Spring June 5th, 2019

Shifting the Paradigm: Revealing the Music Within Music Technology

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SHIFTING THE PARADIGM: REVEALING THE MUSIC WITHIN MUSIC TECHNOLOGY

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A project submitted in partial fulfillment

of the requirements of the University Scholars Honors Program

Seattle Pacific University

2019

Approved ____________________________________

Date____

ABSTRACT

Examining perceptions of music technology raises questions about why people often overlook music technologists and why people perceive music technologists as a lesser part of the musical experience. The issue of musicianship becomes a key factor in addressing the perceived inferiority of music technologists. The examination of the dominant theory of musical communication will reveal the qualifications for musicianship, and then the work of music technologists will be evaluated using these qualifications. A brief history of music technology will provide general information about the field and a recording session case study will serve as a basis for the assessment of music technologists as musical. Since the primary theory of musical communication analyzed here developed out of the classical music tradition, the work of music technologists will also be considered in the context of the classical genre. This analysis reveals the importance and musicality of music technologists, which results in the need to reevaluate current theories of musical communication.

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Introduction

"You should expect not to be noticed," "if no one notices you that's a success," "being unnoticed is a job done right"—from the very beginning of one's training as a music technologist, mentors pass down phrases such as these to their mentees exalting invisibility and lifting it up as the ultimate goal. The sentiment behind these phrases contains no ill-intent but instead attempts to explain the relationship between performers and music technologists. Within the classical genre, the demand for invisibility increases exponentially. The dominant traditional way to visualize musical communication originates from the classical perspective and presents a progression from composer to performer to listener as the way people receive music. This model continues to characterize how many people conceptualize musical communication today, even if only subconsciously. However, musical communication often occurs via recordings currently as people access music through various online streaming services. Even in live concerts, technological mediation occurs. Presenting musicianship as the main goal of music technologists instead of invisibility would also result in the desired hiddenness without diminishing the role of the music technologist. While they sit outside the traditional structure of musical communication between the composer, performer, and listener, music technologists' musicianship and technical knowledge make them vital to the musical experience, and the current theories of musical communication need revision to reflect their contribution.

Traditional Forms of Musical Communication

A discussion of the nature of music could encompass an entire thesis of its own, but for our purposes we will approach the subject as necessary background information for discussing the musicality of music technologists. In the simplest definition possible, music is organized sound. Obviously, such a definition lacks specificity. A longer definition of music from a Western perspective depicts music as "an art that is concerned with combining sounds…to produce an artifact that has beauty or attractiveness, that expresses something, that follows some kind of internal logic and exhibits intelligible structure, and that requires special skill on the part of its creator."[1] Music thus is sound with structure crafted by someone for beauty. People often speak about the emotional release that comes from music and while truth resides in that sentiment, "Music… serves us better, I believe, when it offers us insight, intuition, and empathy."[2] Music moves beyond surface-level emotions and speaks into the eternal questions of what it means to be human. Music qualifies as a means of communication because "music embodies the attitudes and gestures behind feelings—the movements… of our inner being, which animate our emotions and give them their dynamic content."[3] Music communicates something to all involved despite music's nearly undefinable nature and the triad of composer, performer, and listener has defined the image of musical communication for centuries.

Musicianship and musicality refer to the skills needed to craft music. Musicality is the "sensitivity to, knowledge of, or talent for music; the quality or state of being musical."[4] In the living out of music, one becomes a musician. While one might argue that music technologists do not need a talent for music, the success of a music technologist does depend on a sensitivity to and knowledge of music. A music technologist who lacks musical understanding inhibits the musical experience, but a music technologist with musical knowledge enhances it. As discussion

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[1] "Music," *Funk & Wagnalls New World Encyclopedia*, *EBSCOhost*, January 2018, ezproxy.spu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=funk&AN=mu172200&site=ehost-live.
[2] Lawrence Kramer, *Why Classical Music Still Matters*, (Berkeley: University of California Press, 2007), ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/spu/detail.action?docID=291505, 9.
[3] Roger Sessions, *Musical Experience of Composer, Performer, Listener*, (Princeton Universsity Press, 2015), ProQuest Ebook Central, https://ebookcentral-proquest-com.ezproxy.spu.edu/lib/spu/detail.action?docID=3031403, 26.
[4] "Musicality," *Merriam-Webster*, January 6, 2019, http://www.merriam-webster.com/dictionary/musicality.

of the individual roles that comprise the flow of musical communication occurs, one should be cautious to not divide music into separate categories because “the experience of music is essentially indivisible, whether it is embodied in the impulse to produce, or in the response, through re-production.”[5] Music is one entity. The roles overlap and intertwine, with each aspect of composer, performer, music technologist, and listener essential to the whole.

The traditional image of composer, performer, and listener has long defined how people conceptualize the musical process. The composer crafts the music they want to bring into being, the performer plays the piece, and the listener receives it. This creates a progression in which “the composer, the performer, and the listener are in a certain sense collaborators in a total musical experience, to which each makes his individual contribution.”[6] While each role makes an essential contribution to the whole, each needs the others to create music. Mark Katz, professor and musicologist, acknowledges the longstanding prevalence of this triadic relationship as he states that “Recordists fall outside (or perhaps in between) the traditional triad of composer, performer, and listener.”[7] Katz, however, does not progress further than acknowledging the outsider nature of music technologists; he neglects to substantially address the importance of music technologists regarding musical communication. But his acknowledgement of the traditional triad illustrates its prominence in Western music culture.

As with the nature of music, debate has circled around the classification of the composer as a musician. However, refusing to acknowledge the musicianship of the composer neglects their musical knowledge and sensitivities used to craft their compositions. From the viewpoint of music as an activity, the composer “introduced into the raw material of sound and rhythm

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[5] Sessions, 20.
[6] Sessions, 107.
[7] Mark Katz, *Capturing Sound: How Technology Has Changed Music*, (Berkeley: University of California Press, 2010), 44.

patterns that became recognizable and therefore capable of repetition."[8] The composer is the primary act of production. The composer strives to bring their musical ideas into coherent shape. The process of development varies from composer to composer, but in the end the composer has crafted a new piece of music for the performer to animate and interpret. In the act of composing, "The composer is no longer simply a craftsman; he has become a musical thinker, a creator of values."[9] The act of composing is a musical act and thus the composer is a musician. A composer's musicianship is absolutely necessary to the musical process because without their work nothing would exist for the performer to interpret and reproduce, nothing for music technology to mediate, and nothing for the listener to hear.

It seems easiest for people to see the performers' inherent musicality as they present the music to the audience, becoming visibly linked to the act of music-making. The performer holds the vital role of bringing the music crafted by the composer to the public. As exemplified in classical music, "The role of performance is prominent… since classical music comes into being in the passage from a written score to a sounding performance— a simple and obvious journey that is neither simple nor obvious."[10] Music needs life, to move beyond simply notes on a piece of paper, which the performer provides. The performer discovers and recreates the musical gestures in the composer's work because "Without fidelity a performance is false, without conviction it is lifeless; in other words, it is hardly music."[11] Music needs the performer to act with both accuracy regarding the composer's score and with conviction to bring the music to life. To play an instrument or perform with the necessary level of fidelity requires inherent technical knowledge. While performers play the music of the composer, one should not dismiss the

[8] Sessions, 5.
[9] Sessions, 67.
[10] Kramer, 10.
[11] Sessions, 78.

performer as "a mere convenience or a necessary evil"[12] because "Music is by its very nature subject to constant renewal."[13] The idea that "true music" exists in the score alone negates the importance of the performer and their musicality. The performers' work to embody the musical gestures in the composer's piece, combined with their general musical knowledge, necessitates their designation as a musician.

The musicality of the listener remains even more contested than that of the composer. In today's world, "for most people enjoying music no longer means knowing how to play it, the experience of music making remains in the background."[14] The listener's knowledge of music results from more subtle knowledge gained through repetition rather than from formal musical training in the modern world. However, listeners still display musical knowledge as they can anticipate a drum break in a song, distinguish the difference between major and minor keys, and appreciate artists who manipulate the musical form effectively. The question of the listener as musical then shifts to their level of engagement in the musical process.

If one approaches music as an activity, then a listener's qualification for 'musicianship' depends on their active participation. Composer Roger Sessions declares that "To listen implies rather a real participation, a real response, a real sharing in the work of the composer and of the performer, and a greater or less degree of awareness of the individual and specific sense of the music performed."[15] To listen requires involvement in the music. However, Sessions too quickly dismisses people who simply hear music or attend concerts. These listeners still participate in the flow of musical communication, just perhaps on a lesser level than dedicated listeners; the designation of amateur listeners could be employed here, paralleling how amateur composers

[12] Sessions, 85.
[13] Sessions, 85.
[14] Kramer, 10.
[15] Sessions, 7.

and performers participate in the flow of musical communication.[16] Music can occur for its own sake such as at concerts or as music as adjunct to something else.[17] Sessions appears to claim that those engaging with adjunct music do not fully listen and should not be considered listeners. However, he does not define the situation fully and consequently, his analysis of the listener dismissed amateur listeners without adequate consideration. Sessions states that in the modern era, the number of listeners has grown dramatically since the advent of commercialized recording, but he neglects to discuss if these new listeners listen at the level he deems acceptable. In fact, Sessions defines four stages of listener development—hearing, enjoyment, musical understanding, and discrimination—and the first two stages contradict his own standards about what defines a listener.[18] The listener does need to be actively engaged but Sessions remains vague about what qualifies as participation. Lawrence Kramer, composer and musicologist, frames the situation of listener better as “It is not a passive submission to the music but an active engagement with it, a meeting of our ability to become absorbed— sometimes for just a few moments or even less, sometimes for hours on end—with the music’s capacity to absorb us.”[19] Momentary active engagement with music does not invalidate the listener. Kramer still requires the participation of the listener but without depending on formal musical training or length of engagement, which more accurately reflects how listeners engage with music today.

In the modern world, the listener also is the consumer. A notable argument against the listener as an important part of the musical communication process states that the listener does not contribute to the music but merely consumes it. However, the listener does impact the music

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[16] Obelkevich, James, “In Search of the Listener,” (*Journal of the Royal Musical Association,* Vol. 114, No. 1, 1989), Taylor & Francis, Ltd. on behalf of the Royal Musical Association. https://www.jstor.org/stable/766382, 103.
[17] “Music,” *Funk & Wagnalls New World Encyclopedia.*
[18] Sessions, 92-100.
[19] Kramer, 11.

as a consumer. Well-liked genres and songs are played more frequently on the radio and to meet demand, production of more songs with a similar format or content occurs. A specific example of the listener impacting music occurred in Jamaica when the genre of rock and roll overtook R&B in the United States. The Jamaican producers began to make their own R&B records to meet their audience's continued demand for that specific genre when the supply dwindled from America and so, "The needs of the audience, intuited and directed by DJs and selectors, transformed the nature of the recorded music, influencing production in a recursive process."[20] The demands of the listener resulted in what music was created. As such, the major argument against the listener neglects to address how, with market supply and demand, the listener does enact influence over the musical process. The listener interacts with the final stage in music production but remains influential and vital to musical communication nevertheless.

The term music technologist functions as a catch-all term used to refer to people working in the field of music technology, or, in other words, working with music via technology. The beginning of the recording industry necessitated the creation of the music technologist's role and, "by the early 1930s the three defining attributes of modern music production were already realisable: the ability to capture any sound source from any location; the ability to produce a multidimensional soundstage; and the ability to combine temporally distinct events."[21] These qualities of music technology remain prevalent in the twenty-first century and continue to define how music technologists interact with music. Before recording, the overlap of music and technology was minuscule to nonexistent. The traditional progression of composer to performer to listener accurately captured the flow of musical communication. Today, the separation

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[20] Richard James Burgess, *The History of Music Production*, (New York: Oxford University Press, 2014), 113.
[21] Amanda Bayley, ed, *Recorded Music: Performance, Culture and Technology*, (Cambridge: Cambridge University Press, 2010), 92.

between music and technology is minuscule to nonexistent. Technological mediation occurs in almost all music, in both recordings and live events. Even classical concerts, which appear purely acoustic endeavors, involve music technologists in some manner, whether in running live sound, recording the concert, or designing the concert hall. The musical and technical knowledge of the music technologist is vital as "the best equipment in the world is of no use if the person operating it doesn't know what they are doing."[22] Music technology is more than just the gear. Some major roles within the field of music technology include producers, recording engineers, mastering engineers, front of house (FOH) engineers, monitor engineers, production managers, and road crew. Most of the names describe the specialization of the job, such as recording, running FOH live sound, mixing monitors, mastering recordings, or managing productions. Each has their own specific skills, but all music technologists need the same basic musical and technical understanding to succeed in their respective jobs.

As in everything, popular stereotypes heavily shape the public perception of music technologists. What the media chooses to focus on weighs heavy on how people perceive music technologists and helps build stereotypes. Since many documentaries that feature music technologists center on the rock genre, people apply their ideas of rock musicians to music technologists without considering how they function in other genres. Broadly, the common representation presents music technologists as rebellious, grungy males who joined the field because they could not make it as a musician. Like all stereotypes, this image fails to capture the entire picture and does more harm than good as it perpetuates false ideas about music technologists and contains the potential to make music technologists a second-class group of workers on the fringes of musical society. The stereotypical image of music technologists

[22] Paul White, "The Role Of The Mix Engineer," chap. 12 in *The SOS Guide to Live Sound: Optimising Your Band's Live-Performance Audio*, (Burlington: Focal Press, 2017), 216.

overlooks that music technologists work in more genres than rock and pop. More men do currently work in music technology as a recent study reveals that "in 2015, women accounted for less than 5 percent of people in music technology."[23] This statistic does not allow for the erasure of women's participation and existence in music technology. The popular image of music technologists as male undermines the females currently working in the field, or those interested in joining the field. While some people do join the field because of their limited success at achieving stardom as a performer, numerous other reasons hold greater sway over people deciding to become a music technologist, such as enjoying the technical challenges it provides, wanting to bring music to people, or liking the fast-paced nature of the field. The skills required of a music technologist differ from the skills of a performer; just like performers and composers have different strengths, some peoples' skill sets align with the field of music technology more resulting in their pursuit of music technology. Music technologists are not failed performers. Rather, "the combination of a decent technical background and a degree of musical empathy, never mind the level of commitment required, is not that easy to come by."[24] The role of the music technologist needs a unique combination of skills. Like any stereotype, the popular image of music technologists is flawed and has contributed to the lack of acknowledgement that music technologists receive for their musicianship.

In the modern world, music technologists must be inserted between the performer and the listener in the flow of musical communication. Before the listener can receive music, various forms of technological mediation occur in almost all situations. The music a listener hears on a recording contains the influence of numerous musical technologists. The performer's experience during recording or performance is shaped by music technologists who either help build a good

[23] Julie C. Dunbar, *Women, Music, Culture: An Introduction*, 2nd ed, (New York: Routledge, 2016), 356.
[24] White, 216.

environment or prevent it. And composers also interact with music technology as many compose in programs such as Finale or Sibelius. Music technology shapes all the roles of musical communication, and "In all its permutations, music production is—at its essence—an art form, whose goal is to produce a unique sonic artifact that captures the vision of its creators, the imaginations of its audience."[25] Music technology showcases the culmination of musical communication in its very nature. The overwhelming involvement of music technology in music currently, along with how it exemplifies the nature of music, necessitates the inclusion of music technologists in discussions of musical communication.

While the composer, performer, and listener all interact with music in unique ways, one must remember the deeply interwoven nature of music. Each part proves vital to the completeness of musical communication. In the creation of music, "the three functions sometimes overlap, with the performer supplying whatever for him is missing in the work of the composer, the listener hearing the composition sometimes beyond the performer, and the composer, to a very important degree, visualizing."[26] Even within the defined focuses of each role, overlap occurs. Although a simple linear progression captures the flow of musical communication, a Venn diagram with four circles symbolizing the four roles, where music lives in the central overlap, offers an alternative representation of musical communication that better captures how the roles intertwine and need each other to create music. The idea of overlap applies to the role of the music technologist also; the music technologist focuses on moderating technological mediation, but they can shape the music like a performer or engage in intentional listening like the listener. And conversely, performers mediate music with technology through pedal boards. Music is not divisible into singular roles. The most important aspect to "A healthy

[25] Burgess, 179.
[26] Sessions, 107.

musical culture is one in which the creative function, the function arising from a strong and prevalent love for music."[27] The composer, performer, music technologist, and listener all engage with music out of their love for it on some level and together illustrate how music communication occurs in the modern world.

A Brief History of Music Technology

The search for capturing sound initially began apart from music within scientific and mathematical fields, with no attention devoted to playing back the documented sounds.[28] In 1877, Thomas Edison invented a device that allowed for both recording and playback.[29] The phonograph, Edison's chosen name for his invention, was conceived and marketed as a business machine; instead of taking meeting notes, the phonograph would capture the event, and one could then play back the recording whenever they needed it. With the phonograph, recording occurred as "The collecting horn captured and focused acoustic sound waves onto a diaphragm that vibrated and transmitted those mechanical vibrations to the cutting head, which inscribed the analog grooves into the recording medium."[30] Initially, Edison used tin foil to record onto, but its fragile nature meant it could only be played back a few times before ripping. Shellac offered an alternative to this issue and then later the material changed again to vinyl. While Edison conceived of the phonograph as a business machine, the Colombia Phonograph Co. "had more success selling music than business machines. In particular, cylinders of the United States Marine Band under John Philip Sousa were popular."[31] The invention's purpose shifted to music.

[27] Sessions, 101.
[28] Burgess, 5.
[29] Burgess, 5.
[30] Burgess, 16.
[31] Burgess, 11.

The financial success of selling the phonograph as a music machine, combined with Emile Berliner's gramophone which focused solely on the playback of records, resulted in music becoming an item for marketable consumption. Recorded music started to become a commodity, and the common perception of music shifted accordingly.

Recording with the phonograph required no electricity or electrical interference making it an entirely acoustic process. In the early days of recording, music technologists had minimal control. The only ways to control the levels of the different musicians in the recording session involved adjusting the musicians' position in relation to the recording horn or adjusting the musicians' individual dynamics. Music technologists could not simply raise or lower a fader to achieve good ensemble balance. However, even within a constricted situation, "specialized engineering skills were beginning to become a necessity. Noble alludes to the expertise required in operating the recording machine and choosing and placing the horn in order to obtain a 'fine round tone.'"[32] T.J. Theobald Noble wrote one of the earliest reports of acoustic recording techniques, illustrating how standards for the ideal recording developed and the responsibility placed on the shoulders of music technologists. From the very beginning of the development of music technology, recognition of the skills required from music technologists to obtain high quality recordings existed.

Electric recording signaled the rise of microphones and of radio. While David Hughes invented the first carbon microphone in 1878, the need for electronic amplification of microphones prevented widespread use until the 1920s.[33] Electric recordings use electricity to amplify and capture the sound, unlike a phonograph that would acoustically etch the sound captured by the recording horn directly onto the disk. With electrical recordings, one could

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[32] Burgess, 17.
[33] Burgess, 29-30.

"capture sibilance and subtle sounds as well as a wider frequency spectrum and louder instruments."[34] Higher-quality recordings became standard and music technologists gained greater influence over the recording. With microphones, musicians could record in more comfortable set-ups that mirrored how they performed live. Music technologists now needed to have knowledge of various microphone types and microphone placement.

As the essential first step in signal flow, microphones capture the sound source and turn the sound into electrical impulses allowing for music technologists to do their job. Oscillations in air molecules create sound. One of the most impactful aspects of a microphone is its polar pattern. Polar patterns illustrate the directionality of how a microphone captures the sound in a 360-degree diagram (see figure 1).

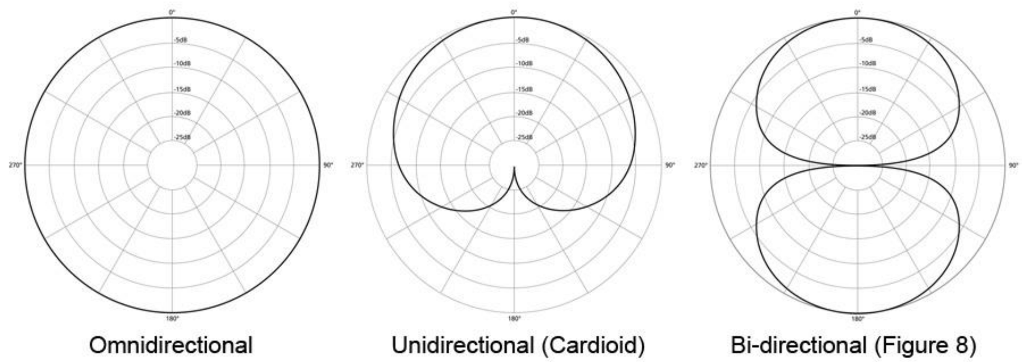

Figure 1. Polar patterns of omnidirectional, cardioid, and bi-directional microphones.[35]

In an omnidirectional pattern, the microphone captures sound from all directions equally. If one wants to capture the natural reverberation of a room, an omnidirectional microphone excels at that, but it can lack definition or capture significant bleed from other sound sources depending on the situation. A cardioid pattern looks similar to an upside-down heart, meaning that the

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[34] Burgess, 33.
[35] Ken Theriot, "Polar Patterns for Omnidirectional, Unidirectional, and Bidirectional Microphones," *Disc Makers Blog*, 9 Mar. 2015, blog.discmakers.com/2015/03/pros-and-cons-of-the-figure-8-mic/.

microphone is picking up less sound from the back than from the front. This proves useful in many situations, such as concerts, because it allows for a more direct pickup of the sound source and eliminates background room noise. Most vocal microphones are cardioids because they still have a full sound and can focus on the individual voice of the vocalist. A bidirectional polar pattern indicates that the microphone will capture sound equally from the front and back but eliminate sound from the sides. They provide more direction than omnidirectional or cardioid microphones, which is useful for eliminating bleed, but it can also pick up undesirable reverberations or noise from the back. There are other polar patterns, but they are all combinations of these three primary patterns.

Another important aspect of microphones is their frequency range. Most capture the full range of human hearing, 20 Hertz to 20,000 Hertz, but some microphones will boost certain frequencies. For example, vocal microphones will often boost the midrange because that corresponds to where the human voice resides, or kick drum mics will focus more on the low range frequencies than the high range. Each type of microphone also has its own coloration, or way that the microphone itself impacts the sound as it captures the signal, which changes the sound the music technologist has to work with in the mixing stage. Some microphones add a lot of color to the sound and music technologists bring knowledge of such idiosyncrasies to their microphone selection. Additionally, the principle of proximity effect will impact the frequency response of a microphone as it "leads to an increase in low frequency response as you move the mic closer to the source. The closer you get, the bigger the bass boost."[36] One can tactfully utilize this phenomenon to enhance the tone of a sound source, but it can also create problems with feedback and imbalance. Music technologists must be conscientious of the frequency range

[36] "Microphone Basics (5): What is the Proximity Effect?," *Neumann.Berlin*, 2015, http://www.neumann.com/homestudio/en/what-is-a-dynamic-microphone.

when selecting microphones or else it could improperly capture the sound at the very beginning. Similarly, microphone placement is of crucial importance. If a vocalist holds their microphone too far away from their mouth, the intelligibility of their words decreases and the risk for feedback increases as the music technologist has to compensate by increasing the gain level. The goal of microphone placement and selection is to capture the best sound possible from the sound source with minimal bleed from the other microphones. Microphones, and the choices made surrounding microphones, influence every step of the musical process that follows.

Radio became a source of major competition to the music industry and pushed them to have higher-standards regarding recording. Radio offered a free alternative to buying recordings, making it very desirable and accessible for the public, regardless of income. The music industry's initial slow response to the development of radio and then their reactions to keep the industry profitable still have an impact on the musical world today. In an attempt to spur more business, they undercut their profit as they supported the idea of music as a "free" commodity. In 1942 Capital Records began to give radio stations free copies of records, but "Giving them product for free and not demanding a performance royalty for use of the sound recording (separate from the performance royalty paid to publishers and composers) continues to financially disadvantage American labels, artists, musicians, and producers."[37] The profits that trickled down to music technologists, the stereotypical second-class of the music world, continue to be minimal. While economically, the music industry's response to radio has resulted in long-lasting problems, the desire for higher-quality recordings to compete with the radio industry resulted in many of the major developments in the field over the next decades. Some of these included the AC bias tape recorder, magnetic tape, Les Paul's sound-on-sound technique, the 8-

[37] Burgess, 64.

track recorder, plate reverb, transistor radios, the cassette Walkman, and automation.[38] All these inventions and improvements occurred within the field of analog recording, and they all increased technology's influence on music.

Analog recordings capture the entirety of a waveform, etching, inscribing, or magnetizing it directly onto the final playback material. The phonograph exemplifies this as the sound captured by the recording horn immediately became etched into the record. Analog recording persisted after the transition away from the acoustic phonograph to electric recording. Mid-twentieth-century analog recording studios would record onto a master tape and replicate it for consumer sales. The whole process was physical. Sound existed as electrical impulses, but sound did not exist within a computer. One example of an analog recording studio is Sound City which was known for their rock recordings and famous Neve soundboard.[39] The amount of equipment needed to make an analog recording was massive including microphones, microphone preamps, a mixer with numerous channels, and effects racks as a very pared down list. To record, one had to go to a studio. Analog recordings capture all the soundwave and while conversion from moving air molecules to electrical impulses occurs, no conversion to the digital realm happens in analog recording.

However, with digital recording, the audio is captured and converted into digital 0s and 1s that replicate the original soundwave. Instead of capturing the complete aural waveform, "When a sound wave is digitized, using what is called an analog-to-digital converter (ADC), it is not reproduced in its entirety; rather, select 'samples' of the wave are assigned binary numbers."[40] The waveform becomes samples, small segments of information, that then recreate

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[38] Burgess, 45-101.
[39] *Sound City*, directed by Dave Grohl, (Sundance Film Festival: Roswell Films, 2013).
[40] Katz, 138.

the wave in the digital audio workstation, or DAW, as it'll be referred to hereafter (see figures 2 and 3).

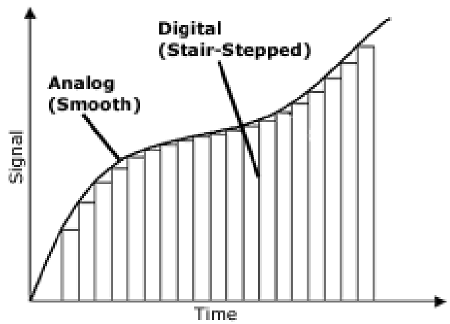

Figure 2. An overlay of digital and analog waveforms comparing the two.[41]

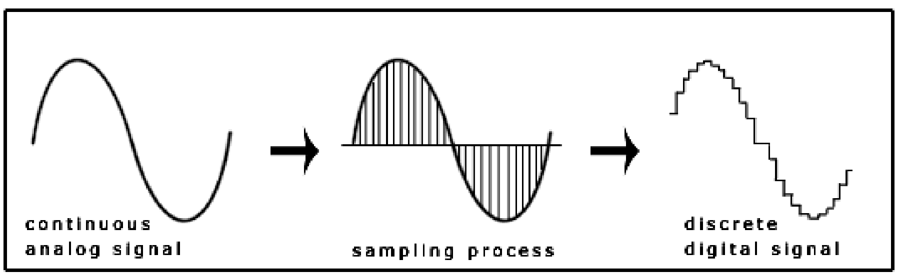

Figure 3. The process of creating a digital waveform from an analog wave using sampling.[42]

Within the DAW, music technologists can manipulate and control the smallest pieces of information, such as individual volume levels, track splicing, and effects. Dr. Stockham's Soundstream Digital System recorded the first published test recording of Santa Fe Opera in 1976.[43] Stockham's estimation of physical size, capacity, and sample rate was slightly off in his initial recordings, but "by 1982, the seventy-four-minute CD, sampled at 44.1 kHz/16 bit, debuted from Sony/Philips"[44] and set the standard for digital audio recording. With digital

[41] Tom Jeffries, "A Diagram of the Difference between Analog Audio and Digital Audio," *Blaze Audio*, 2018, www.blazeaudio.com/blog/2018/09/16/analog-audio-vs-digital-audio-5/.
[42] Azizah Abdul Manaf, "Sampling of Audio Signal," *ResearchGate*, 2012, www.researchgate.net/figure/Sampling-of-audio-signal_fig3_266488076.
[43] Burgess, 104.
[44] Burgess, 105.

recording, a preset number of channels did not limit the recording process. And many of the outboard pieces of equipment that analog recording needed, like effects or equalizers, became incorporated directly into the DAW. Music technologists have more freedom to make artistic decisions in digital audio, like those regarding miking,[45] because it has more recording capacity. By the turn of the century, music was a portable, accessible commodity.

Today, most work in music technology occurs within the digital realm. Unless one goes to a specialized studio, most use digital methods to capture the sound and produce the final work in one of many DAWs, such as Pro Tools, Ableton, Digital Performer, Reaper, Cubase, or Logic. Basic DAWs such as GarageBand come preinstalled on iMacs, which showcases the widespread influence of digital recording through the general access people have to it. Systems such as Audinate's Dante Audio Network have invented ways of transporting digitized sound over extremely long distances and created integrated networks for recording. Digital soundboards are sought after because of their higher capacity, processing power, and flexibility. Equipment generally costs less money today than at the advent of recording which, along with the widespread access, spurred the democratization of the recording process. With most of the recording process located within a laptop, recording has become more affordable and accessible for people outside of recording studios. More recording studios, and more studios not affiliated with big-name labels, exist now than ever before. Even within the digitized world, analog systems receive praise for their higher fidelity while the digital MP3 receives criticism for its lower quality, but digital recording is sufficiently embedded within the industry and here to stay.

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[45] In this thesis I have elected to use the spelling of 'miking' for the commonly spoken term used by music technologists to describe the process of selecting and placing microphones. There is no agreed upon spelling of the term currently, with the other popular alternative being mic'ing. The term is widely regarded as proper in the music technologist community even though grammatically it turns a noun into a verb; this has occurred in culture before, in how 'Googling' has become synonymous with the phrase 'look it up on the Internet.'

Music technology and the recent developments in the wider music industry have deeply influenced the consumer in the modern world. Napster and peer-to-peer sharing played a pivotal role in developing the perception of the right to obtain music for free in the twenty-first century, which now dominates Western culture. This shift in the music industry mirrored the impact that radio caused in the 1930s, yet the industry made the same major mistakes in the 2000s as they refused to change their ways to incorporate new methods of accessing music and missed their opportunity to benefit from the new technology. In both situations, little work to counteract, or prevent, the exploitation of freely shared music and the idea of music as free occurred. Instead, the music industry dug their heels in and tried to stick with what had worked in the past.[46] This tactic failed, and widespread digital distribution of music was normalized, but the benefits went to companies outside of the music industry, like to Apple with iTunes.[47] It appears that the average consumer has an awareness of technology and an acknowledgement of the importance of technology, but people also seem unaware that music technologists operate said technology. This heightens the invisibility of music technologists because it does not appear like a piece of the picture is missing at first glance.

The Musicality of Music Technologists

The combination of aesthetics and technology is crucial to music technology because it exemplifies the balance that music technologists try to achieve in their work. One must consider "the intimate relationship between aesthetics and technology and the question whether… the practical and the artistic can truly be separated."[48] The history of music technology suggests that

[46] Burgess, 122.
[47] Burgess, 126.
[48] Katz, 86.

separation between the two cannot occur because the practical and artistic interweave so much in the industry as a whole and in the individual day-to-day decisions of music technologists. Art can develop out of technological needs and, "Necessity, it seems, may sometimes be the mother of aesthetics."[49] Aesthetics tie tightly into technology and music technologists embody their intertwined nature. Both aesthetics or, in other words, musicality and technology are the priority of music technologists. Without one or the other, music technologists could not fulfill their role in the musical world; the combination of both aspects makes music technologists essential to the flow of musical communication and to music in general.

The musicality of music technologists qualifies them for inclusion in the flow of musical communication. However, people in both the music field and the public may doubt the validity of attributing musicianship to music technologists. Technical decisions can also have musical reasoning behind them though; the two realms are not mutually exclusive. For instance, performers make technical decisions that impact their musicality. Clarinetists have to decide which alternate fingerings work best for particular passages of music. This technical decision impacts the music because if the performer makes a poor decision regarding which fingering to use, the musicality of the passage becomes hindered or inaccessible. Furthermore, percussionists decide which types of sticks or mallets will create the sound desired by the composer, and trombone players need to know how far to adjust their slide position based on the chordal position of the note. The decisions regarding the hardware of performers is bound up in their musicality, and the same rings true for music technologists. Decisions regarding microphone selection, preamp selection, and microphone placement comprise some of the common technical decisions a music technologist makes, and they center around musical considerations. Like the

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[49] Katz, 98.

clarinetist decides which fingering will provide the passage with the right musical flow, music technologists select which equipment will provide the concert or recording the right musicality.

Understanding frequencies and ensemble balance serves as another example of something that presents both technical and musical considerations for music technologists. In live sound, "The purpose of putting all the instruments through the PA system is not just to make everything louder in large venues, but also to give the engineer control over the band's balance."[50] The goal of good ensemble balance has existed since the beginning of the recording industry when music technologists would reposition the performers around the phonograph's recording horn to get a better mix. Now, with higher-quality equipment, music technologists can manipulate the frequency spectrum on individual tracks. Each element needs its own space in the mix to produce a record with clarity and balance. These goals are shared throughout the musical field because:

> Whether you're a composer, an ensemble director, or an engineer, part of producing a good ensemble balance lies in knowing how to 'carve out' space in the spectrum so that all of the instruments can be heard in the desired manner with the understanding that instruments have frequency ranges that overlap each other to some extent.[51]

Unlike with a composer or an ensemble director however, the language used to describe the work done by music technologists to achieve a good ensemble balance is more technical. Directors preach about balance, listening, and how the ensemble's sound fits together, and composers discuss how they want a warm, full, or deep tone, but music technologists use vocabulary like frequency range, Hertz, and audio spectrum. The diction itself sounds more technical in how music technologists approach discussing ensemble balance. This difference in language has subconsciously supported the idea that while music technologists work toward the same goals as composers and performers, their work only resides within the technical realm and they do meet

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[50] White, 223.
[51] V. J. Manzo, *Foundations of Music Technology*, (New York: Oxford University Press, 2016), 11.

the qualifications for musicianship.

Similarly, the skill of listening that composers and performers desire is also sought after by music technologists. In the music field, “Developing a good set of ‘listening ears’ is probably the most difficult and the most important skill to acquire.”[52] Listening is a shared goal among all musicians. Good listening skills enables good music. In a symphony orchestra, the performers need to listen to their own tone, tuning, and timing, but they also need to listen to all the other parts around them and understand how their part fits into the larger picture. Composers need to listen and analyze the music they come across in their studies and visualize what they want their compositions to sound like. Music technologists’ desire and prioritization of listening points to their inherent musicality. They need listening skills to craft a good EQ (equalization), place microphones, mix shows or recordings, and generally function in their profession. Like performers, composers, and listeners, music technologists strive to have good listening skills. When the goals of music technologists align with the goals of positions that people accept as musicians, then it follows that music technologists are also musicians. The presence of shared goals, along with the musicality of said goals, illustrates the musicality of music technologists.

The comparison between recording and composition also proves useful in the analysis of music technologists’ musicality. In this comparison, the act of sound manipulation in the recording process parallels the compositional techniques composers utilize. As such, “The principles of compositional thinking represented in such terms as motif, theme, form and design are applicable to the record making progress.”[53] The act of recording mirrors the act of composition in how it sculpts and shapes the music. Furthermore, “the history of recording practice demonstrates repeatedly a process that combines songwriting, performance, arranging,

[52] Manzo, 15.
[53] Bayley, 319.

recording and mixing in an interactive artistic project whose resulting works expand traditional conceptions of musical content, meaning and style."[54] Recording includes the actions of composing and performing. A process defined by musical actions is thus musical itself.

The practice of neglecting the musicality of music technologists is not a new issue. From the beginning of the recording field, people have perceived music technologists as a purely technical part of the recording process. Fred Gaisberg can be considered the first or, at least, the most famous and successful early producer. However, "Despite Gaisberg's explicit musical contributions to his early recordings, musical ability was not considered necessary to be a recorder. It was viewed as a technical position."[55] The perception of the music technologist as a technical position that does not require musical talent stems from the development of the field and has simply persisted into the present. Changes in the field and the increasing mediation of music technology have not changed the belief in the purely technical nature of music technologists. Technology sets music technologists apart from other musicians, and while an important aspect to recognize, the constant focus on the technical elements overshadows the musical elements that music technologists also must possess. This perpetuates the idea of the music technologist as a primarily technical role instead of as a musical position that works through technology.

The misperception of music technologists as only technical also fails to acknowledge how music technologists embody numerous different aspects of the music industry in one position. Early on, people recognized that "Without intermediation of the technical, musical, and financial aspects, combined with an understanding of the end purpose for the recording, there

[54] Bayley, 321.
[55] Burgess, 17.

would be no useful product to sell."[56] The musical, technical, and financial aspects of music intertwine in the field of music technology. The perception of music technologists as only technical fails to acknowledge that "whilst there was a good deal of technical expertise required to be a successful recorder, there were also varying degrees of creative, musical, A&R, organizational, entrepreneurial, and people skills involved."[57] Like any job, music technologists have deeper knowledge and purpose than the baseline of what their job title suggests. Music technologists do more than just hit the record button in a recording session. One must remember that "The recording studio and its machines were always integrated with the creative aspects of production."[58] The musical and the technical, which music technologists embody, are two sides of the same coin. Music technologists are musicians despite the long-standing imagery of them as simply technical workers. A shift in understanding needs to occur and for this to happen, music technologists must be included in discussions of musical communication.

Seattle Pacific University Wind Ensemble Recording Case Study

For primary research I oversaw a classical recording project involving Seattle Pacific University's Symphonic Wind Ensemble. The SPU Wind Ensemble recorded three works in two three-hour sessions during a single day at the on-campus recording studio, Nickerson Studios. The pieces recorded include Morton Gould's *Pavanne*, Peter Meechan's *Soul Divine*, and John Philip Sousa's *Liberty Bell March*.[59] The SPU Wind Ensemble was a forty-five-member group at the time of this recording and followed modern standard band instrumentation, apart from lacking bassoons. People involved included Dr. Daniel Helseth as the director of the ensemble

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[56] Burgess, 16.
[57] Burgess, 18.
[58] Burgess, 42.
[59] Recordings can be accessed through Digital Commons at SPU or other music streaming services.

with Carson Talerico as recording engineer and Ron Haight as producer. Personally, I organized the logistics of the session, oversaw the set-up, participated in the session as a performer, and have since been the mixing engineer, along with producing and mastering the recordings. Despite being a relatively small-scale recording project, the SPU Wind Ensemble recording exemplifies how a basic recording session occurs, the musicianship of music technologists, and the vital role music technologists hold in the flow of musical communication.

Microphone selection and placement are the first crucial step in the recording process. For the SPU Wind Ensemble recording, I decided to use the Blumlein technique with the addition of another spaced pair for the main microphones along with numerous spot microphones (see figure 4).

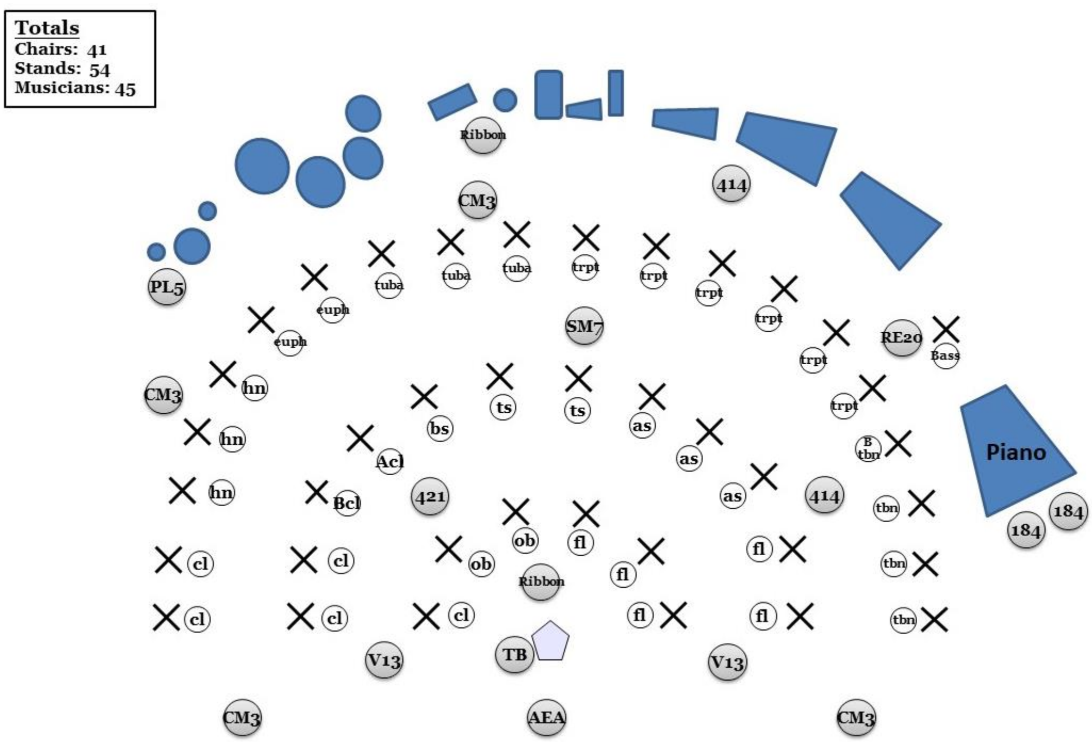

Figure 4. Diagram of chair and microphone set-up for the SPU Wind Ensemble recording.[60]

[60] Julie Bowers, "SPU Wind Ensemble Recording Microphone Set Up," May 2018, JPG.

In classical recording, stereo miking techniques are utilized to capture "phantom images of the instruments in various spots between the speakers. These image locations—left to right, front to back—correspond to the instrument locations during the recording session."[61] The goal is to capture and recreate the localization of the instruments as they were in the recording session. To achieve this, I used the Blumlein technique, which uses "two coincident bidirectional mics angled 90° apart" to achieve "sharp imaging, a fine sense of depth, and the most uniform possible spread of reverberation across the reproduced stereo stage" (see figure 5).[62]

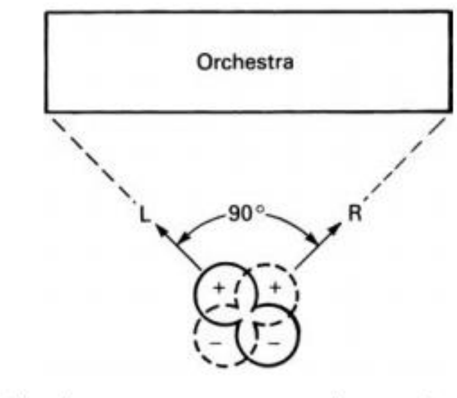

Figure 5. Diagram of two bidirectional microphones in Blumlein positioning.[63]

I used the AEA R88 microphone which contains two ribbon microphones in fixed Blumlein positioning. This ensured the correct angle between the two microphones and had the added benefit of only requiring one microphone stand and reducing the amount of equipment needed. However, with the Blumlein technique, if the microphone is placed too close to the ensemble, such as under five feet away as in the SPU Wind Ensemble recording session, "the stereo spread becomes excessive and instruments in the center of the ensemble are emphasized."[64] To

[61] Bruce Bartlett, *Recording Music on Location*, (New York: Focal Press, 2014), 135.
[62] Bartlett, 222.
[63] Bruce Bartlett, "The Blumlein or Stereosonic Technique (Coincedent Bidirectionals Crossed at 90º)," *Recording Music on Location:* (New York: Focal Press, 2014), 223.
[64] Bartlett, 223.

counteract this disadvantage, I used an AB spaced pair of condenser microphones, Line Audio CM3s; I partnered these with the AEA microphone to craft the main microphone mix for all three tracks (see figure 6).

Figure 6. Image from SPU Wind Ensemble recording session showing the microphone set-up. AEA R88 seen in middle above Dr. Helseth, with two CM3s located to either side.[65]

I used a cardioid pattern on the CM3s to eliminate possible unwanted reflections from the wall behind the microphones and spaced them about eighteen feet apart. In spaced pairs, "spacings greater than 3 feet give an exaggerated separation effect, in which instruments slightly off-center are reproduced full-left or -right."[66] However, this apparent disadvantage compensated for the over-emphasis of the center instruments from the Blumlein technique.

In addition to the main microphones, I used fourteen other microphones as spot mics in the recording session. The use of spot mics is common in classical recording because it provides

[65] Colin Chandler, "Danny Reviews Newest Take," May 2018, JPG.
[66] Bartlett, 228.

"extra control of balance and definition."[67] Each of the sections had one spot mic, which Haight repositioned between pieces to capture the soloist, if a solo occurred in the upcoming piece. For example, a Shure SM7 microphone captured the solo trumpet line in Gould's *Pavanne* and a spaced pair of Neumann KM 184s captured the piano's solo line in Meechan's *Soul Divine*. I chose to use an SM7 for trumpet because it could handle the large quantity of sound the instrument produces, has more specific directionality with its cardioid polar pattern, and has bass roll-off with an emphasis on the mid-range which mirrors the frequency range of the trumpet. I selected Neumann 184s for the piano because they are small diaphragm condenser microphones, have a high overload capacity, and have good clarity. Likewise, Haight and I chose the other spot microphones based on which would capture the instrument's tonal quality best and based on the microphone inventory of Nickerson Studios. Microphone selection and placement for the SPU Wind Ensemble recording session showcases how music technologists need both technical and musical knowledge in the initial steps of the recording process in order to accurately capture the sound produced by the ensemble. Without the sound captured well with thought devoted to microphone coloration, pattern, and placement, one eliminates the possibility for a musical recording before the recording even begins.

Determining which analog-to-digital converter (ADC) to use is the next important step in the set-up of a digital recording session. This decision dictates how the conversion of the acoustic sound into the series of 0s and 1s that recreate the soundwave in the DAW will occur and sound. Haight, Talerico, and I decided to use the Dante/Focusrite interface, predominantly for the convenience that using the in-house installed system of a studio provides. But apart from that, Dante/Focusrite has an extremely high quality of conversion and tremendous flexibility in

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[67] Bartlett, 161.

routing. The Dante system makes it simple to program the inputs and outputs of each individual microphone and route them from the studio to the recording booth. At Nickerson Studios, the routing between the XLR patch boxes located in each room is controlled by a central patch bay (see figure 7).

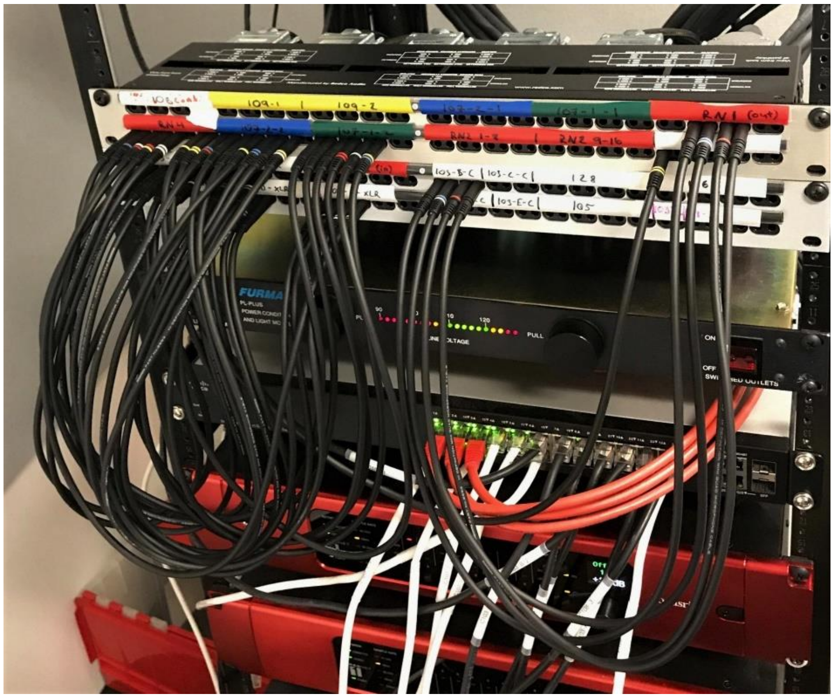

Figure 7. Nickerson Studios' patch bay showing the routing for the microphones in the recording room to their preamps through the Dante/Focusrite system.[68]

While based in technical reasoning, the analog to digital converter decision has a major impact on the music because if the ADC used has a poor conversion quality, the recording will sound poor and hinder any musicality.

Decisions regarding preamp selection have a similar relationship of technical and musical influences as analog to digital converters. Preamplifiers raise the signal level from mic-level, the lowest level, to the higher line-level needed for the DAW. Recording equipment "all expects

[68] Carson Talerico, "Nickerson Studios' Patch Bay," May 2018, JPG.

a *line-level* signal. A line-level signal is at a much higher voltage, which is to say a louder volume."[69] The DAW cannot process the low mic-level signal without increasing the amount of noise in the signal so "The first and foremost goal of a preamp is to raise the volume of a mic-level signal and to do this cleanly."[70] Raising the level cleanly ensures that any noise picked up in the recording process remains lower than the signal. Additionally, it is important to leave enough head room, or space, before the level will peak when setting the gain on the preamp. Music technologists use their musical knowledge of what specific instruments or groups sound like in order to select a preamp that enhances that sound. For the SPU Wind Ensemble recording, preamps were chosen so everything had plenty of dynamic range and there were no negative effects on the color of the microphones. On the main AEA R88 microphone, a Chameleon Labs 7602 preamp was selected. Haight chose this preamp because of its large dynamic range, its coloration, and its built-in adjustable EQ. Having a large dynamic range is especially important on the main microphone of a mix because if it is clipped or compressed, it will compromise the musical quality of the entire recording. Additionally, with this combination of the AEA microphone and Chameleon Labs preamp, it mimics the historical combination and sound of using a ribbon microphone and a Neve soundboard, which people used because it added depth and body to the sound. For consistency, Haight used the Chameleon preamps on the CM3 stereo pair also (see figure 8).

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[69] Jared Hobbs, "What is a Preamplifier? Why Do We Need Them?" Ledger Note, January 12, 2018, https://ledgernote.com/columns/studio-recording/what-is-a-preamplifier/.
[70] Hobbs, "What is a Preamplifier?".

Figure 8. Nickerson Studios' mixing desk and preamps. The Chameleon Labs preamps are light gray and located on the left, Grace Design preamps are in the middle, and Mackie preamps are on the right. The RedNet preamps are in the patch bay rack.[71]

For the spot microphones, Haight utilized a variety of different preamps. On the oboe and low woodwinds, Haight selected the Grace Design Model 1 preamp because of its transparent, clean nature (see figure 8). With a transparent preamp, the unique characteristic sounds of the oboe, bass clarinet, and tenor saxophone could come through without interference. The Mackie preamps used on most of the brass and percussion instruments were chosen because of their ease of use (see figure 8); no rewiring had to occur to use them as they were available in the studio. While they did not harm the sound, they also did not add much to the sound. Similarly, the RedNet preamps used for the piano microphones and various woodwinds are not as transparent or unique as the Grace Model 1 preamps, but they do not add unnecessary color and allow for the capture of a nice, pure sound. The decisions made by music technologists regarding preamp selection are influenced by a variety of factors, such as availability, technical excellence, and impact on the sound, all of which impact the final musical product.

[71] Julie Bowers, "Nickerson Studios' Mixing Desk," April 2019, JPG.

After the recording session has finished, the next step in the recording process involves deciding which takes captured the music best and then splicing those individual takes together into a new master take. Cutting and splicing is a common technique used in all recording sessions. It developed because "The notion of the perfect recording, transparently presenting an exemplary performance, is but a logical step from the principle of the *Werktreue* or 'authentic' performance."[72] Its name derives from how music technologists used to cut tape and splice it together when recording to tape in the late 50s and 60s. The desire and demand for an authentic, perfect performance from recordings resulted in the development and continued prevalence of the cutting and splicing technique. For the SPU Wind Ensemble recordings, Haight, Dr. Helseth, and I decided early on that we primarily wanted to splice together larger phrases that captured the musicality of the line as opposed to using extremely short takes that while technically flawless would sacrifice some of musicality. Obviously, technical excellence was a goal also, but not to the extreme of consistently splicing single-note takes together (see figure 9).

Figure 9. Example of how large sections were used to form the master take from Meechan's *Soul Divine*. The vertical lines show where the cutting and splicing occurred at.[73]

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[72] Bayley, 37.
[73] Julie Bowers, "Meechan's *Soul Divine* Edit Window," May 2019, PNG, screenshot.

During the SPU Wind Ensemble recording session, all three pieces followed the same process of recording of starting with a full take, working our way through the piece recording logical smaller sections of music, and then going back to sections that may have needed one more take at the end. After the recording session happened, Dr. Helseth, Haight, and I met to review the takes and decide which ones we would like spliced together into the master. I used 2015 Pro Tools, version 11.3.2, for my DAW because it was available in the studio and I have the most experience and confidence with Pro Tools. When cutting takes together in a DAW, the music technologist proceeds through the piece chronologically overlapping the two takes that need splicing together and shifts their position until the transition sounds as clean as possible without fades. They then add fades so in a fraction of a second the music drops to nothing and then fades into the new take without any noticeable change for the listener (see figure 10).

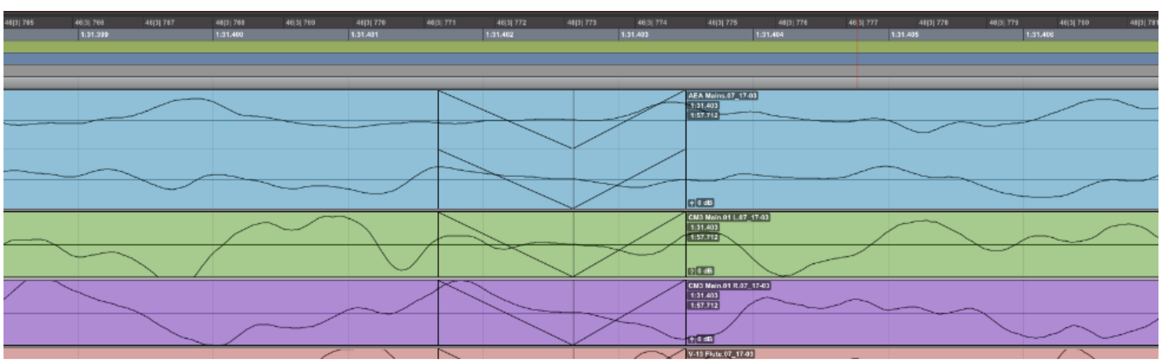

Figure 10. Example of a fade from Sousa's *Liberty Bell March*. Each light gray vertical line indicates a thousandth of a second.[74]

Out of the three pieces recorded by the SPU Wind Ensemble, Sousa's *Liberty Bell March* proved the easiest to cut and splice because Sousa composed the piece in clear episodic sections and we generally had good, technically accurate full-section takes. Gould's *Pavanne* was also

[74] Julie Bowers, "Fade Example," May 2019, PNG, screenshot.

episodic but had more technical errors so smaller sections needed splicing together in less convenient places. I had to make some single-note cuts at the end of the piece because there was no single-take where the trumpet section played the phrase with the necessary technical proficiency (see figure 11).

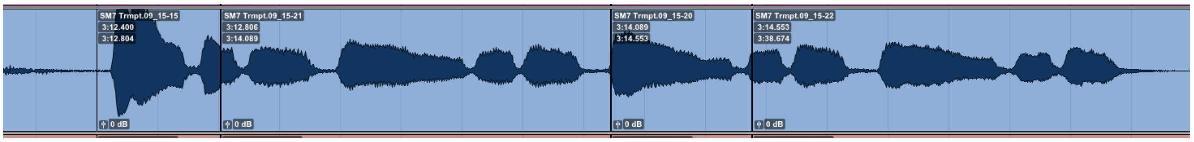

Figure 11. Trumpet track at 3:12 of Gould's *Pavanne* that showcases the minute edits made to get a technically accurate line.[75]

I tried to place my cuts between notes where possible because that is usually the most musical tactic but, in some places, I instead had to make cuts in the middle of notes to preserve the musicality of the phrase. The demand for perfection in recording from the industry and the public necessitated that I make single-note cuts in this section. Unlike the other two pieces, Meechan's *Soul Divine* has a continuous slow build into the musical climax of the piece. Consequently, I had to make some technically difficult cuts to maintain the illusion of continuous playing. To do this, I zoomed in as far as possible on the waveforms to find where the peaks and valleys would line up best and then I used an extremely short fade out and fade in to make the transition as seamless as possible (see figure 12).

[75] Julie Bowers, "Trumpet Track at 3:12 from Gould's *Pavanne*," May 2019, PNG, screenshot.

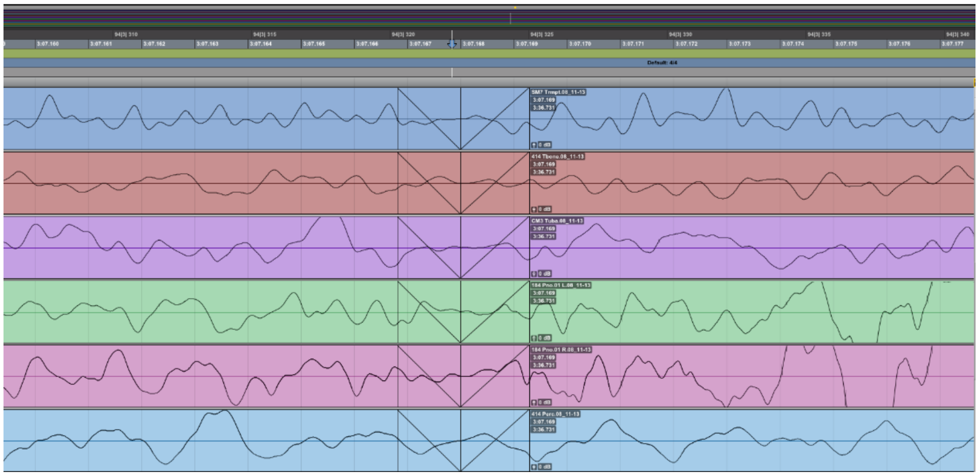

Figure 12. Example of a cut and fade made in the middle of a section of continuous playing from Meechan's *Soul Divine*. Each light gray vertical line again indicates a thousandth of a second.[76]

The decisions made by Dr. Helseth and Haight about where to make cuts and then my work to bring those decisions to life showcases a combination of musical and technical skills. Musicality decided which takes were used and where cuts occurred, unless necessity dictated otherwise, and then it required technical skills to make the transitions unnoticeable.

The mixing stage of the recording process further demonstrates how the musical and technical knowledge music technologists utilize makes them vital to musical communication in the modern world. I had to know what a wind ensemble sounded like musically to properly mix the SPU Wind Ensemble recordings. I set the CM3 spaced pair's level 7 to 10 decibels (dB) lower than the AEA R88's level on all three songs to maintain the localization captured with the Blumlein technique while adding the needed reinforcement to the extreme left and right of the mix (see figure 13).

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[76] Julie Bowers, "Splice in the Middle of Continuous Playing from Meechan's *Soul Divine*," May 2019, PNG, screenshot.

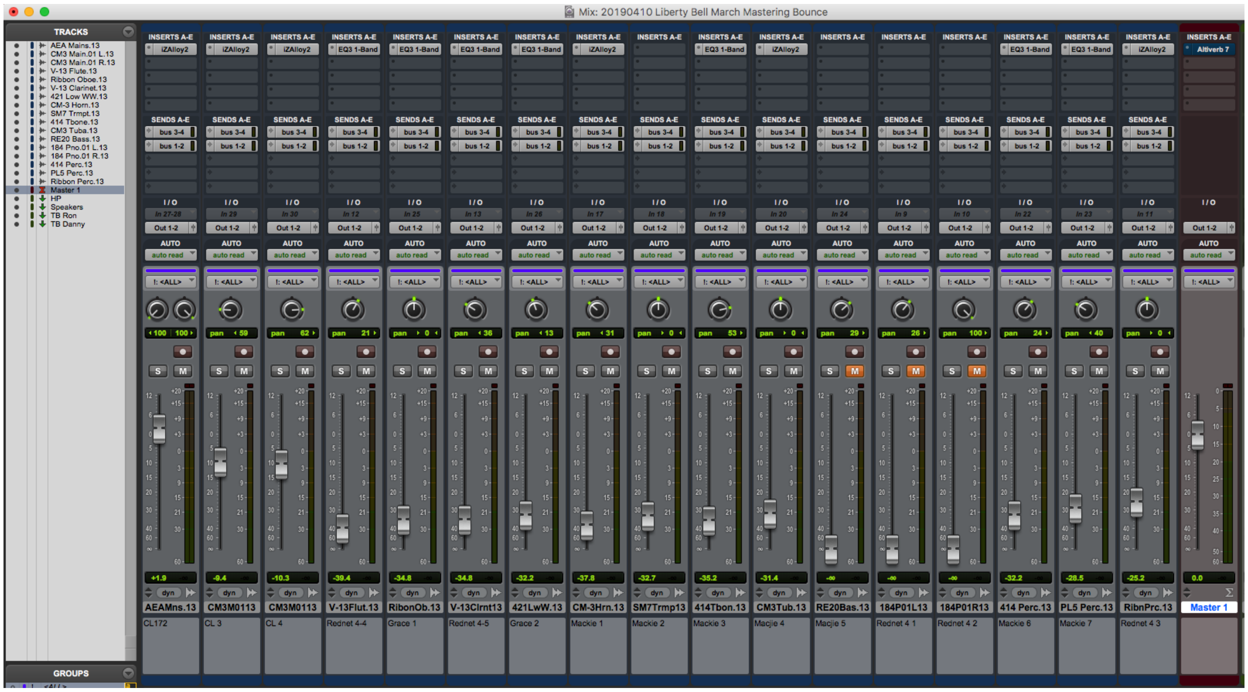

Figure 13. The mixing window of Sousa's *Liberty Bell March* illustrating the volume difference between the AEA R88, CM3s, and spot microphones. Also shows the panning on the individual tracks.[77]

Spot mics can prove difficult to mix because their panning must match its localization within the main microphones. One way to test if the panning of spot mics aligns with the main mix involves muting the individual channels to "alternately monitor the main pair and each spot mic to compare image positions."[78] This technique provides a quick way to test the accuracy of one's spot mic panning. In addition to their panning, a good mix demands a proper balance between the spot mics and the main microphones. If the music technologists mix the spot mics too loud, they overpower and eliminate the depth captured in the main stereo microphones, destroying the illusion of a live performance desired in classical recording. I set the spots mics on the SPU Wind Ensemble recordings generally 40 dB lower than the main AEA R88 microphone, with

[77] Julie Bowers, "Mixing Window from Sousa's *Liberty Bell March*," May 2019, PNG, screenshot.
[78] Bartlett, 161.

variation between each of the pieces and instruments (see figure 13). In certain instances, the spot mics got greater prominence. For instance, in Gould's *Pavanne*, at the 1:35 minute marker, an oboe and trombone duet occurs that did not sit at the front of the mix like it needed to. I automated the oboe volume to increase 25 dB and the trombone volume to increase 30 dB in their duet section, and then both returned to 35 dB below the AEA. This allowed for the duet to sit at the forefront of the mix for a brief time with the proper balance between the oboe and trombone, but not remain there past their featured section. This situation showcases a musical decision executed with technical knowhow by a music technologist. The balance between the piano and the remainder of the ensemble in *Soul Divine* also necessitated volume adjustment on the piano track in specific sections due to its soloistic nature. However, beyond adjusting the volume level of spot mics, I did not manipulate the main volume, which is sometimes done to give the illusion of greater dynamic contrast. The mixing stage of the recording process requires musical and technical knowledge from the music technologist. This stage holds major influence over the final musical product that reaches the listener. As such, music technologists greatly shape how listeners experience music from the composer and performers. Neglecting to include music technologists in the flow of musical communication misrepresents their impact on music.

EQ involves manipulating the frequency response of the audio. Music technologists can boost or cut frequencies in order to shape the frequency response of individual tracks or of the entire mix. In digital audio, applying an EQ plug-in to the track allows for this manipulation to occur. I did the EQ work on the SPU Wind Ensemble Recordings concurrently with the mixing process. A majority of the EQ work involved adding high pass filters (HPF) to eliminate the extreme low frequencies that muddled the mix to the tracks of instruments who do not live in the low frequency range. This required musical knowledge of the various tessituras of different instruments. I also used numerous low pass filters (LPF) on *Pavanne* specifically because the cymbal from the drum kit had too much prominence in the mix. By applying a single band EQ plug-in to function as an LPF on tracks such as the tubas or French horns, who sat next to the drum set in the recording session and don’t stretch too far into the high frequencies themselves, I eliminated some of the unnecessary cymbal noise and brought out the French horn’s sound (see figure 14).

Figure 14. Single-band EQ applied to the French horn track to remove the cymbal high-end.[79]

I didn’t use an actual LPF but instead severely notched the high end to mimic an LPF at the frequency where the cymbal was harshest in the French horn microphone. Music technologists often use EQ to achieve good ensemble balance because it allows each track to have its own space and definition. The oboe track in the *Pavanne* also showcases the effective use of EQ. Bleed between instruments is always a problem on spot mics and is an accepted reality of utilizing the spot mic technique. However, the oboe lacked any definition in its spot microphone as the rest of the ensemble overpowered the oboe’s sound. This issue likely occurred because of

[79] Julie Bowers, “French Horn Single-Band EQ,” May 2019, PNG, screenshot.

microphone placement. I put a 7-band EQ plug-in on the oboe track to define the oboe's tone by boosting the mid-range and cutting out the unnecessary high and low frequencies (see figure 15).

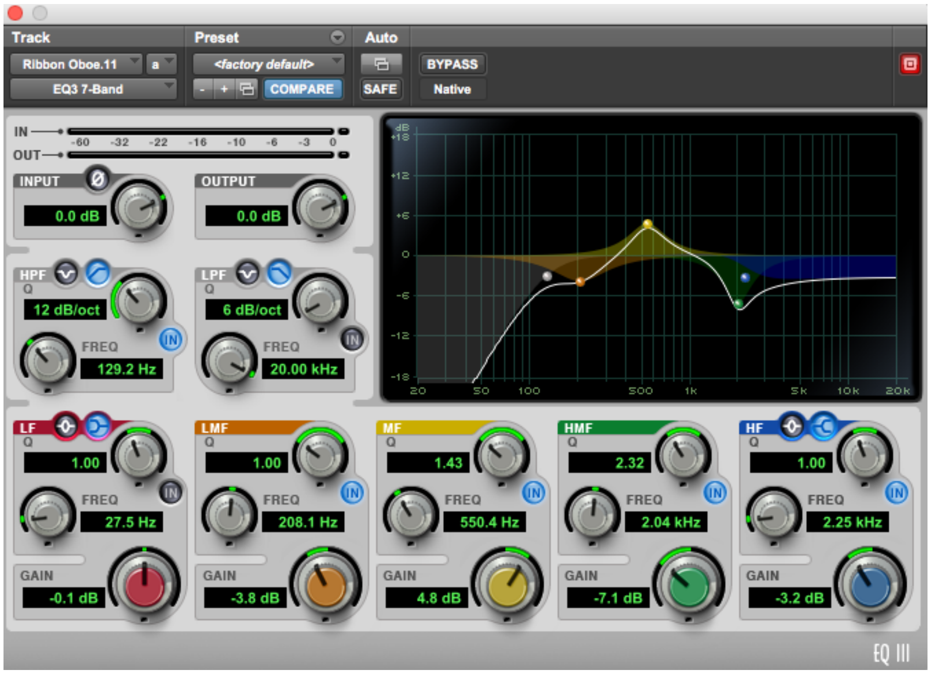

Figure 15. The EQ plug-in on the oboe track used to separate the oboe's sound from the rest of the ensemble which had bled into their track.[80]

I used my musical knowledge of what an oboe should sound like to craft the EQ to focus on the oboe sound alone without making it sound unnatural or crushed. The music technologist needs both musical and technical knowledge to sculpt EQ's to successfully match the instruments and the mix.

Mastering occurs after all the mixing work of the individual tracks has occurred. Some of the purposes of mastering include, "unifying the sound of a record, maintaining consistency across an album, and preparing for distribution."[81] As the final step, mastering is the last place to catch and fix any errors and ensure that the recording has the sonic qualities one desires; "the

[80] Julie Bowers, "Oboe Seven-Band EQ," May 2019, PNG, screenshot.
[81] "What Is Mastering and Why Is It Important?," *iZotope*, iZotope Inc, 1 Mar. 2019, www.izotope.com/en/blog/mastering/what-is-mastering.html.

role of the mastering engineer has expanded to become the final check for both the technical and artistic aspects of a project."[82] It is one of the more specialized positions in the music technology field and consequently requires more technical explanation. Originally mastering did not occur separately from the mixing process, but it eventually became required to ensure a positive experience for the consumer.[83] Like most of music technology, "mastering remains a combination of practical and aesthetic processes."[84] Mastering requires intense focus, understanding of market standards, technical knowhow, sonic awareness, and musical knowledge in order to craft a professional-level, good recording.

Haight and I worked together on the mastering as I did not have enough prior experience and because mastering requires a new perspective on the tracks so having a different person work on it inherently provides that. Haight and I began by bouncing out all the completed mixes as stereo wav files and creating a new Pro Tools session to work in. This allowed us to make sure all the tracks had the same sound and feel. Gould's *Pavanne* and Sousa's *Liberty Bell March* had the same initial volume level, but Meechan's *Soul Divine* did not reach the same volume in its loud sections. To counteract this, Haight moved the song to a different track in the session and raised the volume fader until the loud sections sounded the same between the three songs (see figure 16).

[82] Michael Romanowski, "Five Things To Know About Mastering Your Music," *ProSoundWeb*, 7 Dec. 2015, www.prosoundweb.com/channels/recording/five_things_to_know_about_mastering_your_music/.
[83] "What Is Mastering?," *iZotope*.
[84] "What is Mastering?," *iZotope.*

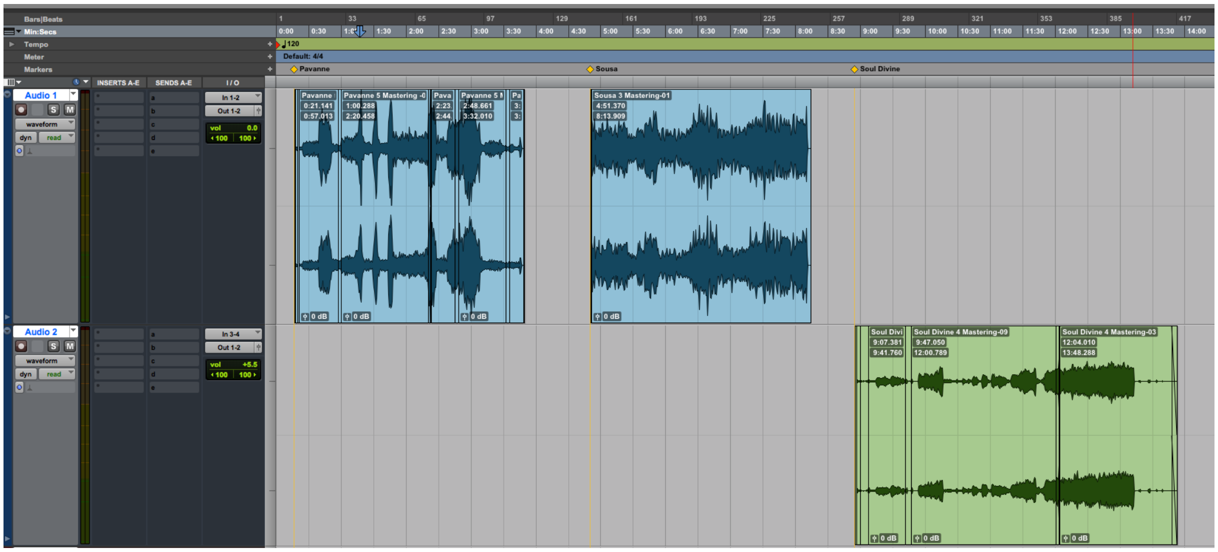

Figure 16. In order, Gould’s *Pavanne*, Sousa’s *Liberty Bell March*, and Meechan’s *Soul Divine* in the Mastering session’s Pro Tools mixing window.[85]

Even in judging by the waveforms alone, the difference in volume is obvious. We raised the volume on the *Soul Divine* track 5 dB to reach a consistent volume. With this problem addressed, Haight moved onto applying a denoiser to the master fader. This removes the quiet background noise that naturally occurs in recordings, such as from air ventilation systems or traffic outside the recording studio. It may seem minor and inaudible, but it provides for a cleaner recording. Haight used the RX^3 Denoiser for this task (see figure 17).

[85] Julie Bowers, “Mastering Mixing Window,” May 2019, PNG, screenshot.

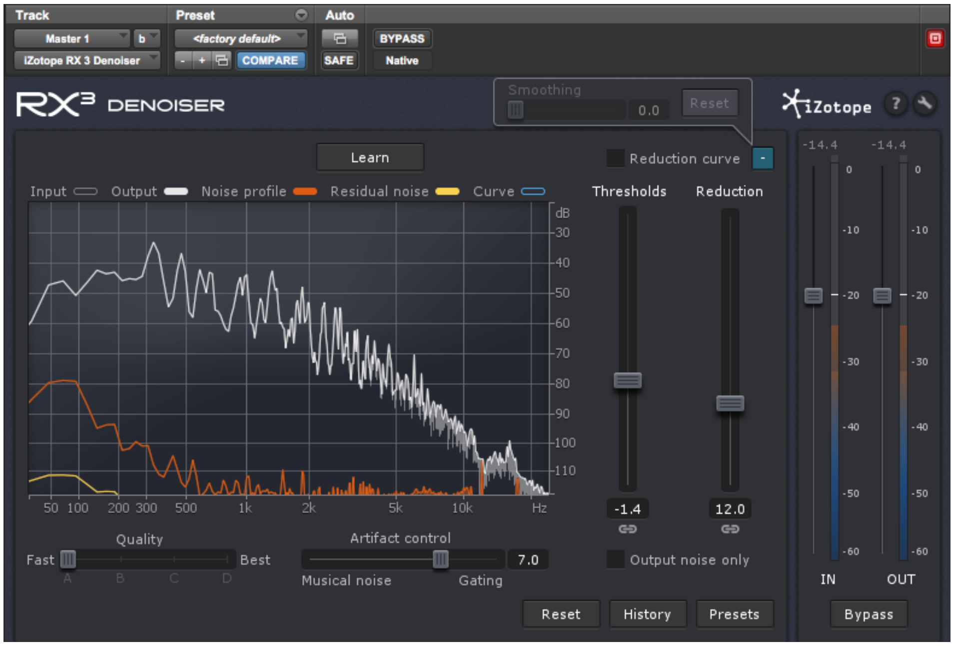

Figure 17. RX^3 Denoiser plug-in with the orange line representing the background noise that's being counteracted and the white line as the noise profile of the song itself.[86]

He selected a section of silence in the recording, had the denoiser learn the baseline background noise that exists, and then the program counteracted it in the tracks. In the case of the SPU Wind Ensemble recordings, the denoiser indicated a couple specific frequencies resonated harshly in the room. Rather than have the denoiser over-compress those sections, Haight added an iZotope Alloy 2 EQ plug-in and put in a notch at 533 Hz and 12,164 Hz to remove those problem frequencies from the mix (see figure 18).

[86] Julie Bowers, "RX^3 Denoiser on SPU Wind Ensemble Mastering Session," May 2019, PNG, screenshot.

Figure 18. iZotope Alloy 2 equalizer plug-in used on the Master fader to notch out harsh frequencies in the room for the SPU Wind Ensemble Recordings.[87]

We made fairly severe but narrow notches to combat the problem efficiently without having a detrimental impact on the sound of the final songs. These steps and decisions follow the procedure for mastering a recording, but they all work toward the final musical goal of a clear, accessible, professional record for the consumer.

Haight then added the iZotope Ozone 6 plug-in to the master fader. This plug-in allowed us to bring a professional quality sound to the Wind Ensemble recordings. Haight set it up so that the audio flowed through the equalizer, dynamics, imager, and finally the maximizer. The order of plug-ins is incredibly important decision music technologists make because it drastically influences what happens to the track and the final musical product. For example, if we applied reverberation before we notched out the problem frequencies, then the issue may be amplified by

[87] Julie Bowers, "Mastering Equalization," May 2019, PNG, screenshot.

the reverb and the notches could remove more sound information than desired. The decision regarding the order of plug-ins or elements of a plug-in is thus a musical and technical decision made by music technologists. Haight used a pre-set called CD Master on the equalizer to set the initial levels to sculpt a professional sound (see figure 19).

Figure 19. Equalizer in iZotope Ozone 6 showcasing an HPF and high frequency shelf.[88]

It included an HPF which we set to 37 Hertz because that was the lowest frequency present in the Wind Ensemble recordings. It also had a high shelf, which raises the high frequencies, that we raised a bit more to balance the high end of the band with the low end. The dynamics section simply adhered to the setting of the pre-set. Haight's work involved musical and technical knowledge and helped make the recordings cleaner and easier to listen to.

I personally did the most work in the imager for this step of the mastering process. The imager allows a music technologist to see the frequencies of the recording within a polar pattern and to adjust the broadness of the frequency ranges within that field (see figure 20).

[88] Julie Bowers, "iZotope Ozone 6 Equalizer," May 2019, PNG, screenshot.

Figure 20. Imager in iZotope Ozone 6 which shows the frequency spectrum and polar sample of the song at the time the screenshot was taken.[89]

I set the bass frequencies at -67 to center the low end and keep it within the center third of the polar sample without sounding over-compressed and unrealistic. With this adjustment the low instruments kept their fullness, but they became less overwhelming and distracting within the mix. The impact of centering the bass frequencies was most evident in Sousa's *Liberty Bell March* where the wide tuba and trombone sound overpowered the remainder of the ensemble. With the imager engaged however, the tubas and trombones came into balance with the band. I centered the low-mid range a bit to round the corners of that section of the frequency spectrum and slightly centered the highs to bring some of the high rings and cymbal hits into focus but not too much in order to maintain the localization of the cymbals. I did not influence the high-mid range because it sounded too washy when I raised the level and unnaturally crushed when I

[89] Julie Bowers, "iZotope Ozone 6 Imager," May 2019, PNG, screenshot.

lowered it. These decisions required musical knowledge to ensure that the final product did not sound sonically false.

The final step within the iZotope Ozone 6 plug-in involved setting the levels on the maximizer. The maximizer adjusts the volume level and helps make it more consistent across the songs; this is a common problem in classical recordings because they include a wide range of dynamics. Using the maximizer set a specific range for the volume of SPU Wind Ensemble recordings to reside in and helped raise their overall level. Haight set the ceiling of the maximizer to -0.4 dB and the threshold to -18.8 dB (see figure 21).

Figure 21. The maximizer in iZotope Ozone 6. The top blue line shows how the level going over the ceiling level and the meters on the right side illustrate how much of a volume boost the maximizer provided to the songs.[90]

The threshold indicates at what level the maximizer will begin to boost the volume and the ceiling sets the highest level that boost will reach. The maximizer helps add consistency to the

[90] Julie Bowers, "iZotope Ozone 6 Maximizer," May 2019, PNG, screenshot.

volume of recordings, which industry standards demand and helps the listener access the music.

With the sonic space and levels set, I moved on to repairing a few instances of distracting noise in the recordings. These moments required more attention than the mixing stage granted. With the songs in a stereo waveform, I could use the spectral repair tool to address the problem quickly and efficiently. One of these moments involved the sound of a trombone emptying their spit valve in the middle of a quiet chord in Gould's *Pavanne*. This take had good balance, blend, and tuning in the ensemble whereas none of the others did; using the spectral repair tool allowed me to use this good take and not compromise the musicality of the recording. I isolated the section with the noise and then the spectral repair program analyzed it to produce a spectrogram (see figure 22).

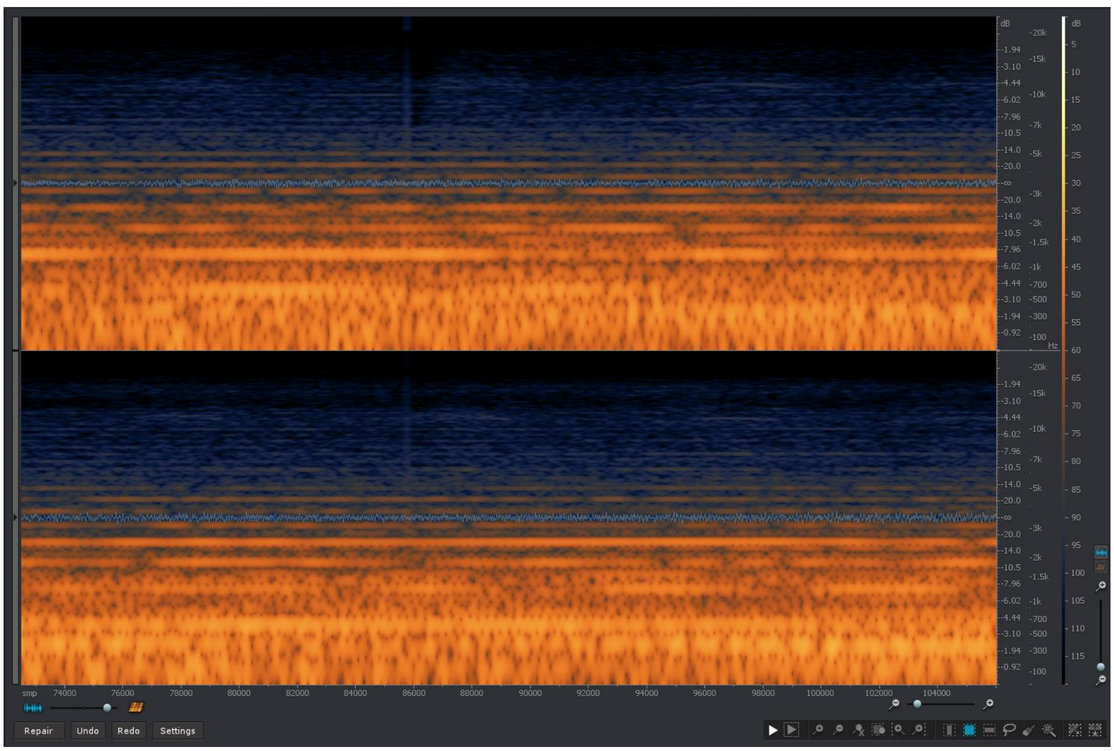

Figure 22. Spectrogram of section analyzed under spectral repair. The vertical line toward the middle showcases a noise that was repaired with this program.[91]

[91] Julie Bowers, "Spectrogram created during Spectral Repair," May 2019, PNG, screenshot.

The vertical line visually represents where the spit valve noise occurred. I highlighted the section, hit repair, and the program recognized what was out of place and eliminated it so only the nice, balanced chord remained. I applied spectral repair to five other moments in *Pavanne* where chairs scrapped across the floor, distracting background noise existed, and where a cut between takes was still audible. Sousa's *Liberty Bell March* was the cleanest recording of the three and had no spots that needed repair. In Meechan's *Soul Divine,* I applied spectral repair to two sections, one of which had a strange click and the other had a loud background noise in a solo piano section. With this technical tool, the focus of the listener could remain on the musicality of the SPU Wind Ensemble instead of drifting to interrupting noise.

Finally, I added a reverb plug-in to the master track. I used Altiverb 7 and decided on the Disney Hall in Los Angeles preset as the basic sound I wanted (see figure 23).

Figure 23. Altiverb reverberation plug-in. The right image illustrates how the reverb is applied across the frequency spectrum.[92]

I liked this preset because it did not overwhelm the recordings and it sounded similar to the space

[92] Julie Bowers, "Mastering Reverb on SPU Wind Ensemble Songs," May 2019, PNG, screenshot.

the SPU Wind Ensemble typically performs at for their live concerts. I adjusted the preset to have less bass and slightly lowered the length of the reverberation. I did this so the low end would not overwhelm the upper instruments and so Sousa's *Liberty Bell March* would remain clean. While other trains of thought exist, I decided to apply the same reverb to all three songs. This ensured that all three songs sounded like they were recorded in the same location, which was important to Dr. Helseth, Haight, and I. Since all three of the songs are very different sonically, having the same reverb helps unite them. I ended up placing the reverb plug-in before the iZotope Ozone 6 to maintain the definition and clarity Ozone 6 provided to the recordings. The reverb helped tie the recordings together and create the desired sense of space.

This evaluation of the SPU Wind Ensemble recordings provides insight into the recording process, the work of music technologists, and their musicality. While this recording session was not large-scale, it still showcases how classical ensemble recording occurs and the music technologist's role within the process. The stages of choosing microphones, placing microphones, cutting and splicing takes, applying EQ, and mixing all clearly demonstrate how a music technologist must be musical or the recording will suffer. Even the more technical decisions like choosing an analog-to-digital converter, choosing preamps, and mastering need to include musical consideration. Through analyzing the recording process, one can see the musicality required from music technologists in order to create a professional recording.

Live versus Recorded Music

The differences between live and recorded music may seem so simple that they scarcely need mentioning. Recorded music exists in the cloud, iPods, MP3s, CDs, and vinyl; live music is experienced in person at concerts. The distinction appears cut and dry. However, like the musical and technical aspects of music technologists intertwine, the recorded and the live overlap also. The impact of recordings on live performance and the impact of the ideal of liveness on recordings have greatly shaped both aspects of the music industry.

Within a short period of time, recordings have rewritten the expectations of what qualifies as good music. Recordings generally cost less than concert tickets making them more accessible. As such, they have more sway over widespread public opinion because more people experience music via recordings than through live situations. The repeatability of recordings also increases their influence over musical standards. As recordings gained prominence, “In a total reversal of earlier performance practice, the recording became the hallmark of desired sound.”[93] While live performances are fleeting and unique, recordings are preserved sound and thus repeatable, and “For listeners, repetition raises expectations.”[94] With the recordings ingrained in the listeners’ minds, live performance must meet the standards of recordings now. One needs to remember that “recorded sound is *mediated* sound. It is sound mediated through a technology that required its users to adapt their musical practices and habits in a variety of ways.”[95] Listeners have adapted their musical practices to include recordings to such an extent that now recordings form their basis of understanding music. Music no longer exists separate from recordings. Like listeners have changed their musical practices, the conception of musical communication also needs adjustment to include music technologists since they mediate recorded sound.

With the all-encompassing presence of technology in the music field, the concept of ‘live’ has expanded beyond engaging with music in a concert setting. The paradox of live

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[93] Dunbar, 339.
[94] Katz, 25.
[95] Katz, 2.

recordings exemplifies this. While the idea of liveness remains tied to live music events, "the perception of liveness depends not necessarily on the total eschewal of electronic mediation but on the persistent perception of *characteristics* of live performance within the context of—and often with the help of—various levels of mediation."[96] Instead of a separation from technology, the conception of liveness has shifted to focus on the attributes of live music, like clapping or audience noise. Live concerts utilize tremendous amounts of technological mediation, so the idea of liveness does not demand separation from the use of music technology. The simple use of amplification or digital reverberation in live shows can "challenge the perceptible connections one usually makes between physical performance gestures and the sounds resulting from those gestures."[97] Music technologists have developed the skills to create the illusion of invisibility to the general audience, but this minimizes people's perception of the overlap between the technological with the live. The attributes of live and recorded music have shifted so the two intersect and music now resides in a space beyond simple definitions. People's opinions of music technologists have not yet shifted to reflect their widespread importance in the both the live and recording sides of the music industry.

The Classical Genre and the Music Technologist

The general problem of shrouding music technologists in obscurity becomes intensified when one focuses on the classical music genre. It minimizes music technologists' presence and importance even further in comparison to popular music. This reality exists partially because wind ensembles and symphony orchestras existed long before the advent of recording and could

[96] Paul Sanden, *Liveness in Modern Music: Musicians, Technology, and the Perception of Performance*, (Routledge, 2013), 6.
[97] Sanden, 20.

perform for the masses without the assistance of technological mediation. Having developed prior to recording, "classical music had already attained its perfect sounding form in the natural sound world, it gave the project of recorded representation something to aim for as recordists sought to push the electronic wizard even further behind the veiling curtain."[98] As such, "recording technology must also reckon with long-standing aesthetic beliefs, ideological traditions and performance practices."[99] Classical music wanted to reap the benefits of the new technology without displaying the change to the audience. Even though classical concerts do not always require sound amplification, music technologists do not simply disappear from the picture. The perception of the live performance just masks their participation. But music technologists are involved in the classical music genre and play an important part in live classical concerts, such as handling stage changes or operating the conductor's microphone so they can effectively communicate with the audience. Even though classical music has existed separate from music technology, now that the two coexist, classical music needs to acknowledge the role that music technologists hold in their field.

Music technologists also remain hidden in the recording process for classical music, which is ironic considering that recording necessitates music technologists. In classical music recording, "The norm… has been the construction of a recording that can be heard as representing the reproduction of a single performance from one privileged listening position, usually the performance as it would be heard by the conductor."[100] Classical recording aims to capture the performance as it would have or could have been heard from the best spot in the house. Acoustically, the music technologist works to capture good ensemble balance and

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[98] Bayley, 311.
[99] Bayley, 307.
[100] Bayley, 96.

cohesion. Unlike in other genres where one utilizes plug-ins or effects as a musical tool, the goal in classical recording involves the portrayal of the performance as if it happened in a hall. As such, the differences in approach between the strategies for live versus studio recordings are minimal in the classical genre. Both want the same acoustic sound. Because the development of recording occurred after the establishment of the classical genre, “the practices of ‘classical’ audio recording not only conform to the aesthetic principles prevalent in Western art music but that the idealistic principles of its practice rest upon an aesthetics of illusion.”[101] Classical recording aims to portray a perfect performance, one without mistakes. However, the only way to achieve this goal is through the work of music technologists in post-production as single-take recordings very rarely live up to these standards. In live recording, these perfectionistic standards sit out of reach and the focus shifts to capturing the unique room energy live concerts create because “When the house lights dim and the performers take the stage, the musical performance truly comes to life. Whatever is not captured is lost forever (retakes are somewhat frowned upon at live events).”[102] Retakes cannot occur in live recordings, but theoretically the music will come alive. The goals of classical recording result in overlooking the involvement of music technologists, even when one understands that to have a recording, one needs a music technologist.

In addition to the classical genre’s desire to hide music technologists, the stereotypical image of a music technologist conflicts with the stereotypical image of a classical musician, which makes it harder to reconcile the two realms. The image of the rebellious rocker distances music technologists from the classical world which people perceive as sophisticated and refined.

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[101] Bayley, 37.
[102] Tim Clukey, “Capturing Your Sound: A Guide to Live Recording,” *Music Educators Journal*, vol. 92, no. 3, January, EBSCO*host*, 29.

The idea of classical music as sophisticated is extremely prevalent in the United States because they attempted to gain credit and high-standing among other European countries through classical music. European musical values followed the colonists to North America and "The concerns of European colonists and their descendants also resulted in deep-seated and enduring anxieties that North American civilization might not provide an appropriate environment for musical art."[103] The United States had, and still exhibits the tendencies of, an inferiority complex and people used classical music to as a way to feel part of high society.[104] Having music in the classical genre though does not automatically grant sophistication. Presenting classical music as superior instead damages the genre in many ways as it becomes perceived as inaccessible. But like all music, classical music exists for people to listen to and one could say "that the gift of classical music is listening itself. The music attuned itself to previously unheard and unheard-of potentialities of listening and made them available to be given."[105] If one accepts that classical music gave people the gift of listening, then music technologists are beholden to classical music because of their reliance on listening. The stereotypes of music technologists and the classical genre contradict, reinforcing the idea of their separation, when in actuality the two realms intertwine more than one would assume at first glance.

In all musical genres, music technologists hold an important role, with many working in multiple genres throughout their careers. The basic principles of signal flow and the frequency spectrum transfer between all genres of music. Each genre has its own idiosyncrasies, many of which tie into the specific musical knowledge that music technologists need, but the technical basics generally remain the same no matter the genre. In classical music, music technologists are

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[103] Ellen Koskoff, ed, *The Garland Encyclopedia of World Music*, vol. 3, (New York: Garland Publishing, 2001), 22.
[104] Katz, 56.
[105] Kramer, 22.

involved in both live and recorded performances by miking instruments, ensuring directors can speak to the audience, and supporting the performers' goal of a smooth, well-managed concert. They need musical knowledge to accurately replicate the sound of the ensemble. In the modern world, music technologists enable the performance of classical music that cannot exist apart from music technology anymore because of the standards held by concert-attendees due to the prevalence of recordings. While the perception of classical music erases the role of the music technologist, they remain vital to the creation and spread of classical music, as in other genres.

The Importance of Music Technologists

Because of the position they occupy in the flow of musical communication, music technologists are incredibly important to people's musical experience. Their work holds major influence over the final product people hear. This is illustrated in how "the primary consideration [in production] is not the process of performance but the sonic end result heard by the listener."[106] In recording, the people involved constantly cast their thoughts forward to what the listener will hear. Music technologists have a large influence over what reaches the listener through their technological and musical involvement in the recording process. In the end, the listener hears the work of the music technologists involved on the album just as much as the work of the performers. The performer mediates the work of the composer and then the music technologist mediates the work of the performer. The work of the composer and performer becomes accessible to the listener through the work of music technologists, not despite it.

A common saying in the music technology world declares that the final product will only be as good as the performers, meaning that music technologists cannot magically fix a group's

[106] Burgess, 43.

poor ensemble skills, timing, or tuning to create a “perfect” recording. Having poor performers, even with good music technologists, will lead to a poor musical experience. However, the converse is also true, even if its less acknowledged; a poor music technologist can ruin the work of good performers. Live concerts illustrate this clearly as the songs can have good composition and performance, but a bad music technologist can destroy it for both the performers and the listener. The performers can feel neglected or frustrated if they do not receive the support they need from a music technologist and the listener will feel disappointed if they come to listen to a band they like but the mix is inaudible or painful to listen to. In live performance, “The glitz of a major public event cannot redeem a poor performance as judged in terms of musical sound.”[107] The music mediated by the music technologist is the most important part of the musical process. Music technologists can make or break a show because of their large influence over the final musical product. If they do not approach the event as a musical endeavor, they can neglect important aspects, like transitions or microphone selection, and make the whole musical experience poor. The musicality of music technologists makes them critical to music because without these qualities, the final result may be technically accurate but lack the desired musical sound.

One may argue that music technologists already have recognition and thus advocating for their musicality is a futile endeavor. While music technologists receive recognition occasionally, most of that recognition occurs after a mistake has happened. Music technologists need normalized recognition for their skills and musicality instead. Often in live events, conductors or performers only recognize the music tech team after a mistake has occurred. Even if their words are positive, music technologists become linked to their shortcomings. Acknowledgement after a

[107] Bayley, 39.

mistake is particularly damning because "In a commercially released recording a minor blemish already signifies a failure of the system – defective production."[108] Because of the intertwining of the live with the recorded, live performance also adheres to these standards. In the music industry, mistakes equal failure. Highlighting music technologists' musicality instead of their mistakes illustrates their importance to the musical process. Music technologists sit in a unique intersection between art, music, technology, and financial demands in the music industry, which makes them more valuable for inclusion in the flow of musical communication instead of disqualifying them. The saying, "Audio is the art that everyone thinks is a science; audio is the science that everyone thinks is art"[109] reveals the complicated nature of music technology. Music technology encompasses more than just technology. The creative and the technological are interwoven to form the core of music technology and recognition of both aspects is essential to acknowledging the importance of music technologists.

Conclusion

Due to their musicality and the critical influence they have over the final musical product, music technologists need to be incorporated into the flow of musical communication alongside composers, performers, and listeners. Music technologists need technical *and* musical knowledge to fulfill their obligations and role in the music world. The elephant in the room regarding music technologists is the popularity and widespread use of home recording. However, amateur composers, performers, and listeners exist, and their presence does not eliminate the inherent musicality of the roles. As such, the musicality and importance of music technologists is not

[108] Bayley, 44.
[109] Gary Zandstra, "Church Sound: Lessons Learned In Blending Science & Art," *ProSoundWeb*, EH Publishing, 27 Feb. 2017, www.prosoundweb.com/channels/church/the_right_blend_of_science_art_to_get_great_worship_sound/2/.

diminished by people who choose to engage with the musical world through home recording. Some professional music technologists even own and operate home studios. The existence of home recording does not negate the importance or musicality of music technologists. Recognition of the importance of music technologists needs to be included in conversations regarding musical communication. This change in mindset not only needs to occur in others, but it also needs to occur in music technologists themselves, resulting in them adjusting their own attitude about themselves and the role they hold in the music industry. A shift in the paradigm in thinking about music technologists needs to occur.

APPENDIX A: GLOSSARY

Acoustic: a sound that exists without needing electrical interference, consider the difference between the acoustic and electric guitar.

Analog: sound capturing and manipulation without digital interference; the entire waveform of the sound source remains intact instead of needing replication in digital code

Bass Roll-Off: a technique used by music technologists to eliminate the low frequency range (somewhere below 100 Hertz normally)

Bidirectional: a microphone polar pattern in which the microphone captures sound from directly in front of it and behind it only; also called a figure-eight after the shape of the polar pattern

Cardioid: a microphone polar pattern where the microphone captures sound from predominantly in front of it; the polar pattern looks like a compressed heart; also called unidirectional but that is a less common usage in the music technologist's vernacular

Condenser Microphone: microphones that use a capacitor to convert sound into electrical impulses, this involves having a conductive diaphragm next to a solid metal plate, the diaphragm moves because of the moving air molecules so the distance between the two parts changes and converts the sound into electrical signal

Digital: data created or replicated through series of 0s and 1s

Digital Audio Workstation (DAW): a type of computer software that allows for the manipulation of digital soundwaves

Dynamic Microphone: microphones that use electromagnetism to convert sound into electrical impulses

Equalization (EQ): a technique in which one raises or lowers specific frequencies to shape the sound; often in live sound this involves finding the frequencies that are prone to feeding back and lowering them to prevent the issue; it can also be used as an artistic tool

Fades: a transitional technique to make volume changes less sudden or cuts between takes unnoticeable; fade outs refer to lowering the volume level to silence while fade ins refer to bringing the volume level up from silence

Frequency: the rate per second at which oscillations occur, measured in Hertz

Frequency Range: the space an instrument occupies on the frequency spectrum

Frequency Spectrum: reflective of the range of human hearing, 20 Hertz to 20,000 Hertz, and generally available for EQ manipulation in most music technology equipment

Gain: the amplification of a signal, conveyed in decibels (dB)

High Pass Filter (HPF): a type of equalization that reduces the amount of low frequencies in the frequency spectrum, it allows the high frequencies to pass through while the low frequencies are reduced

Localization: where a sound sits within the stereo field of a mix

Low Pass Filter (LPF): a type of equalization that reduces the amount of high frequencies in the frequency spectrum, it allows the low frequencies to pass through while the high frequencies are reduced

Mains: a) in classical recording, the dominant microphones that the spot mics will supplement; b) in live sound, speakers right by the stage which transmit most of the sound to the audience

Microphone: a device that converts movements in air molecules created by the sound source into electrical impulses that can then be recorded or amplified

Microphone coloration: the impact a microphone has on the original sound source in changing the feel or sound of it

Miking: the action of selecting and positioning microphones

Moving Coil Microphone: a type of dynamic microphone that uses a coil placed around a magnet to convert sound into electrical signal, when the coil moves within the magnetic field, a small signal voltage occurs in the coil; commonly used for live sound work; music technologists often refer to moving coil microphones simply as dynamic microphones

Omnidirectional: a microphone polar pattern in which sound is captured equally in all directions so the polar pattern is simply a circle

Panning: in recording, where the sound is located; panning determines the localization of a track and can be utilized to create space within the mix; this is easily exemplified in Queen's Bohemian Rhapsody as the voices consistently alternate between left and right

Peaking: when the level of a track or channel gets too loud and goes above the threshold; it is then clipped by the DAW or soundboard to compensate

Peaks and Valleys: the high and low points of a soundwave

Plug-In: a feature of DAWs that allows one to add different pieces of equipment digitally to a track, common plug-ins include EQ, dynamics, compressors, or reverberation

Polar Pattern: a 360-degree representation of how a microphone is picking-up the sound

Reverberation (reverb): an effect used to change the sonic quality of a sound by adding an echo or decay of sound from a space with different acoustics

Ribbon Microphone: a type of dynamic microphone that uses an extremely thin piece of aluminum foil to convert sound into electrical signal; this method allows for the capture of more nuances of the sound because the foil follows the movements of air molecules more accurately; they are inherently bidirectional microphones because the foil can only pick up movement from the front and back

Samples: a small segment of information used to create a digital soundwave

Sampling: using a small piece of someone else's work to create something new

Sibilance: the vocal quality of words

Signal Flow: the progression of audio from the sound source to the listener hearing it; it is one of the most important aspects of music technology

Spectrogram: visual representation of a signal's frequencies in time

Splice: the joining together of two different takes

Take: one recorded segment created in a recording session

Waveform: the visual representation of sound

XLR: a type of microphone cable

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APPENDIX C: FAITH AND SCHOLARSHIP

The interaction between faith and scholarship in America has often been strained or perceived as illogical. However, this does not have to be the case and while living into scholarship and faith can prove difficult, it is not impossible. In fact, historian George Marsden explains in *The Outrageous Idea of Christian Scholarship* that scholarship cannot be separated from a scholar's individual beliefs so scholarship must exist within a larger picture of reality. Incorporating faith into scholarship thus becomes a logical endeavor for some people. As such, one should instead question God's place within this system and how belief in God changes scholarship on a large scale. Questions of moral responsibility can appear paradoxical, but "The problem is not… a lack of moral concern. Many academics have deep moral and political convictions. What they most typically lack is the ability to provide a compelling intellectual rationale for these beliefs consistent with their other intellectual commitments."[110] For faithful scholars, special revelation or the divine does not count as acceptable evidence because it is not a shared standard. Christian scholars still must have solid, verified research; faithful scholarship is not a get-out-of-jail-free card for having subpar academic work.

Furthermore, church historian Mark Noll explores some of the influences on Christian scholarship by examining the influence of the Enlightenment on Evangelical Christianity in the fourth chapter of *The Scandal of the Evangelical Mind*. Two of the most important and influential habits of the mind introduced by the Enlightenment are "a particular kind of commitment to objective truth and a particular 'scientific' approach to the Bible."[111] The Scottish form of Enlightenment thinking argued "that all humans possessed, by nature, a common set of

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[110] George M. Marsden, *The Outrageous Idea of Christian Scholarship*, (New York: Oxford University Press, 1998), 86.

[111] Mark A. Noll, *The Scandal of the Evangelical Mind*, (Grand Rapids: Eerdmans, 1994), 83.

capacities—both epistemological and ethical—through which they could grasp the basic realities of nature and morality" became the dominant form of thinking in the United States.[112] It provided an easy way to establish public virtue in a time when what had previously defined virtue, like tradition or an inherited government, was being torn down. It made arguments easy because "What need was there for a careful rebuttal of authorities, or even a careful perusal of Scripture, to justify rebellion, if it was transparent to the moral sense that such a rebellion was necessary?"[113] Appeals to moral sense came to be the dominant form of argumentation in society so one did not need to develop deeper habits of the mind. The joining of evangelicalism and the Enlightenment resulted in a weak intellectual legacy in the United States as deep thinking was not required by society.[114]

While the past intertwining of evangelicalism and the Enlightenment in America has created problems regarding intellectual rigor, removing or ignoring God in the academic sphere will not solve these problems. Instead, it seems that generalized moral rational, including statements of the divine, need to be replaced with deeper study that utilizes more forms of support and argumentation. In examining how the removal of God from academia impacts human thought, Marsden states:

> With consideration of the divine ruled out as unacademic or unprofessional, it has been widely assumed that humans can solve their own problems—as in the cult of psychotherapy, the cult of technological progress, or in the political cult of social amelioration. According to academic orthodoxy, if these problems cannot be solved by human means, then they cannot be solved at all. Cynicism is the only alternative, as we often see in academia today.[115]

Marsden argues that the removal of God from academia creates more problems than solutions. In

[112] Noll, 85.
[113] Noll, 88.
[114] Noll, 105.
[115] Marsden, 97.

music technology, the cult of technological progress appears, more than the other pitfalls in my opinion, as advances in technology are often presented as a way of “saving” music. In my own work in the field, I find myself drifting toward cynicism somedays. Marsden’s positing of faith as a solution to these issues of arrogance and cynicism that come to people and scholars was impactful to me because it offered me a new way to approach the intersection of faith and academia with the goal of a more positive outlook on scholarly work.

My honors thesis showcases my work to refute cynicism and look for positive solutions instead. The catalyst for my project came after a long day at work. I had worked a concert that evening and seen the people I worked with and care about undervalued and underappreciated. And not for the first time either. Despairingly I thought to myself, ‘Why are music techs so easily brushed aside by other musicians and people generally?’ and then I realized I had my question for my honors project. The realization that I could research the causes behind the undervaluing of music technologists and turn it into my honors thesis filled me with hope, opposed to the initial cynicism I had. Since that moment, I’ve tried to approach my work from a place of growth, openness, and realization; I believe I succeeded in my endeavor, even with the doubts and frustrations that still came throughout the research and writing process. The project was not fueled by cynicism or anger but rather by the hope that the view of music technologists from other musicians, the wider public, and from within themselves could improve.

While my thesis does not focus on a theological issue, the idea of seeing the unseen is very common in Christian Scriptures. With Abraham, Hagar, the Israelites in Egypt, Ruth, Mary, the woman at the well, and countless others, God continually shows how God cares for those unseen by others in the Bible. These connections between my faith and my thesis came later for me as I struggled to work out why I was so passionate about my thesis topic. I came to realize it was rooted in my belief in the humanity of all people, which stems from my Christian upbringing and faith, even though Christianity itself has failed countless times to do this very thing. I've had to wrestle with where the line falls between working a service-based job and the humility that requires with my belief in the importance of the recognition to one's humanity. I still don't have a definite answer, but I do believe that people need credit for their work and their skills despite what kind of job they hold. All people have an inherent worth and humanity that cannot be defined by their job.