

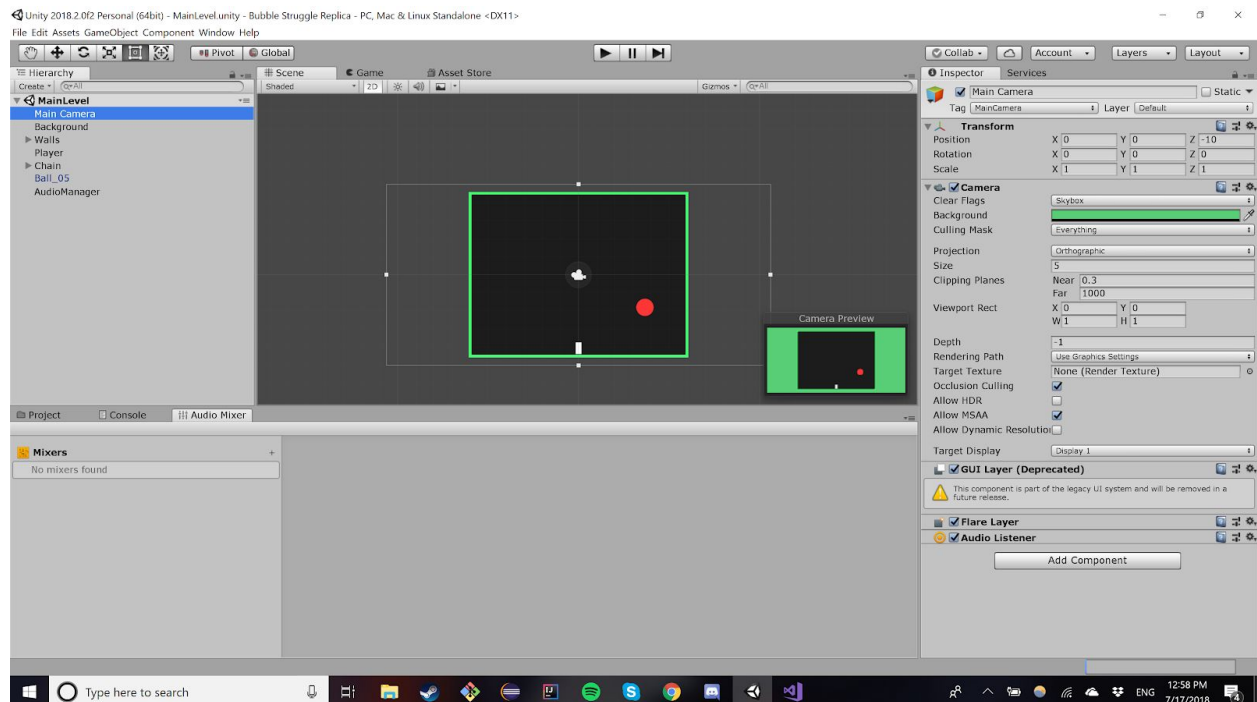
Audio Lab

Anything in **purple** is considered important notes for audio related things, but not required for the lab. However, it is good knowledge to have when using audio. Anything in **bold** is important.

Lab Start

Learning audio can be a confusing roller coaster of emotions, much like life at Cal, so hopefully this lab can help you through tumultuous times. There will be no coding, but feel free to look at the code and use the Audiomanager I created with the help of Brakeys. Anyways, let's start.

In the hierarchy, click on the **Main Camera** first.



In the Inspector, there is a Component called the **Audio Listener**. Think of this as the ears that are going to be listening to what we make. **There can only be one Audio Listener in any scene.** Usually when a scene is created the main camera will contain the Audio Listener, so don't worry about this too much.

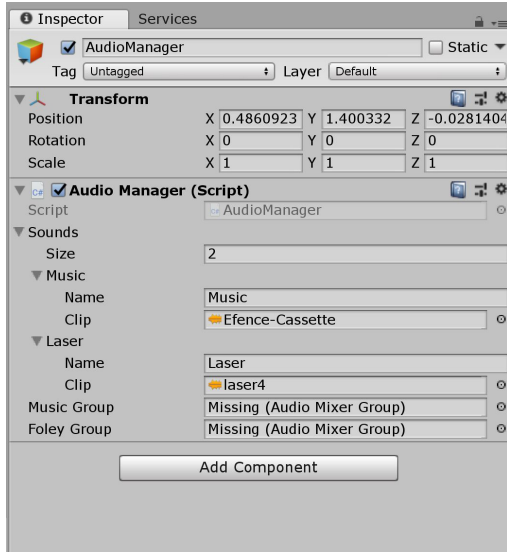
The AudioManager

If you play the current game, there should be no audio of any kind. Playing a game without sound is about as fun as eating only the tortilla of a taco, so let's fix this.

In the hierarchy, click on **AudioManager**, and the following image should pop up.



Edit the size to be 2. Name the first element **“Music”** exactly, and the second to **“Laser”** exactly. After doing so, choose the clip “Efence - Cassette” for Music and “laser4” for Laser. The result should look like the image below.



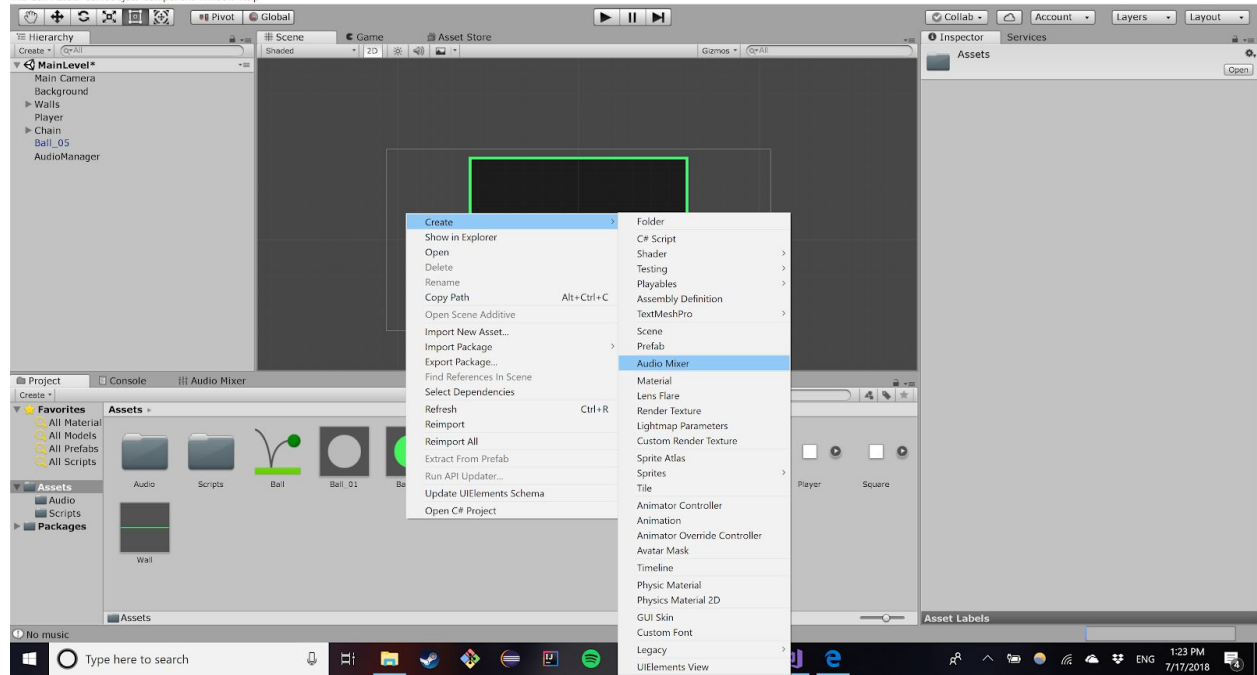
Clips are the actual audio that are going to be played, like songs or explosion noises. However, we need speakers, or **Audio Sources**, to play the clips. **Our AudioManager automatically adds Audio Sources so there is no need to add any manually.** But please, keep in mind that audio sources are 100% needed when you are making any game in order to play sounds of any kind.

Some people choose to add Audio Sources on game objects themselves, like “Dying Noise” on the “Cal Player”, and then play them when an event is triggered. This is a valid approach as well, however, I often choose to use an AudioManager because when you have a lot of sounds, it gets messy adding a bunch of Audio Sources on a single game object. Audio Managers allow us to add a myriad of sounds easily and game objects that need these sounds only need one line of code to call and play them. This is seen in line 29 of the Chain script.

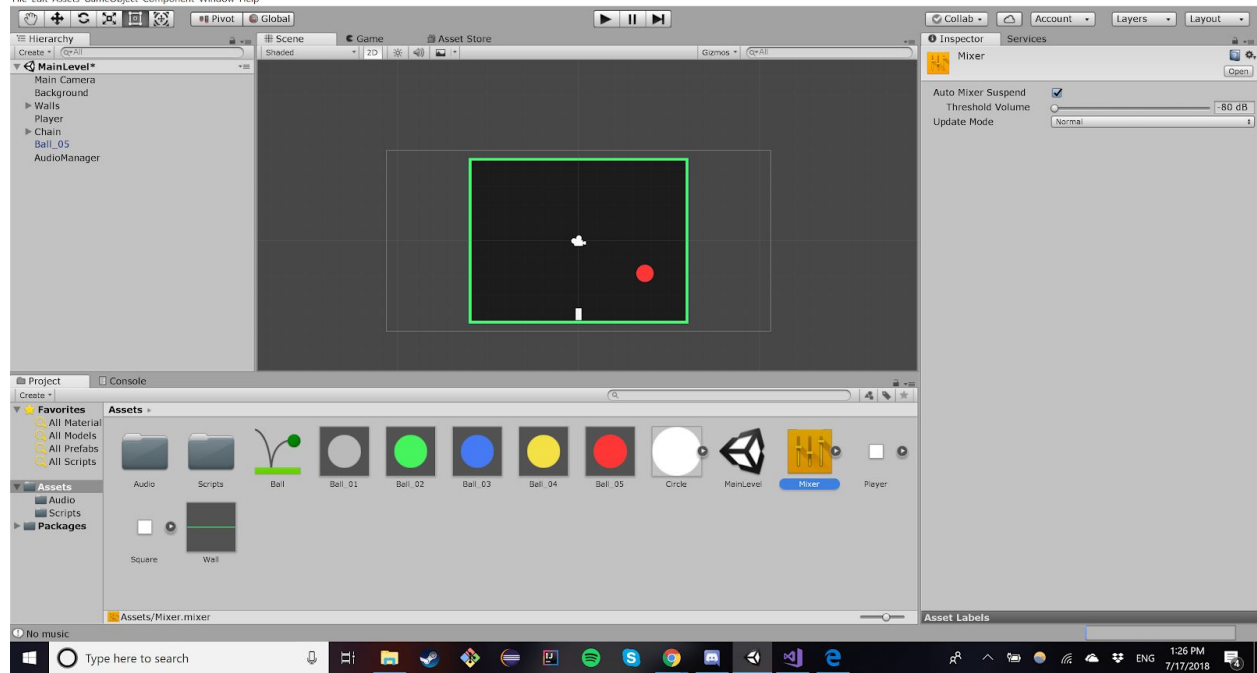
The Mixer

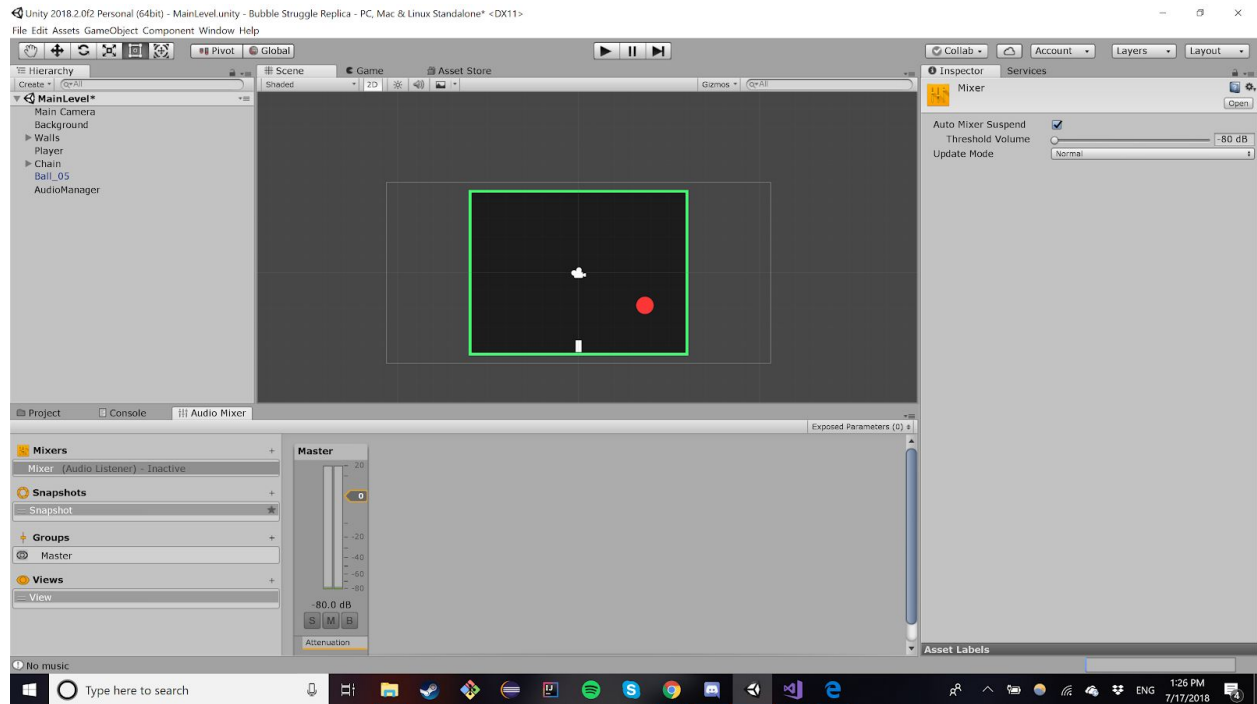
Now that we have added some sounds in the AudioManager, we need a mixer to play with our audio. In the assets folder, (*heh heh assets*), right click and go to “Create”, then go and click on “**Audio Mixer**”. This will create a new mixer, name it to “Mixer” and double click it to open the Audio Mixer tab. Pictures to help guide you are below.

Unity 2018.2.0f2 Personal (64bit) - MainLevel.unity - Bubble Struggle Replica - PC, Mac & Linux Standalone* <DX11>
File Edit Assets GameObject Component Window Help



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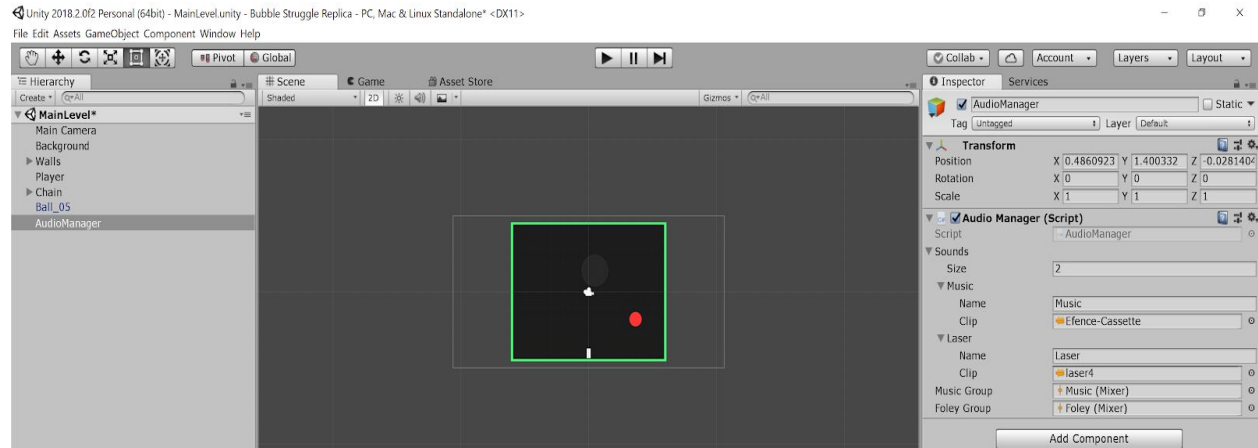




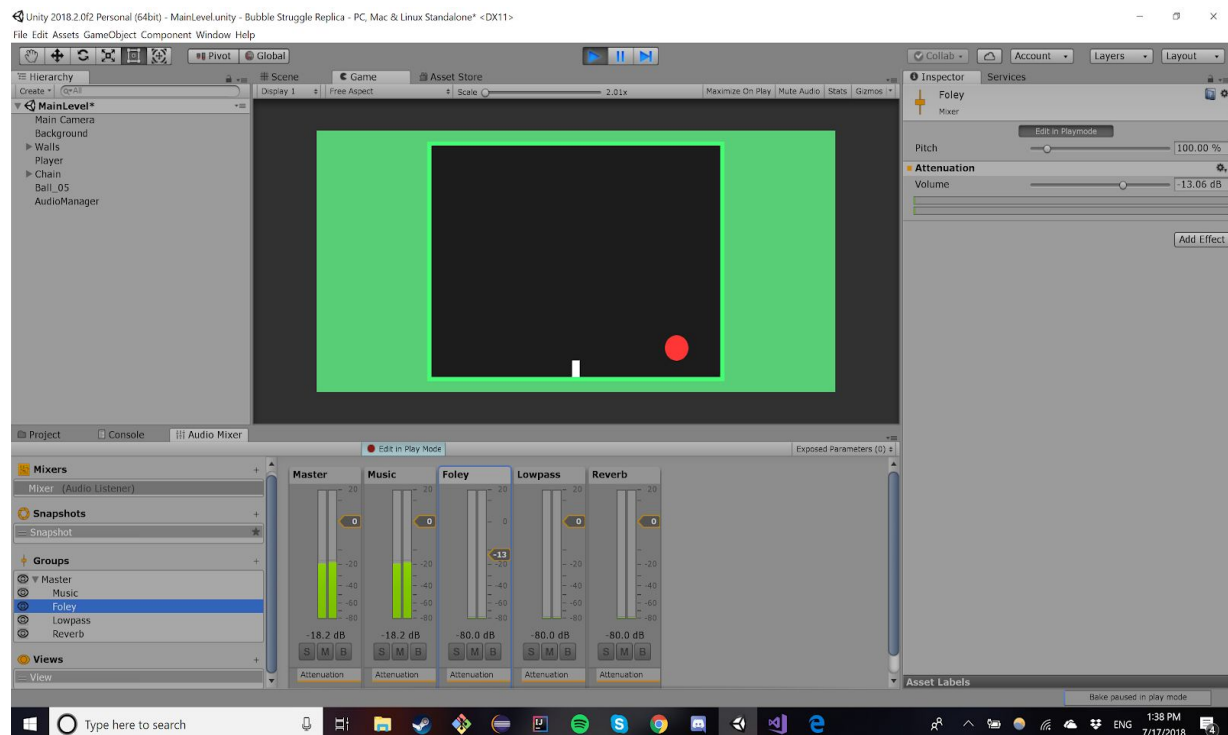
Unlike the networking events of the same name, **Mixers** are how we modify and change audio signals, and there are a bunch of cool effects we are going to go over today. First, go down to where it says “**Groups**” and right click on “**Master**”. It should say to “**Add Child group**”. Repeat this step 3 more times so you have 4 child groups of the master. Name them “**Music**”, “**Foley**”, “**Lowpass**”, and “**Reverb**” accordingly.



Now, click on AudioManager in the hierarchy and in the Inspector, choose the Music Group to be the Music (Mixer) you have just created, and for the Foley Group choose the Foley (Mixer).



What we have done is route the Audio Sources to be played out of these Mixer Groups. Play the game. Make sure you don't maximize on play so we can see the Audio Mixer tab. Click on "Edit in Play Mode" and here we can adjust the mixer groups. If you click on the "Music" group, you can raise and lower the volume of the background music. If you click on the "Foley" group, you can raise and lower the volume of the laser - You hear the laser by clicking on the laser in the scene. You can also adjust mixers by clicking on them and looking in the inspector.

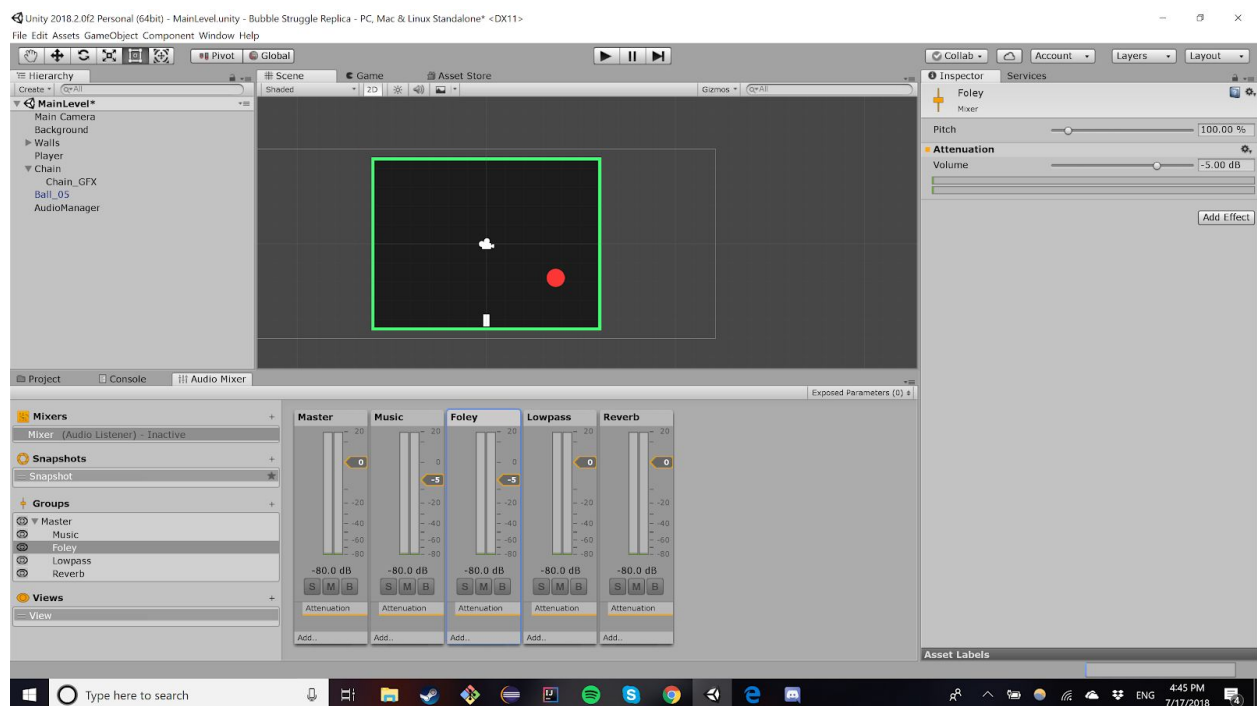


Now, since the "Music" and "Foley" groups are children to the "Master" group, they become slaves to this group, meaning that whenever you adjust "Master" it adjusts these groups (known

as either a master/slave or primary/replica model). However, when you adjust these groups, the “Master” remains unaffected. So even if you set the children's' volumes at max, if the “Master” is super low the overall audio will be quiet.

IMPORTANT: Whatever changes you make to the mixer groups, whether in play mode or not, are saved and will stay that way until you change it again.

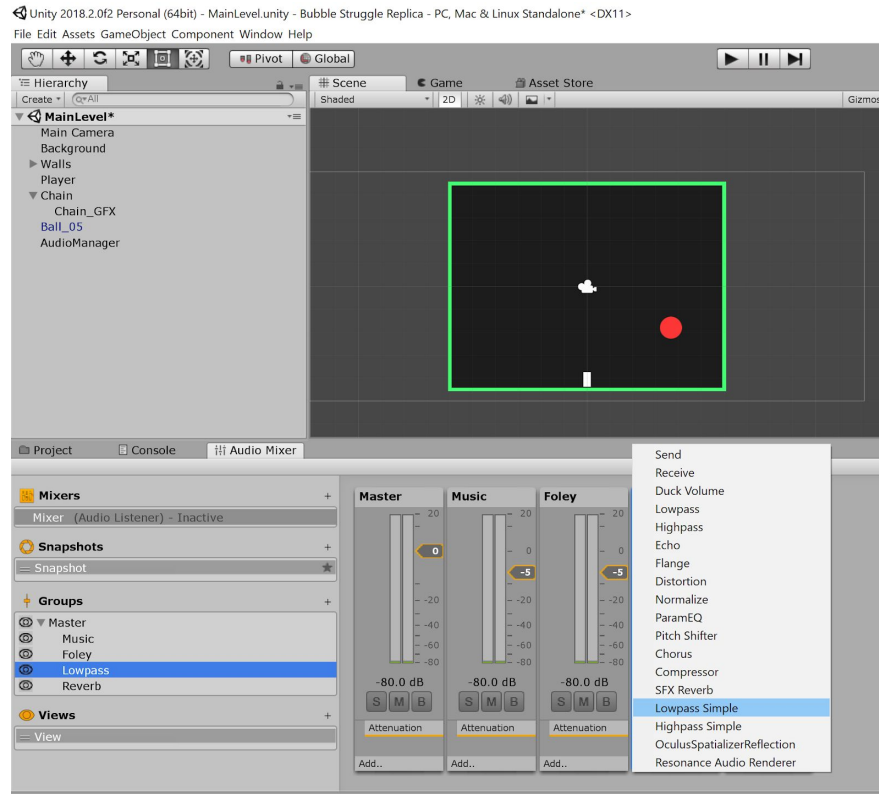
The audio for the laser and music is loud, so set this foley to -5 db and the music group to -5 db as well. Stop playing the game.



Send And Receive: Lowpass

Alright, so now we are going to apply effects to our audio. We can add effects directly onto “Music” or “Foley”, but if we ever want a general effect on many things, it is better it have separate groups that apply effects; this is why we have the “**Lowpass**” and “**Reverb**” groups.

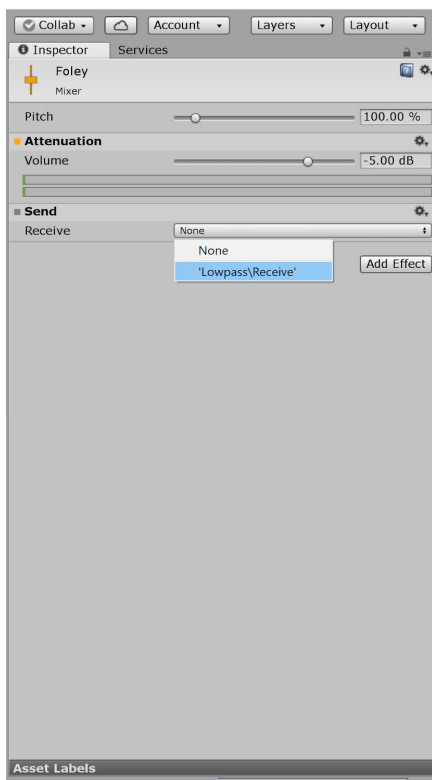
Let’s set up the “Lowpass” effect first. Click on the “Lowpass” group and click the “Add” button at the bottom. Click and add “**Lowpass Simple**”.



Drag the “Lowpass Simple” so it’s right below “Attenuation”. Important note, **effects at the top of each group are applied before those below them.**

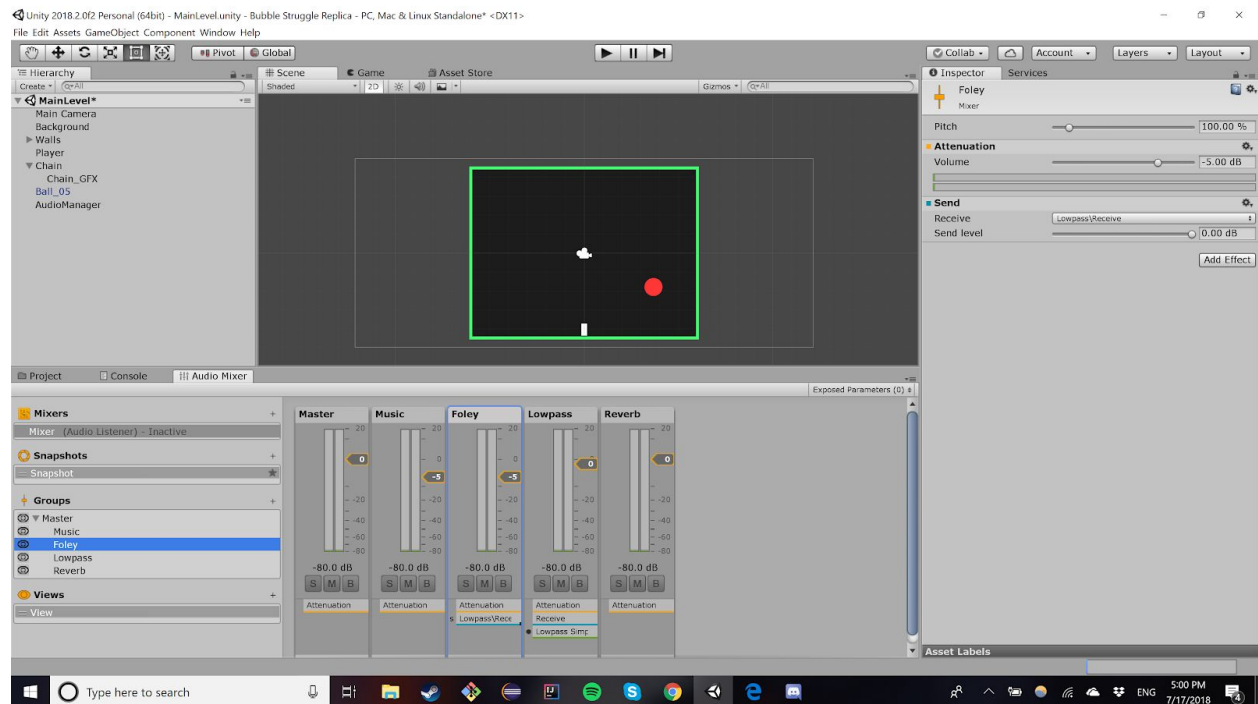
So whenever you add effects, attenuation will probably be first, or at the top and “receive” will be right below it. The “send” will come after the attenuation, as we will see below. **Attenuation** is the amount of signal loss something goes through before being outputted. When you adjust the “volume” on the mixers, it is actually the amount of attenuation, with 0 db being no signal loss and -80 db being complete signal loss.

Now let us add a “Send” and “Receive” to our mixer groups. On the “Foley” mixer, click add and select “Send”. Drag this so it is right below attenuation. On the “Lowpass” mixer, add a “Receive” and put it right after attenuation. Select “Foley” and in the Inspector for “Send” choose the “Receive” to be “Lowpass\Receive”.

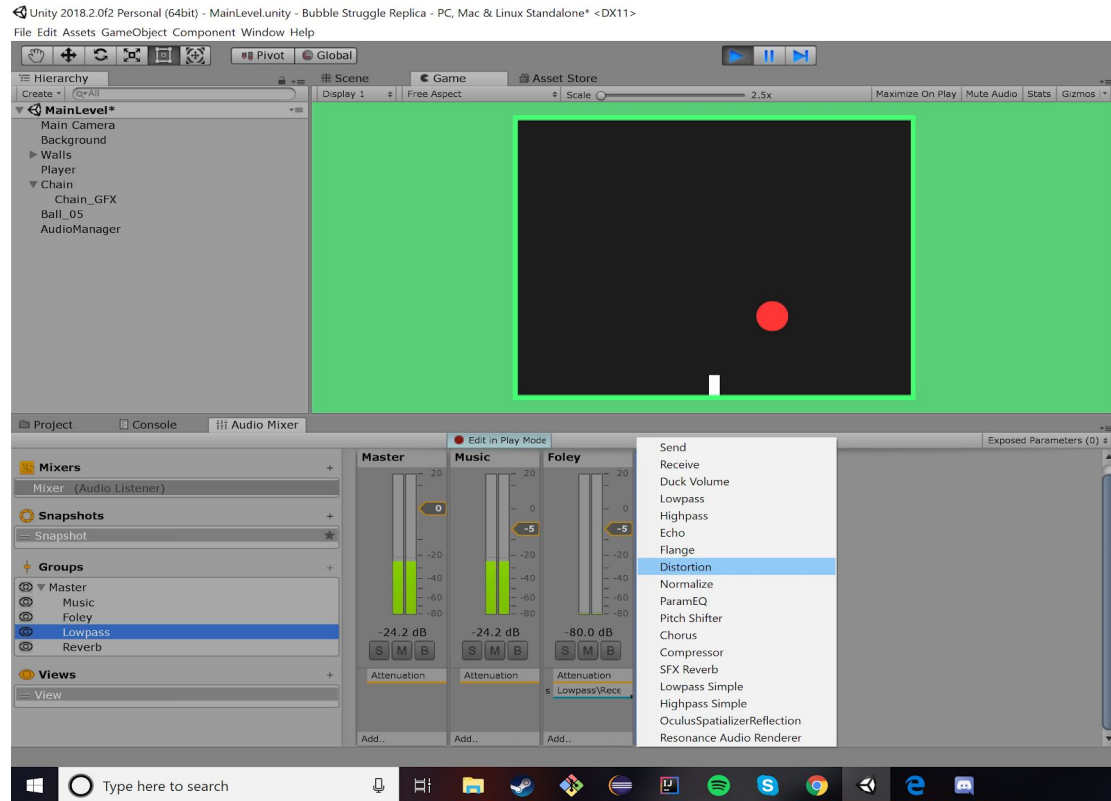


For this next part, please make sure the attenuation of the “Master” is 0, and that the other groups do not exceed 0 db. So, a **“Lowpass Simple” filter is a filter that attenuates higher frequencies, meaning it cuts them out or makes them decay quickly.**

Go over to “Foley”, and make sure the **Send Level** is 0, all the way to the right. The **Send Level** is the amount of the signal that goes through the send, so if it is at -80, then it doesn’t pass through the “Lowpass Simple” mixer at all and at 0 db it completely goes through.



Play the game. Press spacebar or left click in game to hear how the laser sounds because we are going to change it. Click on “Edit in Play Mode” again, and actually press the M below the “Music” mixer to mute it while we work with the laser, OR press the S on the Foley group to solo it. Go over to the “Lowpass Simple” filter. Set the cutoff frequency all the way to the right, you should hear a slight difference. Well that’s cool, but I want to change my laser to be a slightly more zappy sound. Click add in the “Lowpass” mixer, and click “Distortion”. Make sure it is right beneath “Lowpass Simple”.

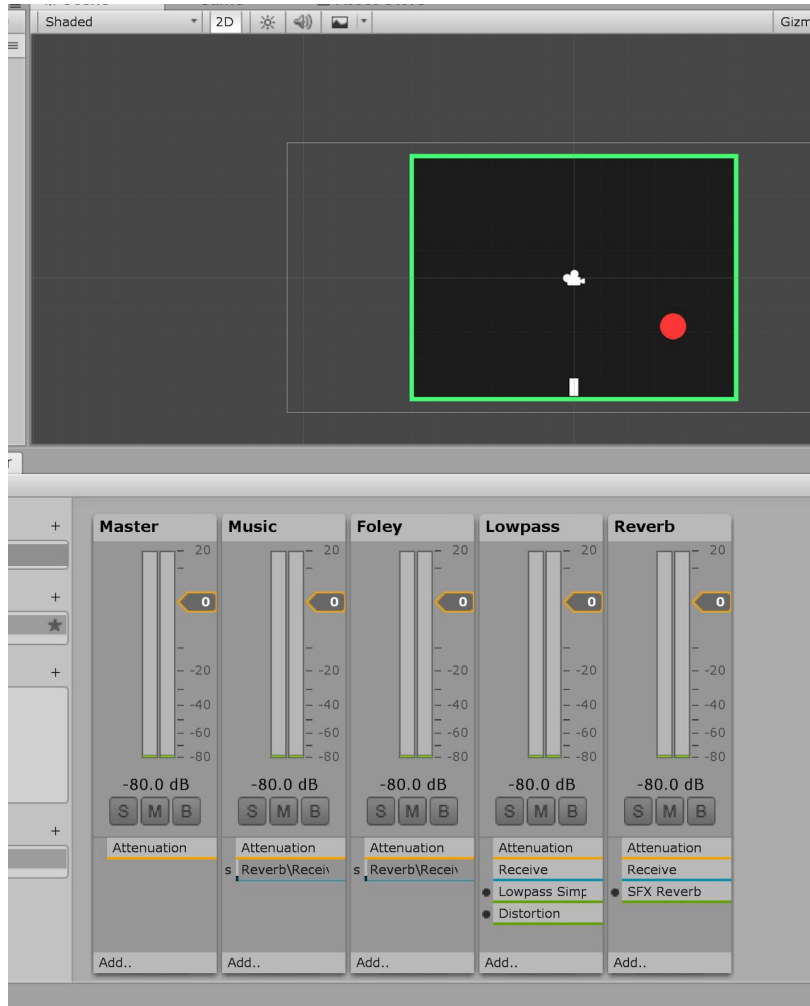


Set the distortion level to 0.95. Now you should hear a more “zappy” laser, as long as send level and cutoff frequency are all the way right. If you wanna hear what it is like without effects, press the B below the “Lowpass” mixer to bypass any effects you apply to a sound. **Make sure you unmute the music/unsolo the Foley and don’t bypass the “Lowpass” mixer, do the last step by making sure the B is not highlighted.** Unplay the game now.

What we have done is this. The lowpass filter causes a cutoff for certain frequencies, but by setting it so high it tries to capture a larger range and actually mutates the clip slightly at higher frequencies. Notice how if you put the frequency at its lowest, the sound goes back to normal when you press spacebar or left click in game. Next, the distortion level takes the signal and increases its gain, or power from input to output, and thus creates either a “fuzzy, growling, or gritty tone” (Wikipedia).

Send and Receive: Reverb

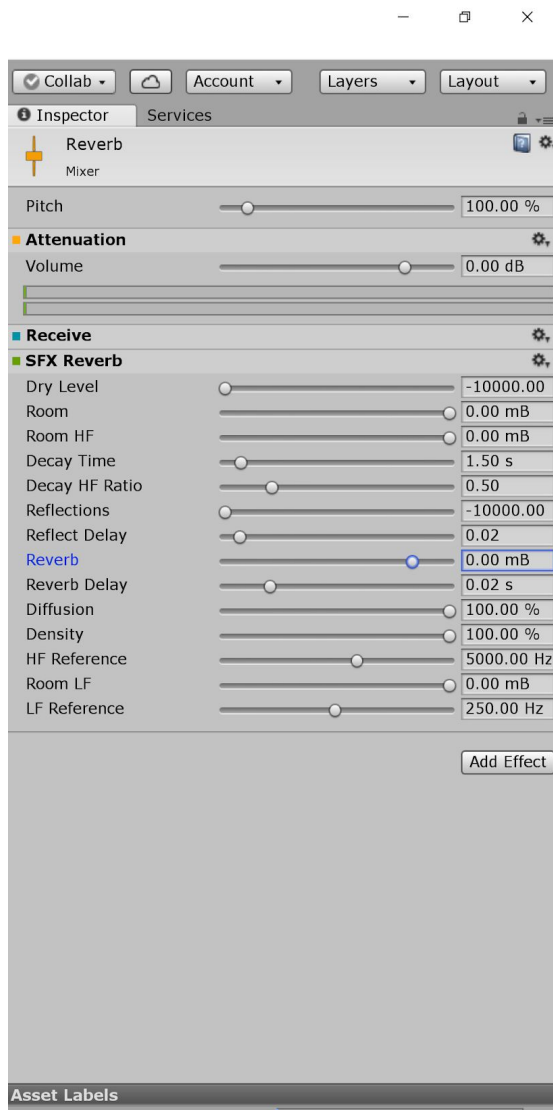
Now, let us do the same for the “**Reverb**” mixer. Click on the “Reverb” mixer and set up a “Receive” on it, as well as adding “SFX Reverb”. Reroute the “Send” on the “Foley” mixer to go to the “Reverb” mixer. Add a “Send” on the “Music” mixer that routes to the “Reverb” mixer. When you complete these steps, it should look like the picture below.



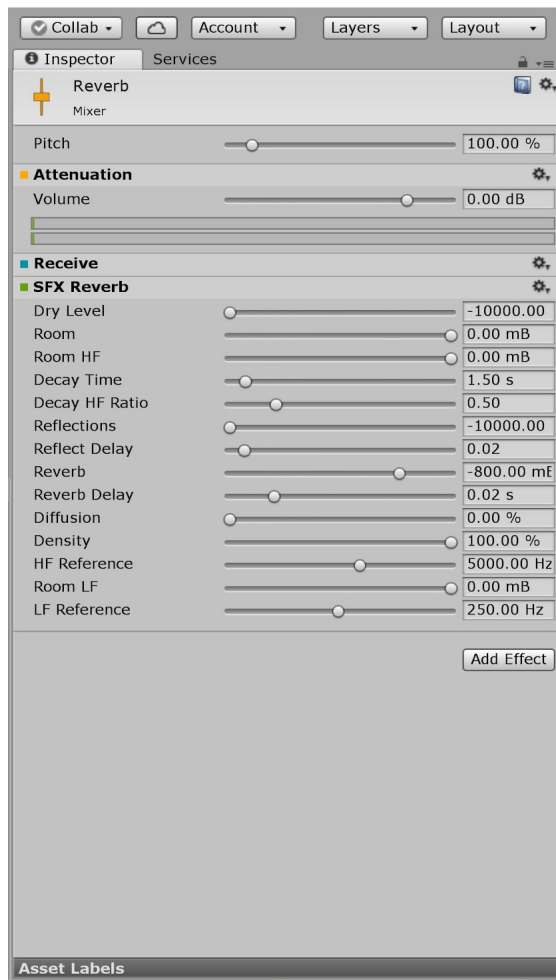
Reverb is one of many cool and diverse effects that can make your sounds seem like they are playing in a large room, playing beyond a wall between the listener and source, etc. Keep in mind **SFX Reverb and other intensive effects can slow down performance**. There are a lot of different traits on the “SFX Reverb”, but don’t be scared, I’ll explain as we go along.

First, make sure that both the “Music” and “Foley” groups have their “Send” levels all the way to the right at 0 dB. For now, let’s mute the “Music” mixer by pressing the M, or by pressing S on the laser, so we can focus on our laser. Play the scene, and click the “Edit on Play Mode”.

First, make sure the **Dry Level** is all the way to the left. Put **Room** all the way to the right, up the **Decay Time** to 1.5 seconds, and **Reverb Delay** to 0.02.

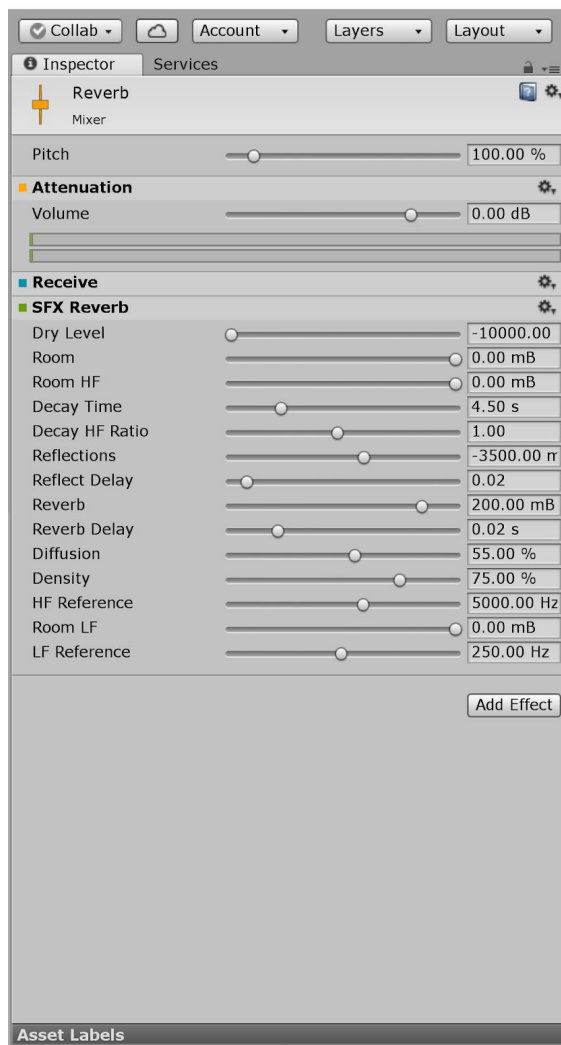


When you fire the laser, it should almost sound like it going through a well or tunnel. This is pretty cool, but now set the **Diffusion** to 0 percent and the **Reverb** to -800.



Now when you shoot, it has an undulating sound that makes it sound like some cool space laser. Now that is as cool as ice folks. Let's mute the "Foley" for now and unmute "Music" to really show you the power of SFX Reverb.

Play the scene again, as in restart the game, so the music starts from the beginning. Set the settings on reverb to the same as those below (make sure "Send" level is 0).



Now, the music sounds like it's playing in a large, empty, acoustic room like the Walt Disney Concert Hall or the Sydney Opera House. Below in purple is an explanation for the various effects and parts of reverb as well as general audio stuff. Check below it for the checkoff list. Feel free to read any of this lab or reference it in the future. Other than that, congratulations! You are now a God-like expert on audio and sound design.

Now you may be thinking, what in the guacamole just happened with SFX Reverb. This is an explanation on stuff, and most of it will just be a list of audio terms and their meanings, kinda like vocab cards.

What I did in the very beginning, was lower the **Dry Level**. “Dry” is the original, unaltered sound. “Wet” is the altered sound. So setting the Dry Level at its lowest means that only the wet signal is occurring when you hear the final audio.

Next, I put **Room** all the way up. Think of Room as the size of the room you are playing in. Right is a bigger room effect on your audio, meaning it sounds “roomier”, like a larger room. The same goes for **Room HF**, but just at high frequencies, and with **Room LF**, but at low frequencies. Notice that Room HF can affect all sounds though, when you play the music and turn this all the left down, or left, the effect is gone. This is why **Decay** also has a HF part.

Decay Time is how long it takes for a noise to completely disappear. So if I play a note on the piano, and my decay time was 4 seconds, after 4 seconds it is gone completely. The **Decay HF Ratio** is how quickly the sound dies. A note may decay in 2 minutes, but if my decay ratio is super small (all the way left), it will go from a super strong sound to super weak very fast so it’s basically unnoticeable and just seems to die immediately.

Reflections are exactly what they sound like. The official definition is “Early reflections level relative to room effect”. This means how a sound is reflected based on the room. A higher level means that the noise is almost directly reflected back to you.

Reverb is the amount of reverberations that any sound produces. So if I have one note, and the reverb is at its highest, it will reverb and bounce a million times. Think of a reverberation as an echo of the audio, and a reflection as a copy at a different pitch (volume) with slightly different key (like C on a piano versus D). This is inaccurate, but works for practical design.

Diffusion is how well a reverb spreads in a room. With 0 percent, the reverb doesn’t spread at all from the source and at 100 percent, the whole room has reverberations that reach it.

Density is how much of the reverberation makes it to a listener. If the diffusion is at 50 percent and the density is at 100 percent, the halfway point of the room will get the full reverb and the complete sound. However, if the density is at 50 percent, then the audio itself will be spread out and harder to understand at the same “distance”. At these same settings, the halfway point of the room will hear the audio, but most of it would just be noise instead of music.

HFReference and **LFReference** are reference levels. “Reference level simply means that a recognized signal will be produced at a certain volume level at the seating position / microphone position”. Google was not very helpful here, but hopefully musicians and sound designers can tell you more.

General Terms

Send level - Amount of audio that is affected by effect

Dry level - Amount of audio that is duplicated

Attenuation - Amount of signal loss in audio

Solo - Only hear this mixer

Mute - Mute mixer

Bypass - Bypass any applied effects on mixer

Ducking - Control one audio's output based on output of another

Threshold - Volume you have to exceed to apply an effect

Send and receive - Where to output audio in order to apply effects

Distortion - Increase gain, producing a fuzzy, growling, or gritty tone (Wikipedia)

Checkoff List

- 1. Play the laser as it goes into the “Lowpass” mixer**
- 2. Play the laser and music as they go through the “Reverb” mixer**
- 3. Show us you can solo groups, mute groups, and bypass sounds**