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Audio Technology: A Tool for Teachers and Singers

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INTRODUCTION

The different eras of music and various genres or styles developed largely as a result of changing orchestration, market demands, and technological innovation. Instrumental music of the Renaissance and Baroque periods grew out of newly invented instruments; the construction of large opera houses evoked grander vocal spectacle in the Romantic and Modern eras; the electric guitar begot rock and roll. Contemporary Commercial Music (CCM) and all of its many genres arose from technologic advancement in live sound and studio recording and continued to develop within the context of ever evolving audio technology.[1] Technology is therefore inextricable from this music in the ways that we experience it, consume it, and sing it.

The field of voice pedagogy is growing privy to the importance of audio technology in contemporary singing. Within the last few years, multiple articles and books have been published that aim to introduce pedagogues to the basics of sound recording technology.[2] However, attaining a cursory understanding of sound production is just the beginning. This article will re-introduce a few fundamental aspects of audio technology and then go beyond definitions to explore how audio technology can benefit singers and their teachers in the context of a voice lesson.

BASIC AUDIO TECHNOLOGY

Signal Chain

When a singer sings into a microphone, the audio signal moves through various pieces of equipment that process and manipulate this signal. This signal is then sent out, or outputted, to the speakers. This basic process is called *signal chain*.[3]

The Mix

For live sound, all of the instruments—microphones, guitars, bass, etc.—are inserted, or inputted, into an audio mixing console, or *mixer*. Each inputted signal on a mixer occupies its own space on the mixer, which is called its *channel*. The audio engineer then controls each channel to create the mix, which is the final sound the audience hears. Every concert of amplified music

goes through this process—the band plays the music, the mixing engineer controls the sound. Generally speaking, the band has little to no control over the overall mix; if you can't hear the singer during a rock concert, talk to the audio engineer, not the singer.

In modern studio recording, all of the inputs run into an *audio interface*, rather than a mixer. This interface allows an incoming signal, such as a microphone, to connect to a computer. The computer records the incoming signal into a *digital audio workstation*, or DAW. Garageband, Pro Tools, Logic, and Cubase are common examples of DAW software.

Tracking and Gain

The most important aspect of music production is the quality of the incoming signal. In studio recording, the process of capturing the signal, effectively inputting it into an audio interface, and then recording into a DAW is called *tracking*. Mic placement, gain staging, and performance are the main elements of tracking. The placement of a singer's microphone, such as the mic's distance from the singer's mouth, will greatly affect the resulting signal. Some people record with the singer's mouth about an inch away from the microphone, while others would be farther away; it depends on what gets the best result according to one's own setup and equipment.

The volume of an incoming signal, such as a microphone, is called *gain*, and it is controlled through gain knobs, present on all mixers and interfaces. If the gain is too high, the incoming sound will become distorted and can ruin a vocal take. This is called *clipping* and means that the gain must be turned down. If the incoming signal is very faint, on the other hand, the gain must be increased. Most interfaces and audio mixers display the gain of the incoming audio with colors: green is fairly low gain, yellow is medium gain, and red is clipping. For the clearest possible signal and best output potential, one should aim to get as much sound out of an incoming signal without clipping. Effectively setting the gain at each stage of sound production is called *gain staging*. If many of the input gains are too high, the final mix will clip; if all the input gains are too low, the final mix will be faint and contain large amounts of noise. Once the singer establishes proper mic placement and gain staging, he/she is ready to start tracking.[4]

Processing Effects

In a DAW or live mixing console, each instrument occupies its own channel. The audio engineer, or mixer, then controls and manipulates the incoming audio. The mixer controls the volume of each channel, in addition to a host of other parameters. The parameters most applicable to singers are effects processing like *equalization, compression, reverb*, and *delay*. It is the combination of these various effects that makes a channel, or input signal, come to life.[5]

As voice pedagogues know, a sound is not as simple as it seems; it is comprised of the fundamental pitch and its multiples, or harmonics. The various strengths of these harmonics define the spectral envelope, or timbre, of the sound. An equalizer, or EQ, adjusts the spectral envelope. If you have ever adjusted the bass, mids, or treble on your car sound system, you have used an EQ. Today, most smart phones are equipped with an EQ. An EQ can be used to make the voice brighter, darker, and all shades in between. An audio engineer might use an EQ to correct for overly resonant harmonics that may be present in a particular singer's voice, for example, lowering the volume of some high frequencies to make a voice less bright. The goal here is not to compromise the singer's natural tone, but to allow the vocal line to fit more effectively within the mix. An equalizer can be used to attain the opposite result as well, making a voice cut through the mix.

Compression essentially flattens the dynamic of an outputted signal, increasing the volume of quiet sounds and decreasing that of loud sounds. A compressor is an essential part of any sound system; it basically creates a volume floor and ceiling. If a channel is not compressed, it will intermittently pop in and out of the overall mix. Any well produced music you hear will have compression, especially on the vocals.[6]

A *gate* is in some sense the opposite of a compressor—it eliminates incoming sound that does not meet a certain decibel (loudness) threshold. Gates are essential in order to better isolate individual channels. They are especially important for singers because singers' microphones will often pick up extraneous stage or room noise, while other instruments may plug directly into the mixer. Using a gate allows only the voice to come through the mic.[7]

Two more effects paramount to any mix and to vocal processing are reverb and delay.[8] Reverb is short for *reverberation*—the bouncing and reflecting of sound in an acoustic space. CCM music aims to deaden naturally occurring reverberation through what's referred to as *sound treatment*, and recreate reverb through digital processing. This is why recording studios have sound absorbing panels on the walls; they deaden the sound, allowing for reverb to be applied digitally in postproduction. Audio engineers use reverb to simulate a physical space, such as a small room, or a large hall.

Delay is another, more overt, effect often used on vocals and can be most easily be described as an echo effect—a sound bouncing off a surface, like reverb, but the surface is theoretically farther away, and the echo is perceived as a separate repetition. The parameters of a delay are endless: the delay can be very quick, called *slap-back delay*, giving the voice a doubling effect, or it can be longer, giving the voice a more sustained sound. Reverb and delay are usually combined to allow the vocals to fit more effectively into the mix, giving them more punch, but without making them stick out too much. The spectrum of how much reverb/delay is present in a sound is usually described on a spectrum from *wet* to *dry*; wet is lots of reverb and delay, while dry is less.

An additional effect that should be addressed is *auto-tune*, or what is more broadly called *pitch correction*. While both of these effects deal with the adjustment of pitch, it is important to differentiate the two terms: auto-tune often refers to a kind of computerizing effect that makes a singer sound like a robot while pitch correction is a more subtle form of intonation adjustment. Most vocal recordings produced today are pitch corrected. If you're listening to a commercial recording produced after the year 2000, it is safe to assume that the vocals have been adjusted so that every syllable is perfectly in tune right in the center of the intended pitch. This includes recordings of "live" performances, as well.

Compression, EQ, gate, reverb, pitch correction, and delay are used in almost all music production, both live and in studio. An understanding of how to utilize these effects is crucial for any singer or teacher of singing who is singing any music that is processed. In modern music making, the production is an additional instrument; the sound engineer is a member of the band; the mix can make or break the final product. To fully develop as a singer or teacher of such styles requires a basic understanding of sound production, and the integration of such production will add to the stylistic authenticity of a performance.

Monitoring

The live performance technology most pertinent for singers is *monitoring*. Monitoring is how musicians hear themselves in performance. Poor monitoring can ruin a performance, and great monitoring can make a performance. Monitoring is especially important for singers; how singers hear themselves drastically affects how they sing. If singers cannot hear themselves, they are more likely to push, strain, and have poor intonation.

Monitoring comes in two forms: speakers and in-ears. The speakers used for monitoring are referred to as *wedges* and usually rest on the floor directly in front of the performer. The wedge amplifies a mix of a band, and usually each performer has his/her own mix. Historically, bands have used wedges for monitoring; but the technology has progressed to in-ear monitors. In-ears are a combination of ear plugs and ear buds; they completely plug one's ears, eliminating outside noise, but also supply audio to the user. In modern concert productions, the stage is loud, with booming drums, screeching amps, and hopefully a cheering audience. A wedge has to compete with all of this noise and be turned up very loudly; and even with sufficient volume, the mix is often muddy, unclear, and deafening. In-ear monitoring solves most of these issues since an in-ear mix is usually far clearer than that of wedges. In-ears also allow the performers to be more mobile and move around the stage without losing the ability to hear their mix.

It's important to point out that noise induced hearing damage is a huge issue for many performers. One author of this article has permanent hearing damage, mainly in the form of tinnitus (ringing in the ears), from a lack of hearing protection during years of performing rock music. In-ear monitors provide the ability to better control the level of sound coming into one's ears and protect one's hearing.

Traditionally, individual mixes of the performers are controlled by the monitoring engineer. In professional productions, there is a monitor engineer on the side of the stage. In lower level productions that typically use wedges, the monitoring engineer is the same person

as the front of house (FOH) mixer or sound engineer. Performers can also adjust their own mixes through a personal, onstage mixer. In twenty-first century productions, most digital mixing consoles are capable of wirelessly connecting tablets or phones, such as an IPad, to use as a remote monitoring mixer. In fact, this author's band mixes the entire FOH sound exclusively with an IPad; there is no physical mixing console.

Mastering one's on-stage monitor mix is crucial in order to effectively perform. A teacher of singing who instructs CCM singers must understand this in order to adequately prepare a singer for live performance.

PEDAGOGIC APPLICATION

How do teachers of singing implement audio technology in their studios? Investing in audio equipment may seem daunting at first, but the cost of a simple audio setup is relatively low compared to generations past. Beyond a personal computer, one would only need an audio interface, a decent speaker setup, and a microphone to complete a basic system.

This equipment allows a teacher to process live vocals during a voice lesson. The singer can sing into the microphone, and through effects setup within the DAW, he/she can hear the processed voice through the speakers. The student and teacher can choose various effects to create the desired vocal processing, depending on the style, and thereby better recreate the mix of the particular song being sung.

The effects processing greatly influences the vocalism. Compression flattens the volume, EQ adjusts the timbre, reverb simulates a space, and delay adds sustain and presence. All of these effects have an influence on the singer's audio feedback loop. Most teachers know that singing in a variety of acoustic spaces, which highly affect a singer's perception, is one of the biggest challenges of singing. An audio setup in the studio allows a teacher to control the auditory feedback.

A secondary use of this vocal processing setup is to actually record vocals. Contemporary music is a recorded medium; more people have heard Michael Jackson's recordings than have ever see him live. Therefore, the ability to track a great vocal is a necessary skill for all singers, especially those singing in contemporary styles. There are many lessons to be learned by recording one's singing, especially in a well equipped recording studio. One of the authors of this article has been recording since his teenage years, and it has transformed his understanding of singing.

The audio effects applied to a vocal track are part of the artist's expression; ignoring the processing and singing acoustically without effects would strip the performance of its authenticity. Imagine Steven Tyler of Aerosmith singing acoustically, or Lady Gaga performing without a microphone; it's not the same. With this setup, one is essentially creating a simulated live monitoring scenario.

Practical Considerations

When setting up one's own equipment, a few precautions should be taken to avoid *feedback*. Feedback is a phenomenon that results from creating a loop between the sound input, such as a microphone, and the sound output, such as a speaker. As a basic rule, the microphone should be pointed away from the speakers. Also, the input gain, as well as the vocal channel in the DAW, should be at a reasonable level; if the vocal gain is too loud, feedback will occur. Lastly, one can use a gate, mentioned previously, to reduce feedback. If the gate's dB threshold is higher than the volume of the potential feedback, the feedback frequencies won't be allowed into the microphone, making a feedback loop impossible.

Though the audio processing setup described here is capable of recording more than just vocals, it would likely be necessary and practical for a singer or teacher to use backing tracks in a studio setting. Backing tracks can be found on YouTube, in addition to many websites that sell instrumental versions of popular songs. An instrumental track can be downloaded and imported into the DAW, occupying its own channel. With this setup, the user will be dealing with only two channels: the instrumental track and the vocal. After the vocals are tracked, one can begin mixing; however, the details of how to achieve a great mix are too vast to include in this article.

CONCLUSION

Singers can achieve greater authenticity in styles that inherently necessitate sound production if they attain a basic understanding of audio technology. A vocal processing and recording studio can be set up and used in

voice lessons with relative ease and low cost. Teachers and singers can collaborate to create a great live sound for rehearsal or record vocals to create professional sounding demos. Audio technology is an integral tool for any singer or teacher of these styles, and it should be understood and utilized in order to best prepare the singer for live performances. Audio technology is here to stay. Rather than simply tolerating this technologic medium, singers and teachers can leverage its capabilities to more effectively perform, practice, and teach in the many CCM genres.

RESOURCES

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NOTES

1. David R. M. Irving, "Italian (and Related) Instrumental Music of the 17th Century," *Early Music* 40, no. 2 (May 2012): 325; Patrick Dillon, "When Is Loud Too Loud?," *Opera News* 75, no. 5 (November 2010): 40; Kyle Devine, "A Mysterious Music in the Air: Cultural Origins of the Loudspeaker," *Popular Music History* 8, no. 1 (April 2013).
2. Matthew Edwards, "What Every Singer Needs to Know about Audio Technology," in Matthew Hoch, ed., *A Dictionary for the Modern Singer* (Lanham, MD: Rowman & Littlefield, 2016), 231.
3. The signal chain is generally connected using XLR cable, the industry standard for audio production.
4. It's always worthwhile to make sure the technology is properly set up before one starts to record so that they're free to perform and express, without having to sing many retakes because of technical difficulties.
5. Edwards, "Audio Technology," 232.
6. "How the Pros Use Compression—Audio Compression Instruments and Mixes," video file, YouTube. Posted by Rick Beato, July 21, 2017; https://www.youtube.com/watch?v=7oOmX3JHwtE&t (accessed December 4, 2018).
7. "Audio Theory - Gate," video file, YouTube, posted February 27, 2014; https://www.youtube.com/watch?v=ocApSr-73MQ.
8. "Reverb and Delay Explained—Sound Basics with Stella Episode 4," YouTube video, Posted March 28, 2017; https://www.youtube.com/watch?v=-jPPJEHMepA (accessed December 4, 2018).

Aaron Cafaro is a New Jersey-based teacher, singer, and keyboardist who takes a unique interest in the integration of voice pedagogy and audio technology. His formal training comes primarily from Westminster Choir College, where he has earned a BM in Music Education and is currently studying voice pedagogy. In addition to his study and experience in classical music, Mr. Cafaro feels at home performing the vast range of genres referred to as CCM (Contemporary Commercial Music). He began appearing in music theater at the age of four and has played in bands since his early adolescence. Teaching out of his independent studio, Mr. Cafaro has had the pleasure to work with a wide range of performers from professional rock singers to aspiring music theater actors. He maintains a recording studio in which he has engineered, mixed, mastered, and produced hundreds of projects with multiple bands and artists. Live sound is also no stranger to him in that he has had years of experience mixing live shows. It is this expertise in audio technology and CCM performance that brings Mr. Cafaro's pedagogy into the 21st century. More info about Mr. Cafaro can be found at aaroncafaro.com.

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Dr. Arneson was the co-director of the CoOPERAtive Program, a young artist program for singers, held at Westminster Choir College, and the co-director of the Voice and Speech department in the MFA program at the renowned Actors Studio of the New School University in New York. He completed Vocology internships at the Grabscheid Voice Center at Mt. Sinai Hospital and the Vox Humana Laboratory at St. Luke's-Roosevelt Hospital, both in New York.

Dr. Arneson served on the editorial board for *Journal of Singing*, and for the revised edition of the Royal Conservatory of Music's Vocal Repertoire Collection, published by Frederick Harris, Ltd. for Carnegie Hall. He is a member of the American Academy of Teachers of Singing and he is the editor/author of *Fundamentals of Great Singing, the Teaching of Michael Trimble* and *Literature for Teaching: Solo Vocal Repertoire from a Developmental Perspective*. His most recent publication is *Literature for Teaching—Teaching Edition: Anthologies of Art Songs and Arias for Young Singers and Teachers*.