"The ABC's of Audio Engineering"

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A. Signal Flow
B. Signal To Noise Ratio
C. Artistic Applications of Mixing Audio Elements

A. Signal Flow:

In order to effectively operate a sound system, it's necessary to understand the signal flow. First, it's important to understand that the signal always has a direction. There is always a signal going from something to something. The signal is always in the form of either sound waves or electronic waves. So, in the case of a vocalist, sound waves come from the singer into a microphone, get converted into electronic waves, routed through the sound system, and then come out the speakers again as sound waves. The list below explains in more detail how these signals get adjusted, affected, split apart, mixed together, and simultaneously routed to several different locations.

Signal Sources:
Microphones, Keyboards, Guitars, etc... go into the
Snake (Some Snakes are also splitters & can route the signals to 2 or more mixers)
Snake channels go into the
Mixer Channel Input Jacks
Input jacks then go to the
Gain or Trim Controls: Adjusts the level of the input signals first. (Use the "Solo" or "PFL" pre-fader-listen buttons to adjust the levels of each channel to obtain a good signal-to-noise ratio, discussed below.
After Gain or Trim, the audio signal goes to the
Pre Aux Sends, then to the **Aux Send Master,** which can go out to an **Amp & Monitor Speakers On Stage,** or a **Recording Device,** or an **Effects Device,** and then back to an **Aux Return or Open Channel**
The Pre Aux Sends for each channel, and the Aux Send Master create a mix that goes out the Aux Send jack before going through any other controls, hence "Pre Auxiliary Send", meaning before any other controls, and not affected by any other controls after this point in the signal chain. Pre sends usually go to on-stage monitors, but can also go to recording devices and effects units. In the case of an effects device, you would then send the output of the device back into the mixer via the aux return jack, or any open input channel.
After the audio signal goes through the Pre Aux Sends, it then goes into the
Equalization Section, or E.Q.
These controls can boost or cut the treble, bass, and midrange frequencies as desired.

Some mixers have a feature which will allow you to not only boost or cut the treble, bass & midrange, but also select the frequency that you will be cutting or boosting. A low cut button is also sometimes used to cut out lower frequencies, which can be quite helpful for eliminating pop sounds on microphones.
After the EQ section, the audio signal goes to the

Channel Faders > **Pan > Assign Buttons > SubMasters > Master Faders** > **Amp & Speakers**
Individual channel faders adjust the level of that channel. Pan controls the amount of signal routed to the left or right speakers in a stereo mix. Assign buttons route the signal to either the submasters and/or the master faders. The submasters are typically used to give individual control over groups of instruments. An example would be that you could route all the vocals to submasters 1 & 2, and all the music instruments to 3 & 4, thus giving you quick control over all the vocals in relation to all the instruments. You could also use the submasters with a multi-track recorder, sending each channel to the corresponding input on the recorder. The master faders adjust the overall level which gets sent out the "Main Out" jacks. The signal then gets sent to the amp & speakers, which produce the sound.

Post Aux Sends > Aux Send Master > Effects Device or a **Recording Device > Aux Return or Open Channel**
The Post Aux Sends for each channel, and the Aux Send Master create a mix that goes out the Aux Send jack <u>after</u> going through the E.Q. and channel fader, hence "Post Auxiliary Send", meaning after the E.Q. & fader, and affected by these controls. Post sends usually go to effects units, but can also go to recording devices. Usually Post Sends are not sent to onstage monitors, but you could do that if you wanted to. In the case of an effects device, you would then send the output of the device back into the mixer via the aux return jack, or any open input channel.

B. Signal-To-Noise Ratio & The Decibel Scale:

In order to get a good sound, it's necessary to understand the concept of "Signal-To-Noise Ratio". The strength or loudness of a sound signal is measured with what is called the decibel scale, abbreviated "dB". Different sounds have different volume levels, and it is the job of the sound engineer to re-inforce the softer sounds in order to create more of a balanced mix. When setting up an audio mixer with multiple channels, it is important to adjust the "Gain" or "Trim" controls first, so that each audio signal is set to an efficient signal-to-noise ratio. What this means is that the electronic signal is set to it's most efficient operating level. If the gain is set too low, the signal will sound weak or distant, and there will be a lot of noise relative to the amount of audio signal. If the gain is set too high, you will hear "distortion" or "clipping", because the electronic equipment cannot handle the overly strong signal. To set the proper level for each channel, first press the "Solo" or "PFL" button, then adjust the "Gain" or "Trim" control so that the dB meter is going up to at least 0dB. 0dB means that you're essentially getting back exactly what you put in, with no cut or boost of the signal. Also, it's important for the musician, or whatever the input signal is, to be performing at their loudest level that they would normally perform at, because if you set their level when they are playing softly, and then they play louder later, the signal could end up distorting. You'll notice that the gain controls will end up being turned up less for the louder instruments, and turned up more for the softer instruments, which will create more of a balance of equally strong signals within the mixer. Once the signal is set at the input using the gain or trim control, it's important to keep a good signal-to-noise ratio throughout the entire audio chain. A chain is as strong as it's weakest link, so all the levels at every point in the audio chain need to be monitored and adjusted, and set to their most efficient operating level, with the maximum amount of undistorted signal, & the least amount of noise. This is the primary task of the audio engineer, and the key to getting a nice clear sound with very little noise.

C. Artistic Applications of Mixing Audio Elements

Getting a good mix, with a particular piece of music, is somewhat of a technical venture, & somewhat of an artistic one. Once you have each musical element established with a good signal to noise ratio, cleaned up & strengthened the audio chain as much as possible, (the basic technical elements), then the rest is pretty much of an artistic venture. Here are some things to think about, & some ideas to try:

Can you hear everything? Scan with your ears, each instrument or part of the music. Can you hear everything, or is something getting lost? Is any one instrument louder than all the rest, and do you want it that way?

What parts need to be featured, & when? Vocals should usually stand out over the instruments a bit, and whatever instrument might be playing a lead line should also be featured at that point in the song. Any instrument could be featured at any point, depending on the music & what the artist wants to convey.

Be aware of the audio spectrum. The audio spectrum consists of the low end or the bass, up through the midrange frequencies, and the treble or high frequencies. Different frequency ranges have different characteristics. The low end will shake the room more, will penetrate acoustical barriers more, and is less directional than the higher frequencies. Be aware that each particular instrument or part of the music has its own frequency range, and thus its own place in the mix. Sometimes a mix can sound better by cutting frequencies of a particular instrument that might interfere, or "walk on" other parts. For instance you could cut the low frequencies on all the instruments, except the bass, kick drum, and maybe the piano, so that the lows from all the other instruments do not interfere with the lows that we want to hear from the bass & kick drum. You might also find what frequency range the vocals are in, and cut those frequencies on the guitars or other instruments that might interfere with that part of the frequency spectrum, thus creating a place within the spectrum for the vocal part(s). Conversely, you can find "hot spots" within the frequency range of each part, and boost those frequencies, in order to make that part stand out more within the mix.

Sound effects such as reverb, delay, chorus, flanging, etc…, can be like icing on a cake for a music mix. Also, too much &/or too many effects applied improperly can ruin an otherwise solid mix. In general, slow, ethereal type songs can generally be enhanced by using more reverb & effects, and with faster, more driving songs, reverb & effects usually makes it sound muddy, or not clean. Also, there should be some thought & experimentation as to which parts or instruments the effects are applied to, and how much effect is used. This area of audio engineering is where the artistic elements really come into play, and open up a whole world of possibilities.