hz
c) 6 dB
d) 2500 Hz or 2.5 kHz
e) 60dBSPL

6) Sabine Equation Question

RT_{60} = .049 * (V/A) ; V = volume of room, A = Absorption

V = W*L*H = 16*30*12 = 5760

$A_{Ceiling}$ = (16*30) * ((.05 + .7)/2)
A_{floor} = (16*30) * .2
A_{walls} = (16*12) * ((.04+.7)/2) + 2*(30*12)*((.04 + .7))/2)
A_{brick} = (16*12)*.04

A_{total} = (16*12)*.04 + (16*30)*((.05+.7)/2) + (16*12)*((.04+.7)/2) + 2*(30*12)*((.04+.7)/2) + (30*16)*.2 = **621.12**

RT_{60} = .049* (5760/621.12) = .4544 seconds

7) 3 songs; their Recording Engineers; studio they were recorded in

alt-j – Tessellate; Charlie Andrew; Iguana Studio
Foo Fighters – Back & Forth; Butch Vig; Dave Grohl's Garage
My Chemical Romance – Welcome to the Black Parade; Rob Cavallo; El Dorado Recording Studios