Introduction to Music Production

Lesson 1: Sound and Signal Flow

#1 Arrival time of sound. So much of what we do in a mix is to create a sense of space, depth and a real location. All these ideas are based on the idea of **PROPAGATION**.

- **Propagation** - sounds moving through the air.
- **Amplitude** - Speed of Sound. (1k/3 sec; 340 m/sec; 1 ft/msec; 1km/3 sec; 1 mile/5 sec. (approximations)
- **Frequency / Timber**
- **Effect Categories effected in a Mix:** Delay, Reverb, Phasers, Flangers

#2 AMPLITUDE - The extent of the wave: how much the air compresses and rarifies (makes more complex) as the waveform propagates thru the air.

- **SOUND in AIR** - the direction of vibration is parallel (the same), as the direction of propagation.

SLINKY DEMO: Longitudinal Wave - push wave through without up and down waves.

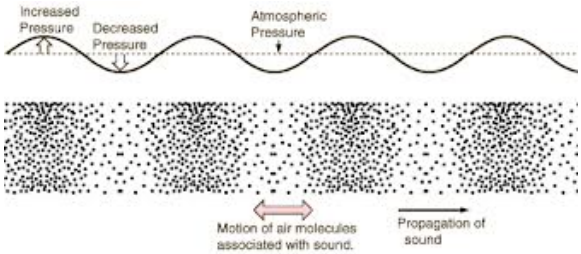
- The amount of compression is the amplitude. **A Transverse Wave:** Swing Slinky back and forth rigorously, high amplitude. Slowly, low amplitude. (Guitar String)
- **Longitudinal Wave (Air):** Push gently: low amplitude, push hard, big wave, high amplitude. It is a longetudinal rarifaction and it's moving in the same direction as the propagation.
- **Rarifaction** (less dense as the air moves by). **Compression** (more dense as the air moves by). The extent of that is our **Amplitude** (louder or quieter to our ears) is measured in decibels. (**dbspl-decibals sound pressure level**). It's a relative measure (no set point for 0). 0=Quietest to pain. Lowering: called Attenuation.
- Air is measured by dbspl (the lowest thing we can hear) 0 to PAIN.
- **Amplitude (measurable by a computer) or Loudness (our perception of amplitude): dbfs** (full scale) the loudest thing that can be represented in numbers within the computer. 0 is the LOUDEST, then negative from there. Amplitude is measureable by a COMPUTER, Loudness is our Human Perception of it.
- **Loudness: Duration** (how long) and **Frequency** (we hear high and lows differently).
- **Dynamic Plug Ins:** expanders, gates, compressors, limiters.
- **Dynamic Range of a Mic:** decibels it will reproduce to sound properly. **In Gear:** the range levels of the noise floor (quietest) up to distortion. **In Music** - range of quietest section to it's loudest.
- **Addition Look Ups—**Log Rhythms, Dynamic Range, Decibels, Fletcher Munson Curves, Equal Loudness.
- **Effects Categories in a mix:** Compressors, limiters, expanders and gates.

prop·a·ga·tion n.

1. Multiplication or increase, as by natural reproduction.

2. The process of spreading to a larger area or greater number; dissemination.

3. *Physics* The act or process of propagating, especially the process by which a disturbance, such as the motion of electro-magnetic or sound waves, is transmitted through a medium such as air or water.



Lesson 1, Con't: Sound and Signal Flow

FORUM: Useful Links for Sound:

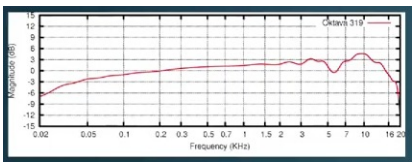
http://www.thefreedictionary.com/propagation
http://en.wikipedia.org/wiki/Sound#Propagation_of_sound
http://www.ndt-ed.org/EducationResources/CommunityCollege/Ultrasonics/Physics/modepropagation.htm

#3 FREQUENCY (measured on a computer). It's how FAST a sound is vibrating. Hertz is measure of frequency.

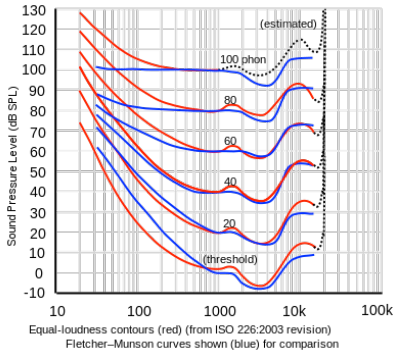
- Our sense of Hi and Low is Pitch. **Pitch** is something we **perceive, like Loudness.** Low - slow pulse, High - lots of pulses.
- **Transverse Wave:** Swing Slinky back and forth rigorously, high frequency. Slowly, low frequency.
- All the principals of sound are independent of each other.
- **Propagations:** are Delays and Reverbs.
- **Amplitude:** expanders, gates, compressors, limiters.
- **Frequency:** (more related to **Timbre** - collection of sound at multiple frequencies.) **Sine Wave -** energy at a Single Frequency; **Instruments** - Multiple Frequencies, i.e. Harmonics, Overtones, Spectrum, Timbre.
- **BOOST** (raise the amplitude) the **Bottom End** (Frequency). "EQ" - An Equalizer is a collection of filters. Amplitude at a specific frequency is a filter, and it's manipulating the timbre.
- **Range of Human Hearing:**

  Lowest = 20 Hertz
  Highest = 20,000 Hertz
  1 Hertz = 1/second

- We don't hear equally across the range.
- Frequency Response Curve Of your gear, acts like an EQ.



- Frequency and Timbre is important to everything we do.
- **Fletcher Munson Curves.** The first research on the topic of how the ear hears different frequencies at different levels was conducted by Fletcher and Munson in 1933. In 1937 they created the first equal-loudness curves.



Equal-loudness contours (red) (from ISO 226:2003 revision)
Fletcher–Munson curves shown (blue) for comparison

- **LOOKUP**
  Sound masking: addition of natural or artificial sound (white noise or pink noise) into an environment to cover up unwanted sound by using auditory masking.
- A sound is said to have a **missing fundamental**, **suppressed fundamental**, or **PHANTOM FUNDAMENTAL** when its overtones suggest a fundamental frequency but the sound lacks a component at the fundamental frequency itself. The brain perceives the pitch of a tone not only by its fundamental frequency, but also by the periodicity implied by the relationship between the higher harmonics; we may perceive the same pitch (perhaps with a different timbre) even if the fundamental frequency is missing from a tone.
- **FREQUENCY RESPONSE:** is the quantitative measure of the output spectrum of a system or device in response to a stimulus, and is used to characterize the dynamics of the system. It is a measure of magnitude and phase of the output as a function of frequency, in comparison to the input.
- **TIMBRE (overtones, relative levels of partials in a sound):** is the quality of a musical note or sound or tone that distinguishes different types of sound production, such as voices and musical instruments, string instruments, wind instruments, and percussion instruments. The physical characteristics of sound that determine the perception of timbre include spectrum and envelope. Timbre is what makes a particular musical sound different from another, even when they have the same pitch and loudness.
- **Manipulates Timber & Spectrum:** Filter Effects.

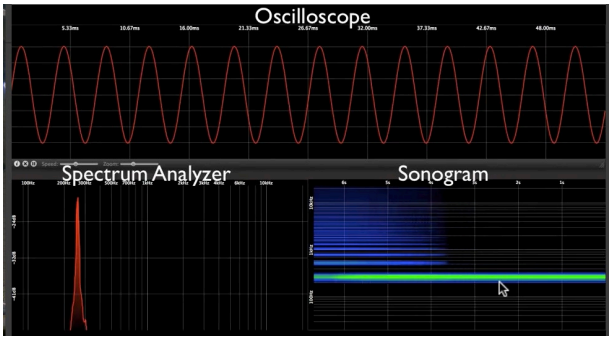
Lesson 1, Con't: Sound and Signal Flow - http://www.independentrecording.net/irn/resources/freqchart/main_display.htm

FORUM: Useful Links for Visualizing Sound

A previous students explanation of propagation, amplitude, frequency and timbre:
http://www.youtube.com/watch?v=bbT8TN-jKXI
Visual demonstration of a concept we've all heard before relating to frequency and pitch.
http://www.youtube.com/watch?v=ngk-ECb8ccQ
Awesome Frequency Chart: http://www.independentrecording.net/irn/resources/freqchart/main_display.htm

#4 VISUALIZING SOUND

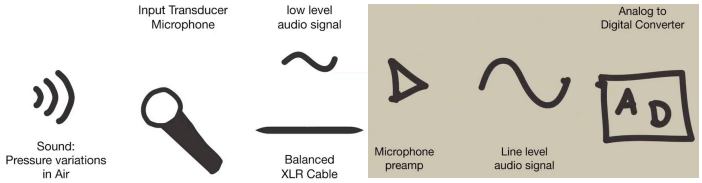
3 Different types displays to give us a good visual representation in visualizing sound.

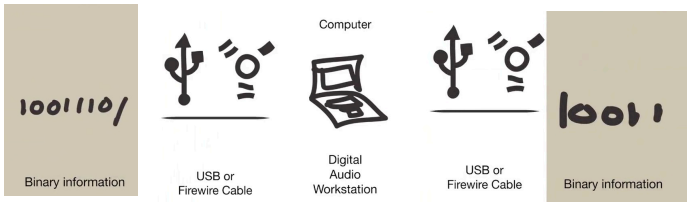


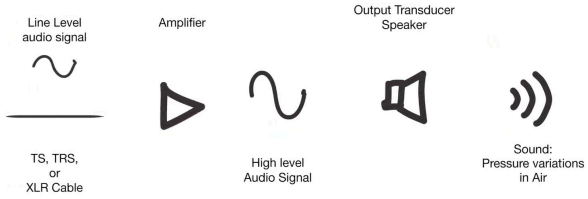
- **OSCILLOSCOPE:** (like a wave form in a DAW) Microscopic view of the audio track. See how pressure varies in the air. Vertically (Y) is **Amplitude** and Horizontally (X) is **Time**. (Hard to see the frequency and timbre of the sounds.) Accurate representation of the speakers movement. Amplitude changes the wave but not the frequency. Timbre change shows how much the sound is changed.
- **SPECTRUM ANALYZER:** We see where the EXACT frequency it is at ... Horizontal (X) — **Frequency** and Vertically (Y) — **Amplitude.** Can tell that sound has a lot of energy at 2k, or 500 hz, etc. It doesn't give us a sense of how the sound will change over time. Momentary picture. **Spectrogram Analysis** gives us the sound changes over time. Timbre is shown as a series of peeks. Octave changes as frequency. Sawtooth Wave - harmonic series: 1st-Fundamental - Each frequency is at an integer multiples of the fundamental frequency. (You will often see a spectrum analyzer in the EQ. The role of the EQ is to manipulate the timbre-relative levels of the partials.
- **SONOGRAM:** Changes over time. (like a Spectrum Analyzer flipped on it's side) **Y-Frequency** is vertical, **X-Time** is Horizontal. **Z-Amplitude. Changing Amplitude:** Gives us a history of the how the timbre and the spectrum have changed. Change the Timbre (converting to saw tooth wave): additional harmonics are shown and how they change over time.
- **Vowel Sounds:** AEIOU: Sonogram: Fundamental Frequency is the basic C plus upper harmonics, variations in pitch is shown as changing frequencies. The mouth is a complex filter (EQ). vowel Sounds are primarily variations of Spectrum.
- **Oscillator** (a Sound Creator).
- **Rarefied:** Less Dense than atmospheric pressure.

#5 CONNECTIONS OVERVIEW

- **Signal Flow - Mic to Computer:** Mic (Input Transducer)Audio Interface: Mic Preamp, Analog to Digital Converter, then to computer and to the DAW.







#6 Mic as a Transducer

- Changes **sound** variations to **voltage** variations. Mics will color the signal in SOME way. Looking at SM58, AKG 414 Condenser: Type, Polar Pattern & Frequency Response to see how to place them when recording common signals.

Lesson 1, Con't: Sound and Signal Flow

#7 Mic Types

- **Condenser** — In Studio. So sensitive you can get feedback loop if used live. Phantom Power or +48 Volts. Med to Large Diaphragm is good one to get started with.

- **Dynamic** — On Stage because it doesn't pick up outside of it's small area very well. It's rugged. Does not require external power.
- **Acoustics of the room and the mic placement has a much bigger impact than the mic.**

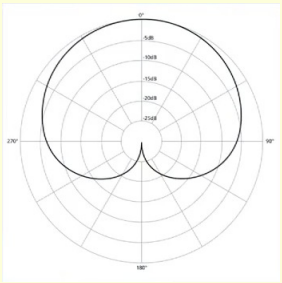
#8 Mic Frequency Response

- **Vocal Range Mic (SM58)** — Freq Response Chart comes with any mic. This has a peek at 5,000 hz which helps voice come in well.
- **Condenser Mic**-Picks up EVERYTHING Range. Flat Frequency Response. Picks up everything equally. "What you hear is what you get."

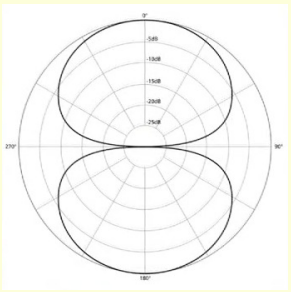
#9 Mic Polar Patterns

- **Polar Pattern -** Describes what it picks up well and what it rejects.
- Always remember when recording the choice of a polar pattern will have a major impact on how much of the space or the room that you are actually capturing.

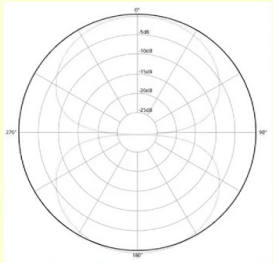
- **Cardiod Pattern (plus different styles of this pattern).**



- **Figure 8**



- **Omnidirectional**



- Decide if you want to capture more of the space or the instrument.
- Some mics lets you choose the pattern with a switch, but it also changes the frequency response.

#10 Mic Placement

- **Placement is the Most Important in Recording.**
- **General Guideline:** Microphones are your ears in the studio. Walk around and listen. Notice how it sounds different when you move around.
- Front Addressed (SM58) and Side Addressed (AKG414). Point the Logo at the item you are recording.

#11 Line Level and Gain Staging

- There are 2 standard line levels: +4 Studio Level and -10 Consumer Level. Ideally you want to bring it up ONCE and leave it there.
- TRIM: **U stands for Unity** - you are not amplifying or attenuating (bringing up or down).
- **Mic Preamp:** Brings it up the the standard line level.
- The worse thing you can do in your signal flow is applify it at one point, then attenuate it at another, then amplify it again. Keep it at Line Level during the entire signal
flow.

Lesson 1, Con't: Sound and Signal Flow

#12 Cables

- Get high quality cables!
- **1/4" Cable:** also known as an instrument cable or a **TS** Cable. **Tip and Sleeve**, single conductor cable, outer sleeves prevents noise. Use as short a cable as possible.
- **1/4**: **TRS** Cable. **Tip Ring and Sleeve** or Stereo Cable.
- **XLR Cable:** Has 3 connectors like TRS. Only used in a balanced configuration. Use these if you need a LONG cable runs (or Balanced type cable)
- **Direct Box: IN**put TS for as a short run and out to XLR for a long run. Has a parallel output.
- **1/8":** Same as the TRS but smaller.
- **RCA:** Functions just like a 1/4" cable.

#13 Interface

- Audio Interface: MOTU - all inputs need to be TRS, Midi Input and Output, Digital Signal in and out, Firewire is good for recording multiple inputs, USB for a few at a time.
- Provides ins and outs, XLR-Mic PreAmp (Trim or Gain), 48 (Phantom Power), PAD is Attenuation (reduces the level of the signal) and headphone output.
- Functions also as an analog to digital converter.

#14 Mic Connection & Gain

- Avoid the sound of making the connection from going through your computer.
- **Connection:** Reduce the input gain all the way down on the Interface. But does not guarantee no sound will come though tho.
- Turn off Phantom Power OFF.
- XLR Cable: MIC is MALE.
- Turn ON Phantom Power.
- **Level:** Set the Level where we want it to be in our final recording. Find the loudest piece you will be in the music.
- Never let it go into the red or get the very top. Better off to keep it a little bit lower.
- **Disconnection:** Turn off the output volume (monitors); mic gain down, then turn off phantom power.

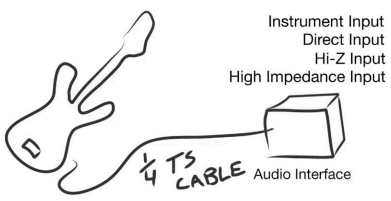
#15 Analog to Digital Converter

- Signal from Mic - analog or continuous signal. Preamp is also an a digital converter, also called a quantization or sampling. Sampling is taking the smallest pieces of audio so we can represent it in 1s and 0s.

#16 Pickup Connections

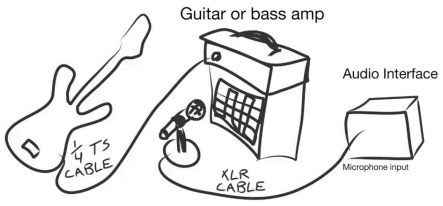
- Connecting a guitar/bass:

Pickup option 1



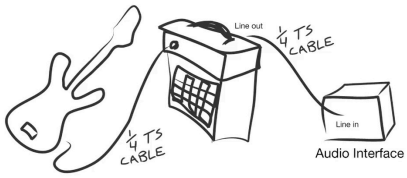
- Turn TRIM all the way down as well as the speakers. Connect bass to the device, make sure it is an Instrument connection.
- There can be a little of a delay (or latency) from bass or electric guitar coming from the speakers opposed to "in the air" as an acoustic guitar.
- Need to monitor these the signal (playback) outside of the computer. Plug into an amp then into the interface: Using a mic you get the sound of the room:

Pickup option 2



- Recording with a LINE OUT from the amp into your interface (you'll hear it in real time):

Pickup option 3



- If no line out, you can use a DIRECT BOX - using a SHORT 1/4" instrument cable to LONG XLR direct to your interface (gets impedance correct). Then input direct to your amplifier from the direct box. Preferred Method, OR:

Pickup option 5