

**THE STUDY OF BASSOON PERFORMANCE
IN THE RECORDED MEDIUM**

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ABSTRACT

The use of audio recording and playback as a way of consuming music has become as widely accepted as the use of a concert stage. Many professional classical ensembles task themselves with producing recordings regularly. At the same time, it is becoming more necessary for performing musicians to have the skills and understanding of recording technology to create their own content and evaluate their playing and the playing of others. While many publications provide detailed knowledge and assistance for recording violins, guitars, and voices, little attention has been given to the bassoon. The historical context for how the bassoon has developed within the realm of recorded music remains unexplored. Additionally, the acoustic characteristics of the bassoon are oftentimes generalized with the qualities of other woodwind instruments, and the techniques employed by audio engineers and recording studios are not analyzed in the context of the instrument's unique properties. The purpose of this paper is to provide bassoonists and audio engineers with a more comprehensive understanding of how the bassoon performance behaves in the recorded environment. Information regarding historical background, instrumental acoustics, and recording techniques will be compiled and uniquely centered around the experience of recording the bassoon. In addition, observational analysis of recorded performances will verify hypotheses made by the compiled research and demonstrate how recordings may be analyzed through the lens of this newly acquired information. The result of this research is a collection of unique instances, from both the past and present, of interaction between bassoon performance and the recorded medium which have otherwise been unappreciated.

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TABLE OF CONTENTS

	Page
ABSTRACT.....	iii
ACKNOWLEDGMENTS	iv
LIST OF FIGURES	ix
CHAPTER	
1. INTRODUCTION	1
The Problem.....	1
The Goal.....	6
The Approach.....	6
2. HISTORICAL BACKGROUND OF BASSOON RECORDING	9
Introduction.....	9
The Acoustic Recording Era.....	9
The Electric Recording Era.....	12
The Dawn of Digital Recording.....	19
Digital Audio Workstations and Modern-Day Recording	22
3. ACOUSTIC PROPERTIES AND CHARACTERISTICS OF THE BASSOON	28
Introduction.....	28
Harmonic Behaviors	29
Sound Propagation	33

Dynamics	37
Starting Transient Behavior	40
Summary	44
4. RECORDING PRACTICES CONCERNING THE BASSOON	45
Introduction.....	45
Overview of Modern Recording Technology	45
Microphones	47
Microphone Placement	49
Microphone Selection	51
Stereophonic Microphone Techniques	53
Spot Microphones	56
Orchestral Recording	61
Concert Band and Wind Ensemble Recording	65
Solo Bassoon with Orchestra or Other Large Ensemble	66
Bassoon with Piano.....	69
Small Wind Ensembles and Other Chamber Music	71
Do-It-Yourself (DIY) Recordings.....	73
Miscellaneous Recording Techniques	76
After the Microphone (Post Processing).....	77
Summary	79
5. ANALYSIS.....	81
Introduction.....	81

Bassoon Recordings of the Philadelphia Orchestra	82
Tchaikovsky's 4 th Symphony.....	88
Saint-Saëns Sonata.....	91
Conclusions.....	97
BIBLIOGRAPHY.....	98

LIST OF FIGURES

Figure	Page
2.1. 3D Spectrogram of the 1924 Recording of Stravinsky’s <i>Firebird Suite</i>	14
2.2. 3D Spectrogram of the 1927 Recording of Stravinsky’s <i>Firebird Suite</i>	14
2.3. Album Cover for <i>Vivaldi 4 Bassoon Concertos</i>	18
3.1. Graphic from Roey Izhaki’s <i>Mixing Audio</i>	32
3.2. Angular region of principal radiation for oboe, clarinet, and bassoon.....	34
3.3. Octave filter oscillogram of the initial transient for a bassoon (played note Bb 1).....	43
4.1. Seating Arrangements for a Woodwind Quintet in Relation to a Stereo Pair of Microphones.....	72
5.1. Bassoon Solo from “The Story of The Kalendar Prince”.....	84
5.2. Spectrogram of the beginning of Weber’s <i>Andante un Rondo Ungarese</i>	86
5.3. Spectrogram of the bassoon solo in <i>Scheherazade</i>	86
5.4. Bassoon Solo from Movement 2, “Andantino in modo di canzona”.....	89
5.5. Measures 1-4 of Camille Saint-Saëns Sonata for Bassoon and Piano Op. 168.....	94
5.6. Thunemann’s Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively.....	94
5.7. LeClair’s Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively.....	94
5.8. Kamins’ Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively.....	95
5.9. Dervaux’s Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively.....	95

CHAPTER 1

INTRODUCTION

The Problem

Imagine a professional bassoonist participating in a live performance with a packed audience. For all intents and purposes, the bassoonist has the satisfaction of knowing that their sound and expression is relayed directly from their instrument to the audience's ears without any filtering except for the acoustics of the hall and maybe the attentiveness of the listener. While the bassoonist's musical intentions may not always land exactly as intended, there is a general understanding that any external variables impacting the performance's reception is essentially out of their hands or anyone else's. In this setting, the passage of artistry is relatively simple and straightforward.

Take this same example and replace the live audience with an array of microphones set up for a recording session. Suddenly, staggeringly more variables are introduced, many of which the performer may be unaware of or lack the same level of understanding. Instead of having a more direct line of communication from the initial projection of sound on stage to the listeners in the seats, the performance is now filtered through at least a dozen more obstructions before being heard by the intended audience. Microphones, their position in the hall, preamplifiers, computers, and any other piece of technology involved all have the potential to impact the auditory perception of the performance. In addition, the way in which all this technology is handled by the artistic staff and engineers based on their tastes might further alter the final sound from what the

original bassoonist had intended. Even once the recording has been completed and is commercially available, the bassoonist's performance is subject to alteration by the different types of equipment and devices that listeners are using. Although it may seem daunting to introduce an unknowable number of variables in this way, and possibly remove a substantial amount of agency from the player, this is the reality of practically any musical recording.

Regardless of personal preference between enjoying performances at a concert hall or from a Bluetooth speaker in the comfort of a living room, there is no denying that recordings have become a monumental way for anyone to listen to music. A report of quarter 2 of 2022 indicated that the music streaming service Spotify had 188 million subscribers to their premium service.¹ Based on data collected from 43,000 music consumers by IFPI research in 2022, only 4% of weekly music consumption occurred at live events (including livestreaming), while the other 96% of consumption occurred via audio streaming at 24%, video streaming at 19%, and the rest coming from other sources like the radio and purchases of either physical items or digital downloads.² In the realm of classical music, the radio has remained a powerful source for consumption, with a 2018 survey from the project Classical Music Rising reporting that nearly 11 million Americans tune in to classical radio weekly.³

¹ Götting, "Spotify," 2023.

² IFPI, *Engaging with Music 2022 Report*, 2022.

³ Classical Music Rising, "Classical Music Radio Facts & Statistics," 2018.

Today, it is simply a given that professional musicians will interface with recordings in some way throughout their career. While live concerts are certainly still occurring and an important part of musical engagement, to completely abandon the prospect of creating content on any recorded platform is to ignore a substantial way that people listen to music. When thinking about how a professional and aspiring professional musician might interact with recordings, the obvious example would be performing for a commercial recording or album. However, there are countless other ways that musicians may utilize recording in their careers such as personal archival, DIY recordings for social media, audition tapes, and even simply for self-improvement. Recording has become just as integral a part in the life of a musician as the instruments they play.

Because of the relevance of recordings for the modern era of music, musicians may wish to seek a better understanding of how to record their own instruments, how an engineer might approach recording their instrument, or how other performers have been recorded in the past. For this reason, many colleges and conservatories offer rudimentary classes on recording technology for their performance students, in order to give them some understanding of the process. However, the amount of information available is dependent on the instrument in question. Naturally, a huge catalog of information can be found to explain the nature of recording the human voice. A quick online search can yield thousands of videos, blogs, and recommendations for how to record vocals. Books like *Vocal Tracks: Performance and Sound Media* by Jacob Smith explain the historical relationship between vocal performance and sound technologies. He compares the two to the relationship of visual acting and the cinematic camera. By doing so, he is able

historically explain how the rise of different vocal styles, like crooning, is connected to the microphone's ability to capture the relevant aesthetics of the style better than if it was attempted in a live setting.⁴ More recently, Rod Davies' book *Coproduction in the Recording Studio* discusses the role of a session singer in modern day recording environments. Guitars are similar, with publications like *Recording Techniques of the Guitar Masters*. While these first two examples may seem obvious because of their relevance in popular music, some classical instruments are also well informed. *Inside the recording studio: working with Callas, Rostropovich, Domingo, and the classical elite*, offers the first-hand account of Peter Andry's engineering experience with the aforementioned musicians and others such as Jacqueline du Pre and Simon Rattle. On the technical side, publications like *Recording Orchestra and Other Classical Music Ensembles* by Richard King, and *Classical recording: a practical guide in the Decca tradition* by Caroline Haigh, John Dunkerley, and Mark Rogers go into exceptional detail about the recording engineering methods used for many classical ensembles and instruments.

Despite these resources, the bassoon remains an instrument that has been woefully ignored in the discussion of recording. Even though the bassoon has just as long of a history and relationship with recording technology as any other musical instrument, there is a lack of comprehensive information that can be referenced to understand how it interacts with the recorded medium. Haigh et al offers a technical examination of how the Decca record label has approached classical recording. The book spends an entire chapter

⁴ Smith, *Vocal tracks*, 82-84.

on recording techniques for the piano, a chapter on the voice, and subchapters on the violin and cello. In contrast, the bassoon is only mentioned within a subsection of a subchapter and is lumped in with the clarinet and oboe despite possessing acoustic qualities that completely differ. Sadly, this is more attention than the bassoon would normally receive in typical recording books.

The bassoon has been a part of the lexicon of musical recording from its inception and is constantly being recorded in the present on commercial solo albums, ensemble albums, do-it-yourself projects published to social media, and more. The lack of instrument-specific discussion about the bassoon as it appears in the realm of recording leaves musicians, engineers and other listeners at a disadvantage compared to other instruments like the guitar or the voice. A performer might not recognize that an aesthetic quality they appreciate in a bassoon recording is only possible thanks to the techniques that were used to capture the audio. Engineers may not recognize the optimal practice for a specific bassoon recording project because they did not have access to information that correlated the nuances of the instrument to their craft. Furthermore, being ignorant of how the mediums of bassoon performance and recording coincide and appreciating the new artform that comes from their interaction makes it difficult, if not impossible, to use bassoon recordings for music innovation. For the bassoon to progress and excel in the digital age that is so dependent on recorded content, there must be a better understanding of how it interacts with the recorded medium itself.

The Goal

It is the goal of this paper to provide a more comprehensive understanding of how the bassoon has interfaced, and how it can interface with the medium of recording. It is not meant to be some sort of ultimate guide for how to achieve the best recorded bassoon sound. Any inferences or criticisms of other's practices or opinions that appear in this paper are included for the benefit of the discussion and are not meant to be proof that one practice is better than another. Since bassoon performance, music, and recording practices are all subjective artforms, no one guide will ever be able to quantify how to perfectly capture the sound of the instrument. Instead, this paper will compile and make accessible as much relevant information on the topic as possible so that way readers can appreciate the relationship between the instrument and recording technology. Fostering this appreciation will in turn help better intellectualize the experience of listening to bassoon recordings and allow practicing musicians and engineers to more easily pursue their version of an optimal implementation of these concepts.

The Approach

In order to facilitate a healthier understanding of what it means for the bassoon to interface with recording technology and platforms, this paper will delve into the subject from multiple different perspectives. To begin, Chapter 2 will focus on significant historical moments related to bassoon recordings. These include instances of technological advancements profoundly altering the way in which the instrument could be captured and heard on records. Additionally, this chapter highlights notable ways in which musical interpretation, repertoire and program selection, and even instrument

selection were influenced by the growth of recordings as a medium for enjoying the bassoon.

Chapter 3 provides an overview of the bassoon's unique acoustical characteristics; specifically, characteristics that are relevant to recording the instrument will be discussed. While all the attributes mentioned are present whenever the instrument is played no matter the circumstance, their presence may introduce new variables and challenges in the recording process. For example, the resonances and sound propagation of the bassoon must be considered when attempting to appropriately place microphones for the instrument. This information is pertinent to the bassoonist as well, who may be able to make alterations to their instrument or performance based on their knowledge of these acoustic characteristics.

In order to address the relatively little instruction written specifically about recording practices for the bassoon, Chapter 4 compiles the scattered mentions of direct and tangentially related practices for recording the bassoon in a variety of settings. This discussion includes relevant microphones and microphone techniques, recording practices for orchestra, chamber ensembles, and solo performances, as well as recommendations that are presented to the DIY recording enthusiast. Cross-referencing publications from the Audio Engineering Society and other sources provides an overview of how the bassoon is typically captured in these environments. A few notable cases briefly focus on optimally recording a bassoon, and it is worth noting the ways each recommendation varies based on aesthetic priorities. However, many recommendations either only reference the bassoon as being part of a larger ensemble or are generalizations

of how to record the woodwind family of instruments. In these cases, the task is to infer how the recording practice would capture the bassoon based on the context of the instrument's positioning, musical role, and the acoustic qualities outlined in Chapter 3.

To conclude this study of the bassoon as a recorded instrument, Chapter 5 will comparatively analyze various bassoon recordings in order to demonstrate how the musical expression of one's performance is influenced when captured in an audio format. This exercise will theorize ways in which significant differences in tone, articulation, character, etc. are possibly linked to the practices outlined in Chapter 4, when coupled with the acoustic knowledge discussed in Chapter 3. Several different examples are used, including settings with the bassoon functioning as an orchestral member, and a soloist. In addition, these examples will either use the same piece of music or the same performer(s) for a point of comparison, in order to limit the number of variables that may contribute to the differences in sound.

CHAPTER 2

HISTORICAL BACKGROUND OF BASSOON RECORDING

Introduction

Although the bassoon is not unique in its interconnection with the process of recording, there are significant moments in the history of recording technology that specifically impacted aspects of the instrument and its performance. In most cases, these moments were incidental, and were not intended to solely impact the bassoon. Nevertheless, the way the bassoon could be used and experienced on recordings changed dramatically throughout the course of the 20th and into the 21st century. Examining these historical moments through the perspective of bassoon performance uncovers a dynamic and evolving relationship that has previously been left undiscovered.

The Acoustic Recording Era

While their long-standing relationship is not often appreciated, the bassoon and recording technology have partnered to provide musical experiences for audiences since the turn of the 20th century. As early as 1890, the United States Marine Band had published an entire catalog of wax cylinder recordings comprised of many works by John Phillip Sousa that are known to have bassoon parts.⁵

⁵ Bourgeois, *From Fife and Drum...*, 2.

In the 1909 orchestral recording of Pyotr Ilyich Tchaikovsky's *The Nutcracker Suite*, known historically as the first symphonic record album, features the bassoon extensively.⁶

These early band and orchestra records were created during an era when only mechanical means of recording existed, also known as the "Acoustic Era." Sound was captured using a large recording horn connected to a diaphragm and cutting stylus. Because of the machine's design, it was critical that the source volume was loud enough, and that positioning of the musician(s) was carefully considered.⁷ This often resulted in ensemble configurations and instrumentations that were starkly different from live performances. The bassoon would often substitute or double lower string parts, especially in the case of songs in order to achieve a proper balance in the final recording.⁸ This utilization of the bassoon is seen frequently throughout the Victor Talking Machine Company's early music catalog, with a large majority of the performances by bassoonist William Gruner of the Philadelphia Orchestra.⁹

In addition to these instances of ensemble bassoon playing, there are many examples of the bassoon taking a more prominent or soloistic role in early recordings.

The earliest recording of the bassoon as a featured chamber instrument in the

⁶ Marcus, "Birth of a Mass Medium."

⁷ Horning, "Capturing Sound in the Acoustic Era," 11-16; Victrola, "Victor Recordings in the Acoustical Recording Era."

⁸ Kopp, "A Tale of Two Systems," 157; Horning, "Capturing Sound in the Acoustic Era," 16

⁹ Huffman, "A Chronological Listing."

Discography of American Historical Recordings is the song *Hostias et preces* by Eugenio Terziani produced by Victor Records in 1904.¹⁰ In 1911, the Rigler-Deutsch Index, Gramophone, and Victor Labels released a recording of Julius Fučík's *Polka Fantastique* (also known as *Der alte Brummbaer*), for solo bassoon and orchestra with Carl Borgwald credited.¹¹ Nothing is currently documented about Borgwald as a performer, and it is unclear if he was even the bassoonist. In a few years' time however, several more solo recordings were performed by more recognizable bassoonists like New York's Auguste Mesnard and Benjamin Kohon, and Gruner.¹²

Due to the limited 3-minute recording length of the early 10-inch 78rpm shellac discs, many of these early bassoon recordings were short, light-hearted works including a heavily truncated version of Weber's *Andante e Rondo* performed by Gruner.¹³ It wasn't until 1937 that Kohon managed to record the entirety of Mozart's *Sonata K. 292* for Bassoon and Cello using 2 12-inch discs, marking one of the first recorded instance of an entire piece that is in today's standard repertoire.¹⁴

¹⁰ Discography of American Historical Recordings, "Terziani, Eugenio."

¹¹ Discography of American Historical Recordings, "Gramophone matrix 15418b."

¹² Discography of American Historical Recordings, "Victor matrix B-24189."

¹³ Wells, "William Gruner."

¹⁴ Discography of American Historical Recordings, "Victor matrix CS-015519."

The Electric Recording Era

The release of Stokowski's recording of *Danse Macabre* in 1925 with the Philadelphia Orchestra is often cited as the beginning of the electric era of recording.¹⁵ In exchange for horns and wax cylinders, recording studios begin using microphones, amplifiers, and magnetic tape machines to capture musical performances. Unlike the previous technology, electric components were able to more effectively capture the acoustic energy produced by musical performances and the spaces they inhabit. This broadened the capturable frequency spectrum of a recording, while also allowing for the sound source to be heard more clearly over any noise that the equipment may have created. Additionally, the necessity of amplifiers made it possible for recording engineers to adjust volumes electrically, as opposed to only relying on the positioning of the musicians.¹⁶

Rapidly, the recording industry converted to the new electric recording technology and left behind the acoustic devices. Alongside these evolving companies, the Philadelphia Orchestra, under the direction of Stokowski, was eager to break new ground with Victor Records. In some cases, the orchestra re-recorded works only a few years after producing an acoustic recording in order to represent their performance with the new level of quality. An example of this is the 1924 and 1927 recordings of Stravinsky's *The Firebird Suite* which can be heard on Stokowski.org. The 1927 recording demonstrates a dramatic improvement in recording methods when compared to

¹⁵ Huffman, "1925 - First Electric Recordings of Saint-Saëns *Danse Macabre*."

¹⁶ Day, *A century of recorded music: Listening to musical history*, 16.

the older version. Not only did the use of electric microphones improve sound quality, but these recording advancements allowed Stokowski and the orchestra to record with a full orchestra (the 1924 orchestration had to be severely reduced) in the Academy of Music in Philadelphia rather than in Victor Record's facilities in Camden New Jersey.¹⁷ In particular, the bassoon solo in the *Berceuse* gives listeners a glimpse at how the new technology transformed the recorded sound of the instrument. Although it has not been verified who the performer is, it is likely bassoonist Walter Guetter heard on both recordings since he served as principal with the Philadelphia Orchestra between 1922 and 1937.¹⁸ To the modern ear, both versions still suffer from large amounts of hiss, crackle, and distortions. But when comparing the two, it's clear that the electric recording offers a fuller sound that provides more detail in the bassoonist's performance. Instead of only experiencing a direct/dry sound, the bassoon's tone is reinforced with the reverberance of the concert hall, adding to the mystery of the musical moment. The balance between the bassoon and the harps arpeggio is also greatly improved. Characteristics in vibrato and dynamic changes are heard more clearly as well.¹⁹

¹⁷ Huffman, "Leopold Stokowski.>"; Huffman, "1927 Electrical Recordings of Leopold Stokowski and the Philadelphia Orchestra."

¹⁸ Huffman, "A Chronological Listing."

¹⁹ The difference between recordings may be perceived differently depending on the listener, playback method, and the integrity of the materials (vinyl).

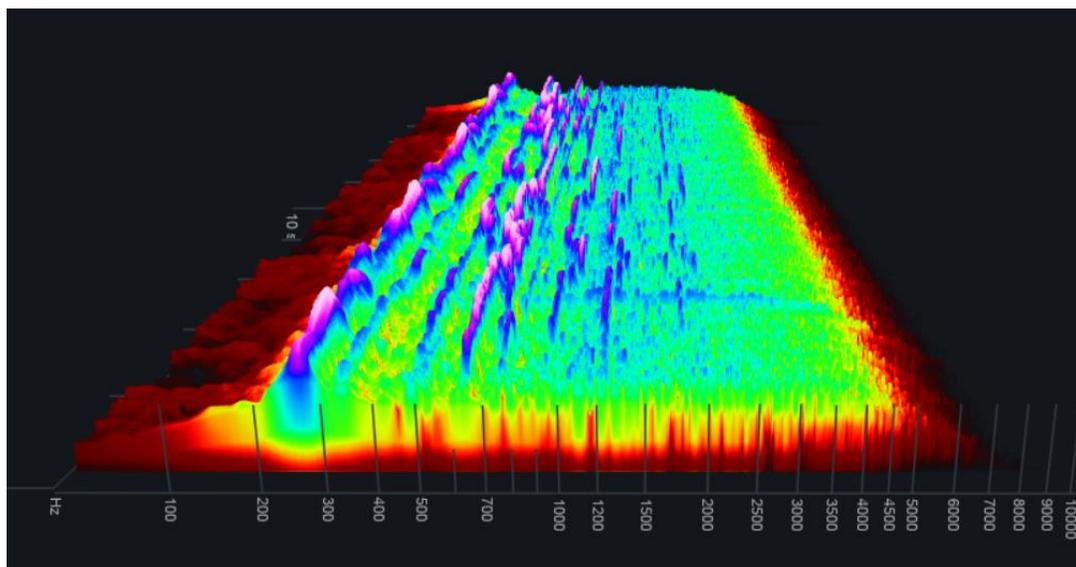


Figure 2.1. 3D Spectrogram of the 1924 Recording of Stravinsky's *Firebird Suite*. Measures 3-6 of the "Berceuse"

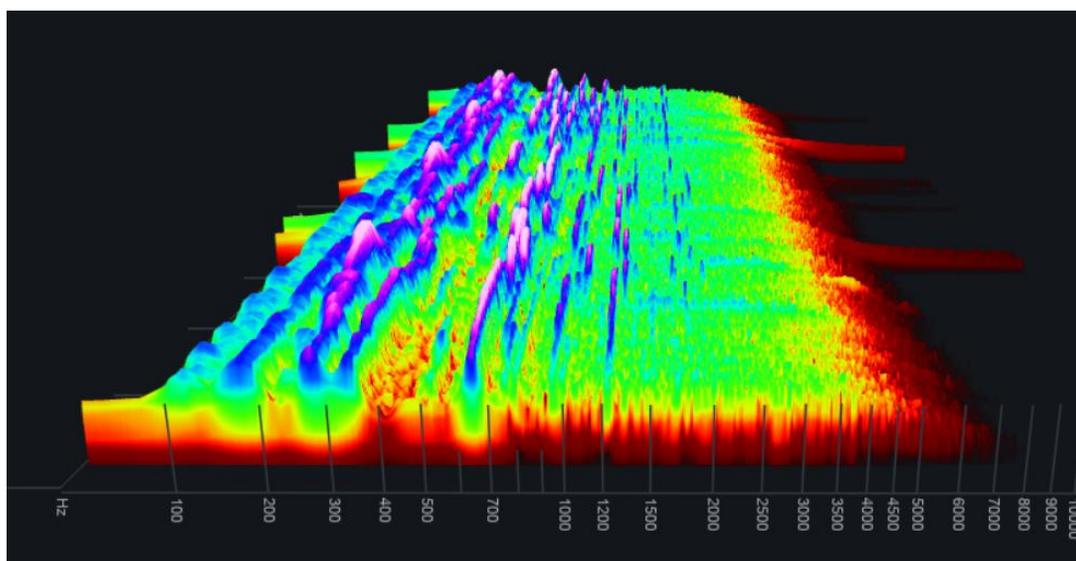


Figure 2.2: 3D Spectrogram of the 1927 Recording of Stravinsky's *Firebird Suite*. Measures 3-6 of the "Berceuse"

Figures 2.1 and 2.2 visually represent how different the tonal spectrum of the two recordings are despite being performed only three years apart by the same conductor and presumably the same bassoonist. These graphs, representing the first four measures of the bassoon solo in the “Berceuse,” show an increase in volume corresponding to the fundamental frequencies in the 1927 recording (illustrated with the larger blueish peaks). Additionally, the upper harmonics of the bassoon’s notes are of a greater amplitude as well. These differences correspond to the improvement of frequency response in the newer electronic technology.²⁰

Around the same time as the advent of electric recording technology, the ability to synchronize audio with film was turning into its own staple of the motion picture industry. Phenomenally, the combination of these two revolutions in recorded sound are suspected to have had a major impact on the culture of bassoon playing (at least in the United States). James Kopp, author of *The Bassoon*, documents that the demands of recording the bassoon led to the German styled instrument being preferred and ultimately becoming a standard over the French style.²¹ In an interview at the 1995 Domain Forget festival in Canada, bassoonist Sol Schoenbach, who was one of the first musicians to study the German bassoon at the Institute of Musical Art (now The Juilliard School), spoke on his eye-witness account of this transition.

²⁰ Philadelphia Orchestra, *The Fire-Bird*, 1924; Philadelphia Orchestra, *The Fire-Bird*, 1927.

²¹ Kopp, “A Tale of Two Systems,” 157-158.

With the advent of the talking pictures, the French bassoon, which [has a] lovely tenor voice, did not register well with the engineering of the talking pictures, the radio and everything like that, and the engineers would ask for the German-type bassoon. Gradually[,] the transition took place...²²

Schoenbach, another former bassoonist of the Philadelphia Orchestra, famously performed the bassoon solos for Disney's 1940 blockbuster "Fantasia," which included Stravinsky's *Rite of Spring* and Paul Dukas' *Sorcerer's Apprentice*. Using sound recording and visual technology to pair well-known symphonic works with Disney's cartoon animations created an artform that was able to reach a new audience of listeners/viewers who needn't worry about being well-versed in classical forms. There is no greater example of this than Schoenbach's performance in *The Sorcerer's Apprentice*, which has now been permanently intertwined with the concept of Mickey Mouse casting magic spells on brooms and buckets. In this way, technology made bassoon performance more accessible to the broader public.²³

Recording technology would continue to advance throughout the middle of the 20th century. During and after World War II, it became clear that vinyl was a much more suitable material for making records than shellac. Vinyl records were able to store longer lengths of audio (over 20 minutes per side on a 33 1/3 rpm turntable). Additionally, the material itself and the components used in vinyl turntables negated much of the hiss and background noise that was inherent in shellac records. Around the same time, magnetic tape became more commonly used for capture and master copies in the recording studio.

²² International Double Reed Society, "My Uncle had a Radio," In *The Double Reed*, 67.

²³ Clague, "Playing in 'toon.", 92-98.

This material allowed for a rudimentary editing process, taking the pressure off performers tasked with playing a consecutive 20 minutes of unblemished music. Meanwhile, the creation of stereophonic recording in the 1950s further enhanced the listening experience. With this method of recording, engineers gained the ability to capture and reproduce an illusion of space within a sound field generated by two speakers.²⁴

Sherman Walt's 1959 recording of Vivaldi Bassoon Concertos is a prime example of the effect of these innovations on a bassoon solo recording. Not only was this album distributed on vinyl, which immensely improves the noise quality when compared to the previously mentioned examples, but it was also released by RCA Victor in both mono (LM-2353) and stereo in their "Living Stereo" series (LSC-2353) as displayed in Figure 2.3. Upon listening, it becomes immediately apparent that Walt is performing from stage right (audience left) in front of the violins with the harpsichord on stage left.

This type of spatial awareness is not possible in the mono recording, where all the instrumental parts lay stacked on top of one another since the album was intended to be played back by a signal-source speaker system. The impact of hearing Walt's performance in stereo is a better sense of balance between lines. The solo bassoon no longer sounds like it is fighting for dominance against the strings because each instrument can live in its own area of the listener's auditory spatial image.²⁵

²⁴ Day, *A century of recorded music*, 19-20.

²⁵ Walt, "Vivaldi 4 Bassoon Concertos.", LM-2353; Walt, "Vivaldi 4 Bassoon Concertos", LSC-2353.



Figure 2.3. Album Cover of Vivaldi 4 Bassoon Concertos. Marketed as part of the “Living Stereo” series.²⁶

²⁶ Walt, “Vivaldi 4 Bassoon Concertos”, LSC-2353.

The Dawn of Digital Recording

Up until the 1960s and 70s, printing analog audio signals onto magnetic tape was the dominant storage solution for producing records. In fact, the entire recording process was accomplished using analog machines with the use of analog mixing consoles, effects processors, and playback devices. However, like their technological predecessors, these pieces of equipment still had dynamic limitations because of the noise and distortions that they would inevitably impart in the audio. If a signal was too quiet, the noise that the machinery would produce would drown out the intended sound. If a signal was too loud, it might be impacted by unintentional distortions because the electrical components were simply not designed to carry that high a voltage. Eventually, there became a need for a new audio medium that could cleanly handle a larger dynamic range.²⁷

As early as the 1930s, successful attempts were made in telephone technology to convert analog audio signals into digital signals using a method known as Pulse Code Modulation (PCM). Only a few decades later, recording technology companies across the world would begin using PCM as a preferred method of producing albums. By the mid-1970s, companies like Denon and Telarc had developed digital recording machines capable of capturing the entire audible frequency spectrum. Some of the earlier systems like the Denon DN-023R still relied on some form of tape (often video tape) to store their signals. But unlike the machines before, these tape recorders stored digital signals rather than analog, which yielded less static noise allowing for more clarity in the intended sound. Because of this, digital recorders had the benefit of capturing a large dynamic

²⁷ Baert, *Digital Audio and Compact Disc Technology*, 6-7.

range (up to 96 dB on digital tape), allowing listeners to almost exclusively experience the sound captured by the microphones and no other unintentional noise.²⁸

This improvement in clarity from these new digital systems was quickly appreciated by the classical recording world. Audio scholar Thomas Fine attributes some of the first commercial classical recordings using this digital technology to the Telarc company in Cleveland Ohio in 1978. These recordings included LPs with Frederick Fennell conducting the Cleveland Symphonic Winds, Loren Maazel conducting The Cleveland Orchestra, and coincidentally, another recording of Stravinsky's *Firebird* with Robert Shaw conducting the Atlanta Symphony.²⁹

Once again, the bassoon can be heard at the forefront of a new revolution in recording technology with the solo in *The Firebird's* "Berceuse-Finale" movement. When comparing this version to the 1924 and 1927 recordings by Stokowski, the improvement in fidelity is unquestionable. Any background hiss has been minimized to such a degree that it no longer interferes with the orchestra's sound (or at the very least, it is negligible). Additionally, there is less of a sense that the recording technology used distorted the frequency spectrum, since around the time of Stokowski's recordings, the threshold of upper frequencies was only at most 8000Hz.³⁰ Because there is less interference from mechanical limitations, the playing sounds more representative of an

²⁸ Day, *A century of recorded music*, 21-23; Fine, "The Dawn of Commercial Digital Recording," 2-3.

²⁹ Fine, "The Dawn of Commercial Digital Recording," 7.

³⁰ Day, *A century of recorded music: Listening to musical history*, 16.

in-person experience, and the listener can hear more musical details. For example, although it may be interpretive differences on Guetter's part, the bassoonist's tone and quality of projection in the 1978 Atlanta Symphony recording invokes a more recognizable piano dynamic. This simply does not describe the listening experience of the 1924 and 1927 Philadelphia Orchestra recordings, which may very well be a byproduct of a limited dynamic range because of the technology.³¹

While using these early digital machines was a clear advancement for commercial recording, digital audio conversion would impact the way recordings were made even further still. Not only were the studio recording machines limited due to noise and distortion, but so was the turntable and vinyl LP, the most common form of playback for consumers. The LP was estimated to have a 70-decibel dynamic range at best, and the nature of a turntable's stylus coming in physical contact with the record often yielded further noise, distortion, and long-term degradation as well. Much like the PCM studio recorders, a digital solution came with the invention of the compact disc, which has a dynamic range of 96 decibels and does not make any physical contact with a stylus or reader.³²

³¹Atlanta Symphony, *The Firebird (Suite, 1919 Version)*; Philadelphia Orchestra, *The Fire-Bird*, 1924; Philadelphia Orchestra, *The Fire-Bird*, 1927. The listener's experience may vary based on the condition of the LP record. Digital copies of the original 1978 recording are also available for purchase.

³²Baert, *Digital Audio and Compact Disc Technology*, 6-7; Day, *A century of recorded music*, 23; Maes, *Digital audio technology*, 107-108.

Not only did CDs impact the production of future releases, but several recordings that were originally released on LP were digitally remastered onto CDs, including many highly acclaimed bassoon recordings. In this way, the recorded performance of an individual was revitalized and extended well beyond its original release. One such example is Gunter Piesk's recording of the Mozart Bassoon Concerto K. 191 with Herbert von Karajan conducting which was originally released in 1973 on LP and digitally remastered and released on CD in 1987.³³

Digital Audio Workstations and Modern-Day Recording

During the same time that these digital strides were being made in the recording studio, personal computers were becoming more common and more powerful. This would eventually mean that computers would not only be a place where digital recordings could be stored, but computers could also be used as an all-encompassing environment to handle the editing, mixing, and production of entire recording projects. To accomplish this, software developers created what is known as a Digital Audio Workstations (or DAW), and one of the first significant DAWs, Digidesign's "Pro Tools" published in 1991, is still an industry standard to this day.³⁴ Pro Tools quickly replaced tape machines thanks to its ability to edit audio without destructively altering the original take, and once it improved and expanded its capabilities, the software even removed the

³³ Piesk, *Karajan Conducts Mozart Concertos; Piesk, Woodwind Concertos For Clarinet, Oboe & Bassoon*.

³⁴ Ashbourn, "The Use of Digital Audio Workstations and the Impact on Music," 97.

need for mixing consoles and other processing equipment.³⁵ In addition to Pro Tools, other workstations, such as Pyramix, have implemented sophisticated editing features for recording orchestras and other ensembles. Textbooks, like *Classical Recording: A Practical Guide in the Decca Tradition*, offer plenty of techniques and methods for fully implementing the DAW into recording sessions.³⁶

Classical music has seen the successful release of a mass quantity of albums in this current landscape of digital recording technology from big-name record labels including SONY Classical, Decca, Deutsche Grammophon, and BIS in conjunction with major symphony orchestras such as the London Philharmonic Orchestra, the Leipzig Gewandhaus Orchestra, Philadelphia Orchestra, and many more.³⁷ Thanks to these productions, modern professional bassoonists are easily heard performing a variety of repertoire in a variety of ensembles. There are also several contemporary instances of bassoonists spearheading their own recordings. Nadina Mackie Jackson, known as “the most widely recorded Canadian Bassoonist”, has led several solo recording projects, both in conjunction with the Canadian Concerto Project and independently³⁸. Bassoonist Frank Morelli’s discography includes four solo albums ranging across history in musical style.³⁹ Sergio Azzolini, has taken on the daunting task of recording the entire collection of

³⁵ Bell, *Dawn of the DAW*, 28-29.

³⁶ Haigh, et al, “Editing and post-production”, In *Classical Recording*.

³⁷ Gramophone, “The Best Classical Albums of 2021.”

³⁸ Mackie Jackson, “Nadina Mackie.”

³⁹ Morellibassoon, “CDs.”

Vivaldi's 39 bassoon concerti with orchestra, a project which has taken the better part of twenty years⁴⁰. The Vienna Philharmonic's principal bassoonist, Sophie Dervaux, released two solo albums in 2022. Mark Ortwein can be heard performing electric bassoon on his newest 2022 album *It Was Time*.⁴¹ In addition to the entertainment value, professional bassoonists have been able to use modern recording to give voice to underrepresented music and musicians, such as Lecolion Washington's album *Legacy*, which highlights the works of African American composers.⁴²

These forms of solo recordings utilize a more traditional production model involving a record label, physical distribution, and in more recent decades, the utilization of a digital distribution service. However, the influence of DAWs and modern technology has extended much farther than the professional recording studio. Having digital recording technology readily available on a personal computer has made it easier than ever for anyone to record.⁴³ Adam Patrick Bell exams this phenomenon from the popular music perspective in *Dawn of the DAW: The Studio As Musical Instrument*. Bell notes the countless resources, such as YouTube tutorials and how-to books, now available to someone interested in a Do-It-Yourself (DIY) approach to recording, thanks to the accessibility of DAWs.

⁴⁰ Discogs, "Sergio Azzolini." It is unclear as of writing this paper whether Azzolini plans to record the two incomplete concerti that Vivaldi wrote.

⁴¹ Ortwein, *It Was Time*.

⁴² Discogs, "Lecolion Washington."

⁴³ Rumsey, *Desktop audio technology*, 3.

In theory at least, the DAW in its current form has signaled the dissolution of the technological division that once shielded the so-called professional sphere. DIY recording in its current state has inherited traits from both the DIY hi-fi and the DIY lo-fi movements, marking out a new path that seeks the best of both worlds. The all-digital DIY-er demands ease of access and use, but also expects greater functionality and fidelity. The traditional means of self-sufficient learning continue to prosper with many of the aforementioned trade magazines still in circulation and an ever-expanding body of how-to books being published that feature catchy titles such as *Home Recording for Musicians for Dummies*, and *Home Recording 101: Creating Your Own Affordable Home Recording Studio (D.I.Y. Music)*⁴⁴

Nowadays, all that is required to produce a professionally formatted recording is a computer, relevant software, and some form of audio interface that can convert the microphone or input signal into a digital signal (now even smart phones are equipped with these items to a degree). By combining the convenience of DAWs and at-home recording technology with the countless social media, streaming, and music sharing platforms that allow users to upload their own audio and video, it is now easier than ever for performers to share their musicianship. Many bassoonists have a well-established presence on social media which showcases their own recording work. The YouTube channel, VG bassoonist, offers dozens of at-home recordings produced by bassoonist Fransisco Joubert⁴⁵. Similarly, arranger and bassoonist Cornelia Sommer has used her YouTube channel to upload herself playing several of her published arrangements.⁴⁶ Bassoonist Terrell Ewell will regularly post recordings of himself instructing and

⁴⁴ Bell, "Space-Less Studios."

⁴⁵ Joubert, "VG Bassoonist."

⁴⁶ Sommer, "Cornelia Sommer."

demonstrating standard bassoon etudes as part of “Bassoon Digital Professor.”⁴⁷

Scrolling through posts on Reddit, Instagram, and other social media outlets yields an abundance of homemade bassoon recordings from professionals, students, and hobbyist players.

Summary

By monitoring the bassoon as a recorded instrument throughout the lifespan of recording technology, it becomes clear that its use and effectiveness within the medium has grown along with the technology itself. Each significant recording development corresponds to tangible evolutions in the way the bassoon is presented in recordings, such as longer recording storage opening the opportunity for lengthier repertoire, or improvements in audio fidelity altering the experience of hearing the finale of *The Firebird*. This proves the existence of an ever-changing relationship between the instrument and the components of recording, that alters the musical product.

A comprehension of these moments in recorded history can give critical listeners context when they analyze the performance of their favorite bassoon recordings. This context will remain vital so long as the desire to record the bassoon or hear bassoon recordings continues to increase and the tools required continue to be more accessible. For example, when attempting to emulate the sound of a certain recording that is decades old, it may be crucial for a bassoonist or engineer to recognize the technology and methods used to capture that sound in the first place. While this may sound pedantic, it is not dissimilar to someone making the same reeds or using a similar instrument to their

⁴⁷ Ewell, “Bassoon Digital Professor.”

favorite sounding player. In another example, scholars of the instrument may be confused to find a limited number of classical standards recorded in the beginning of the 20th century, but an overwhelming number of homemade arrangements and bassoon quartets of the same player recorded today. This again can be explained by understanding the historical context of the bassoon in the recorded medium.

Moments such as the beginning of recording, to the birth of stereo, to the revelations of modern day have all impacted who, how, and what can be heard on the bassoon through a pair of headphones or speakers. Listening to a bassoonist on a recording not only provides a glimpse into their musical or instrumental prowess, but also the way they interfaced with the means of recording during their time and circumstances. Unlike the live concert hall, which remains stagnant except for some periodic renovations, history dictates that the recording platform is an ever-changing landscape that constantly represents the bassoon in a new perspective.

CHAPTER 3

ACOUSTIC PROPERTIES AND CHARACTERISTICS OF THE BASSOON

Introduction

In order to appreciate the modern relationship between the bassoon and all that is involved in making a recording, the unique characteristics of the instrument must be considered. Recording techniques such as microphone selection, microphone placement, and post processing can heavily influence/be influenced by the nature of the sound source's tonal qualities and its sound propagation. Without an understanding of the specific attributes of the bassoon, it becomes impossible to recognize the way they have become impacted by the decisions made in the recording process.

The bassoon is a folded conical-bored instrument and traces its ancestry back to the Dulcian family of instruments from the 16th and 17th centuries. It uses a double reed made from a folded and shaped piece of bamboo cane (specifically *Arundo Donax*) which is wrapped and held together by brass wire. Measuring at roughly 134cm (53.7in) with a total bore length of about 254cm (100in), the instrument lays diagonally across the body and can chromatically produce notes between Bb¹ and F⁵. Two systems of bassoon, the French and German, are currently in existence and each have their own unique characteristics. This paper will focus on the acoustic characteristics of the German system.⁴⁸

⁴⁸ Waterhouse, "Bassoon."

Harmonic Behaviors

In order to produce sound in the traditional sense, the performer excites the reed with air, causing it to vibrate and send air pressure waves down the length of the bore. These waves of vibration are complex, meaning that it can be derived from a collection of simple sine waves. Therefore, the sound can be thought of as having a fundamental frequency (which musically speaking correlates with a note name like A4 = 440Hz) and subsequent harmonics or overtones. Conical bore instruments function the same, acoustically speaking, as open-ended pipes. This means that the fundamental wavelength of the note played is twice the length of the bore (which is altered by pressing or lifting keys). The second harmonic (first overtone) is an octave above this fundamental, or the length of the bore, and each successive harmonic is increased by $\frac{1}{2}$ the bore length (the fundamental wavelength). Therefore, the third harmonic comes at $\frac{1}{2}$ the bore length above the second, which would be $1\frac{1}{2}$ of the fundamental, and so on.⁴⁹

Wavelength (λ) can be converted into Hertz, the unit for frequency (f), using the equation $\lambda = v/f$, where v is the velocity of sound in air (343 m/s).⁵⁰ When using this equation in combination with the harmonic wavelengths of the conical bore, the harmonic frequency can be denoted as $f_1, 2f_1, 3f_1 \dots$ (f_1 being the fundamental frequency), indicating the presence of even and odd harmonics in the produced sound. This differs from harmonic makeup of a cylindrical bore, like the clarinet, which only contains odd harmonics ($f_1, 3f_1, 5f_1 \dots$). In a loose sense, the resonance of a conical bore instrument can

⁴⁹ Rossing et al, *The Science of Sound*, 35, 65, 247.

⁵⁰ Rossing, et al, *The Science of Sound*, 40.

be correlated to that of sawtooth wave, easily heard using a synthesizer, which contains even and odd harmonics with proportionally decreasing amplitude as frequency increases.⁵¹

There are several reasons why the bassoon, thankfully, sounds nothing like a sawtooth wave. The first being that unlike a sawtooth wave, the bassoons harmonics do not decrease in amplitude linearly due to the unique construction of the instrument and the reed. In 1962, Paul Lehman performed an in-depth analysis on the sound and timbral behaviors of the instrument. In this study, Lehman tested the sonic behaviors of several prominent bassoon players as they performed a collection of specific pitches and volumes in an anechoic chamber.⁵² The sampled tones were recorded once per week for 7 weeks and the players were allowed to use different reeds at each sampling. With this data, Lehman concluded that the resulting amplitudes of the bassoon's harmonics are heavily influenced by a resonant formant found between 440-494 Hertz (Hz), with the formant's strongest point at 466 Hz. This means that when a pitch is played, the partial that is closest to or within the formant will be the strongest, except in the extreme low and high registers.⁵³ A weaker formant can be found between 1220-1280 Hz. In his book *Acoustics*

⁵¹ Rossing et al, *The Science of Sound*, 65.

⁵² Bernard Garfield, John Shamlan, and A.L. Angelucci of the Philadelphia Orchestra. Manfred Braun, Oskar Rothensteiner of the Berlin Philharmonic. George Goslee, Vaclav Laksar, Ronald Phillips of the Cleveland Orchestra. Charles Sirard, Lewis Cooper, Robert Pfeuffer of the Detroit Symphony.

⁵³ For Example, when an F2 is played which has a frequency of 87.31 Hz, the 5th harmonic (436.55 Hz) will be the strongest in amplitude as it is closest to the instrument's formant.

and the Performance of Music, Jürgen Meyer et al. identifies additional secondary formants at 2000, and 3500 Hz as well.⁵⁴

The implications of these formants go beyond the realm of clinical study for acousticians and pique the interest of professional bassoonists as well. For example, Lehman's findings were more recently verified by the Cleveland Orchestra's bassoonist Barrack Stees, who documented the harmonic structure of his own playing on his online blog.⁵⁵ In another instance, an interview printed in *The Double Reed* journal in 2017, the late bassoon teacher of The Eastman School of Music, Karl David van Hoesen, spoke of his fascination with analyzing the presence of these partials in relation to the lower notes of the instrument.

...All sorts of interesting things turn up, perhaps the most bizarre is listening to low "C," just a faint humming noise exists at low "C." Partial grows stronger as we move up the spectrum with the strongest one a flat "Bb" (7th partial), the "Bolero Bb," if you will. Strange to think that the greatest energy from our low "C" is really a high "Bb" that's flat.⁵⁶

⁵⁴ Lehman "The Harmonic Structure of the Tone of the Bassoon," 9 – 33; Meyer et al, *Acoustics and the performance of music*, 80.

⁵⁵ Stees, "Seeing the Sound."

⁵⁶ The International Double Reed Society, 2017, 67.

But what does this unique formant mean in the context of a recording? Like many other variables that make up the musical experience, ranges of the audible frequency spectrum are often perceived and categorized in subjective terms. These categorizations are taught to aspiring audio engineers as a way of translating what they are hearing to the technical complexities of their craft. For example, in the 2011 publication *Mixing Audio*, Roey Izhaki breaks apart the frequency spectrum with the following graphic.

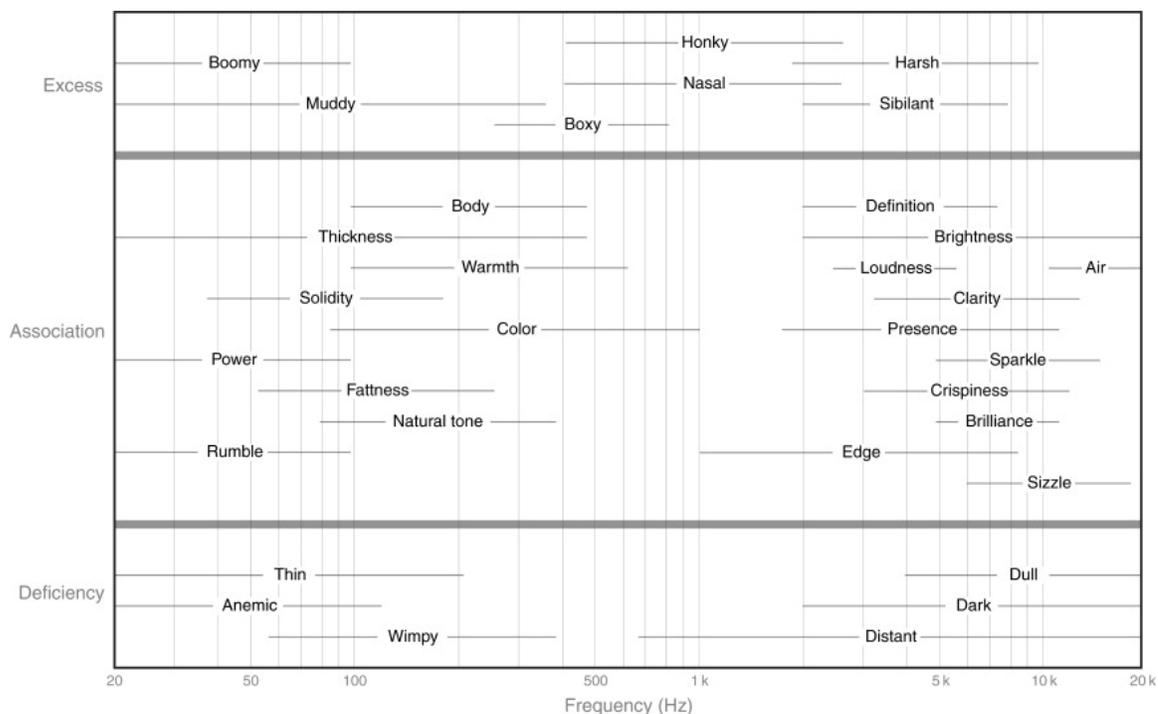


Figure 3.1. Graphic from Roey Izhaki's *Mixing Audio*. "Subjective terms we associate various frequency ranges with, and excess or deficiencies in these ranges. The terms are not standardized, and the frequency ranges are rough."⁵⁷

⁵⁷ Izhaki, 2011, 211.

Notice how in the context of this graphic, the bassoon's formant of 440 – 494 Hz is associated with adjectives such as “Body,” “Thickness,” and “Warmth.” An excess of these frequencies is considered “Boxy,” “Honky,” or “Nasal,” and a deficiency could be considered “Wimpy.” When an audio engineer records the bassoon, they would have to grapple with the aesthetic implications of how the instrument's formants are perceived and translate that to practical decisions. Would the choice of microphone, microphone placement, or hall acoustics reinforce or subtract from the instrument's formants? Does the recorded player or piece benefit from the reinforcement or deduction of these frequencies? What would happen if more of the smaller formants were featured more prominently? As with many qualities in music making, there are few objectively correct answers, and most things are left up to taste. However, considering the 440-494Hz formant, and the other formants to a lesser degree, are such a strong portion of what makes up the bassoon's sound, careful consideration of how to handle these frequencies would be beneficial when producing any recording.⁵⁸

Sound Propagation

When it comes to recording techniques, the bassoon's tonal spectrum must be considered alongside the way the sound propagates away from the instrument. At first glance, the bassoon's sound radiates outward from the instrument like the oboe and clarinet, albeit shifted lower in the frequency spectrum. Lower frequencies will propagate in a spherical or omnidirectional fashion. As the frequency increases and tone holes are opened, the radiation narrows along certain axes as certain null points appear within the

⁵⁸ Izhaki, *Mixing Audio*, 211.

spherical shape. At the higher ends of the instrument's frequency spectrum, the sound will radiate from a narrow axis out of the bell. Unlike the clarinet and oboe, the amount of reduction at certain frequencies that occurs as a result of the player's body obstructing the sound is negligible, especially since comparably lower frequencies are more capable of refracting around the player.⁵⁹

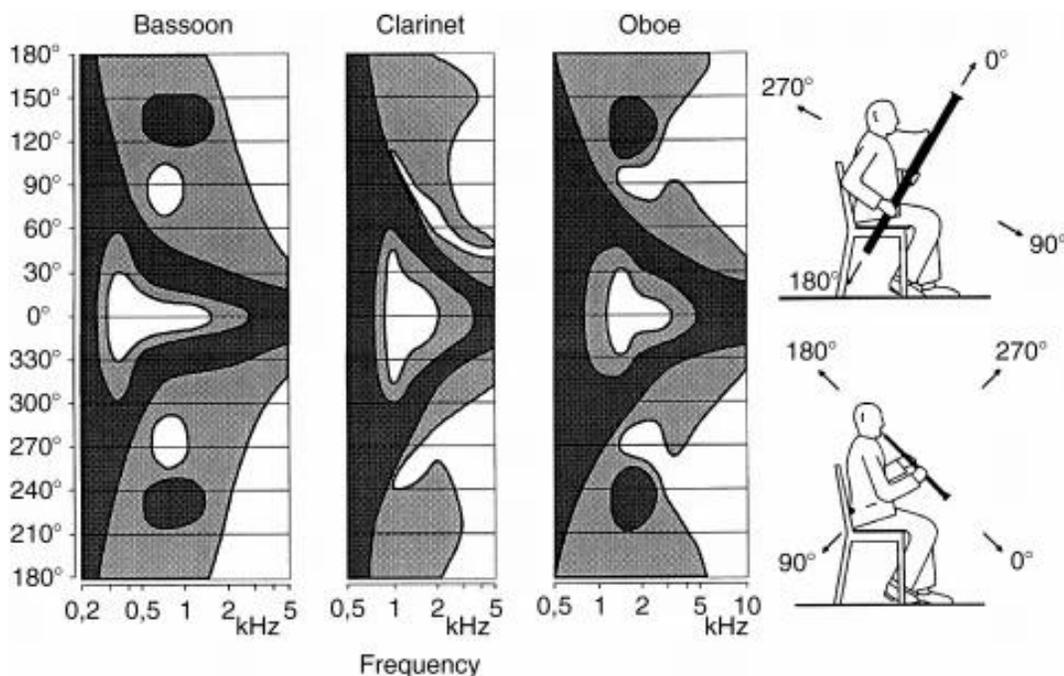


Figure 3.2. Angular region of principal radiation for oboe, clarinet, and bassoon. Average value for entire tonal range.⁶⁰

⁵⁹ Haigh et al, *Classical recording*, 60-61; Meyer et al, *Acoustics and the performance of music*, 147-148.

⁶⁰ Meyer et al, *Acoustics and the performance of music*, 147.

Ultimately, the playing position and orientation of the instrument gives the bassoon a unique sound propagation compared to the other winds. In Meyer et al's comparison of radiation between the different reeded woodwind instruments, 0 degrees is represented as the direction that the bell is pointed in line with the rest of the instrument. For the clarinet and oboe, this means that the null axis is pointed towards the floor directly in front of the player. But for the bassoon, the bell, and therefore the null axis, points upward and off the left shoulder. This means that even though the bassoon shares a similar mapping of sound propagation with the oboe and clarinet, certain bands of frequencies will be directed and interact differently within a given space. For example, the upper frequency from the bell of an oboe or clarinet will be reinforced by an early reflection from the floor. In contrast, the bassoon's upper frequencies will be pointed towards the ceiling and subjected to the reflective or diffusive properties of the venue in that direction.

This dimensional aspect of the bassoon's sound could have a great tonal effect on a recording, particularly impacting where someone may prefer to position microphones and players. Haigh et al. notes that balancing the high frequency range using microphone height, angle, and lateral position is dependent on the radiation properties of the instrument.⁶¹ For example, an impartial microphone that is placed in line with the bell would capture an overwhelming number of frequencies 3 kHz and above, but lack in harmonic content below. In contrast, a microphone placed at 30° off axis of the bell would yield more tone within the 400 – 1500 Hz range but would pick up significantly

⁶¹ Haigh et al, *Classical recording*, 152-154.

less on either side of those boundaries. Therefore, a thorough understanding of the bassoon's unique sound propagation can make sense of how a certain tonal quality was achieved or could be achieved in a recording.

Tone Holes

One of the main contributing factors to the harmonic behavior and sound propagation of woodwind instruments is the acoustic behaviors of their tone holes. In addition to shortening the length of the resonating pipe and thus raising the pitch, open tone holes will reflect lower harmonics back up into the closed portion of the bore while allowing higher frequencies to travel toward the other end of the bore. This helps explain why there is a noticeable build up of upper frequencies radiating from the bell of the instrument. However, these higher frequencies also leak out of the open tone holes themselves.⁶²

Based on their construction, the tone holes give an instrument a cutoff frequency which determines the division between the reflected lower frequencies and the radiated upper ones. For the bassoon, this falls between 350 to 500 Hz.⁶³ This means that the bassoon's open tone holes will be prone to radiate whatever harmonics are present above this cutoff frequency.

Consider the size of the bassoon and consider where the open tone-hole radiation may come from at any given time. For example, the distance between left-hand E and

⁶² Rossing et al, *The Science of Sound*, 250; Benade, *Fundamentals of Musical Acoustics*, 820-831.

⁶³ Benade, *Fundamentals of Musical Acoustics*, 892.

right-hand B tone holes is roughly 28cm (11 in). These distances create the opportunity for noticeable differences in the location of the open tone-hole upper-frequency radiance. This produces a challenge for someone trying to record the sound of the instrument in a musically pleasing way, especially at a close distance. Chapter 5 will further explore the implications of the bassoon's open tone holes in the context of a recording.

Dynamics

In addition to discovering the bassoon's unique formants, Lehman's experiment also unraveled the intricacies of the bassoon's volume range (or amplitude) and how performers achieve different musical dynamics. The players in the experiment were asked to sustain different pitches at three different musical dynamics. Pianissimo (pp) was defined as the softest sound a player could comfortably achieve, while Fortissimo (ff) was defined as the loudest. The third dynamic, mezzo forte (mf), was a pitch produced at 80 decibels. This portion of the experiment found that the average dynamic range of the performers across all registers on the instrument was 10 db. This finding was confirmed by Melville Clark and David Luce in their own research published by the Audio Engineering Society in 1964. Clark and Luce's experiment mapped the average dynamic range of all the standard orchestral instruments. When compared to the other woodwinds, the bassoon has the highest dynamic range, although it is still roughly 4.4 dB less than the average dynamic range of the string family. Additionally, Clark and Luce noted through a least-square best fit line of instrument registers that the lower registers of the bassoon have a much more reduced dynamic range, and the upper registers dynamic range is far more expanded. This change in range is attributed to the inability to play softly in the

lower registers where the attempted pianissimo dynamic of C2 is almost equivalent to a performed mezzo forte dynamic.⁶⁴

While recognizing this trend in dynamic range across the bassoon's registers is important for the purposes of recording, it is also important to keep in mind that the figure from Clark and Luce is a line of best fit and does not show the amount of dynamic variation or unevenness between notes. In another study led by Tim Grothe, an artificial embouchure and air source was used to measure dynamic variance between notes. While still verifying that the lower register suffers from a reduced dynamic range when compared to the upper register, Grothe's study found that the variation in softest dynamic between semitones on the instrument can range up to 15 dB SPL, which is bigger than the dynamic range of any one note. Crucially, this data was collected by recording the radiated sound of the bassoon at 1.5 meters away (just under 5'). Unevenness in resonance is traditionally an undesirable quality of music-making. Therefore, Grothe's experiment serves as a warning that the unevenness in resonance across the instrument can be easily captured in a recording and should be considered when microphones are placed.⁶⁵

Since Lehman's study was both a harmonic analysis and a measurement of dynamics, his findings led him to hypothesize that bassoonists may not be achieving their

⁶⁴ Lehman, "The Harmonic Structure of the Tone of the Bassoon," 9; Luce and Clark, "Intensities of Orchestral Instrument Scales," 10.

⁶⁵ Grothe, "Experimental Investigation of Bassoon Acoustics," 96, 110. It is important to note that perceived loudness is a very complicated concept and not easy to measure. However, Grothe's publication does reassure that the measured variation in SPL does in fact correlate to a difference in perceived loudness.

marked dynamics solely through sound pressure levels. He noted that pianissimo tones consistently had fewer partials than louder tones and inferred that dynamics were also conveyed by varying the harmonic content of the produced sound.

The limited extent of the instrument's dynamic range, suggests perhaps that qualitative differences may play an important role in creating a subjective impression of contrast in the mind of the listener. Perhaps the player unconsciously has conditioned himself to seek in his fortissimo tone a quality characterized by the presence of a large number of partials, and in his pianissimo tone a quality characterized by the presence of comparatively few partials. In this way it may be possible for hi[m] to compensate somewhat for the limited intensity range of the instrument [...] From such a hypothesis one may infer that the player's mental concept of the dynamic level is more important in determining the harmonic structure of the tone than the actual intensity. In seeking evidence to support such a conclusion, it may be observed that there are 11 pitches in the samplings of the professional players for which the intensity of the strongest pianissimo tone of the group is equal to or greater than that of the weakest fortissimo tone, and that in 9 of these 11 case the fortissimo tone contains more partials even though it does not exceed the pianissimo tone in intensity.⁶⁶

This hypothesis of Lehman's might also explain how the uneven resonance of the instrument is overcome by the player. In that case, the perception of an even dynamic across notes and registers is achieved through a linear sense of tone or color. An expansive dynamic range would then assume an expansive tonal palette as well. This adds another layer of complexity to recording the bassoon, since capturing gestures in dynamics now becomes inherently linked to the proper capture of the instrument's harmonic output.

Starting Transient Behavior

⁶⁶ Lehman, "Harmonic Structure of the Tone of the Bassoon", 39.

So far, the acoustic properties discussed make up the characteristics of the instrument's sound when it has reached a steady state, or sustained tone.⁶⁷ At such a point, the energy put into the instrument is at equilibrium with the output of resonant vibrations and whatever other energy the instrument will inherently absorb. But realistically, no instrument achieves this state of equilibrium immediately. First, the vibration at resonant frequencies build over time from no amplitude to their full amplitude.⁶⁸ This period of building is known as the starting sound transient or sound onset.⁶⁹

It is important to note that the starting transient is very crucial in the identification of instruments and sound characteristics. Listeners more accurately identify instruments by hearing the tonal onset beginning of a sustained note in comparison to only hearing the sound in the middle of a sustained note.⁷⁰ Therefore, for the purpose of recording the bassoon, it is worth understanding the nature of the instrument's starting transient so it can be properly represented.

⁶⁷ In the case of woodwind instruments, the term "steady state" is often substituted for "quasi-steady state" since energy must be continuously applied by the player in the form of air.

⁶⁸ Transients are measured to be the point which the sound has reached 3db below the amplitude of the stead-state sound.

⁶⁹ Meyer, *Acoustics and the performance of music*, 38-39.

⁷⁰ Siedenbug, "Specifying the perceptual relevance of onset transients for musical instrument identification," 1079, 1083; Siedenbug specifically discovered in his research that residual transient noise is of little consequence when identifying instruments. With respect to the bassoon, it may be useful to realize that noise generated at the start of an articulation, such as the sound of the tongue contacting the reed, is not a crucial part of instrument identification (however important it may be artistically).

There is a common belief amongst bassoonists and listeners alike that a bassoon has a clear and pointed attack by default. This can be partially explained by the general duration of the instrument's starting transient, on average about 40ms. To put this transient time into perspective musically speaking, a 32nd note at 144bpm would be roughly 50ms in length. While this is obviously a very short duration, it is perceptible to the human ear. In a summary of their measurements of traditional orchestral instruments (excluding percussive instruments which have comparably much shorter starting transients), Luce and Clark suggest that woodwind instruments should be considered to have a short starting transient when compared to other instrument families such as the strings. While the bassoon certainly has a shorter transient than any string instrument, it should be noted that the average duration of the bassoon's starting transient is on the longer side for orchestral woodwinds, with only the flute having a longer average duration of 80ms. Dynamics also have an inverse relationship with the bassoon's transient duration. The louder the dynamic, the shorter the transient.⁷¹

What makes these first milliseconds important? Luce and Clark's measurements would lead to the assumption that the fundamental frequency and harmonics that make up the steady-state tone would grow in amplitude uniformly during the starting transient. However, Meyer asserts that this is not the case and that the precision that is heard in the bassoon's articulation comes from a starting transient that has its own unique frequency weighting. Instead of all the frequencies contributing to the sound developing at once, lower frequencies below 200 Hz (roughly G3) take between 50-80ms to reach the steady-

⁷¹Luce and Clark, "Durations of Attack Transients of Nonpercussive Orchestral Instruments," 196.

state volume, while higher frequencies can reach their peak in 20ms. This measurement aligns much more closely with Luce and Clark's measured transient durations of other fast-transient woodwind instruments like the oboe. According to Meyer, the musical implication of this transient quality could be the tone brightening when playing staccato notes in the low register, or how extremely soft entrances are made difficult with transients this fast in the upper frequencies.⁷²

⁷² Meyer et al, *Acoustics and the performance of music*, 81.

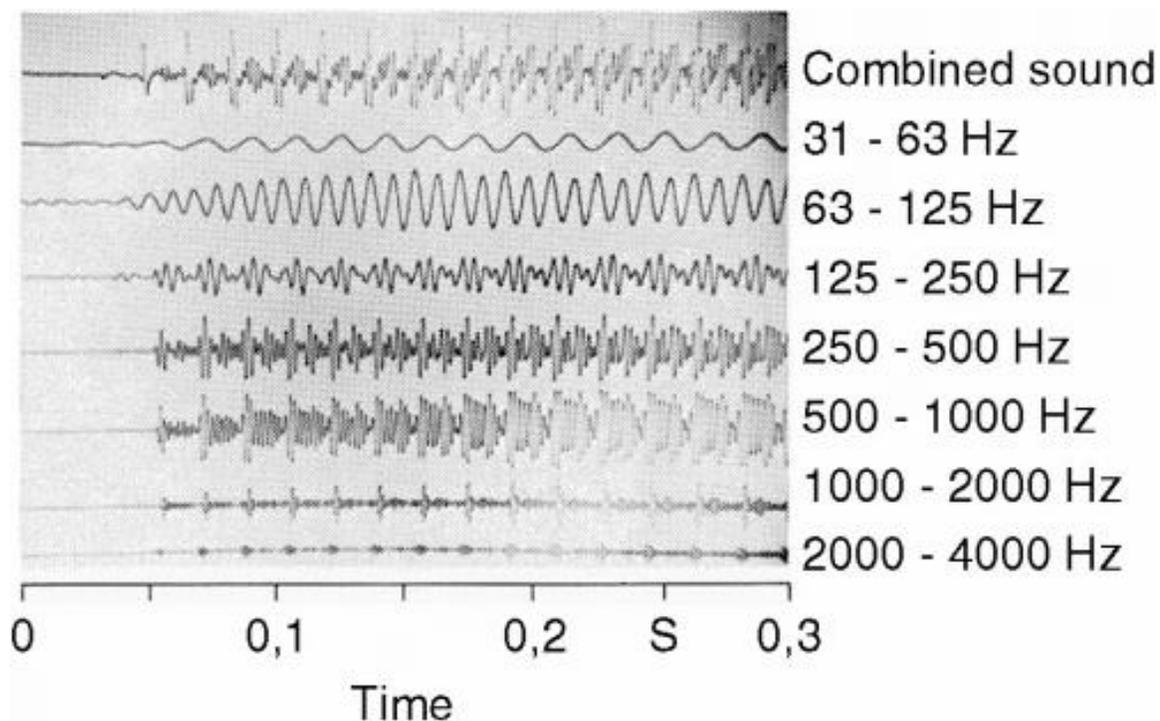


Figure 3.3. Octave filter oscillogram of the initial transient for a bassoon. Played note is Bb 1⁷³

Much of the work involved in audio engineering, for recording or otherwise, happens within the time domain as much as the frequency domain. Microphones can be rated based on their response times to the millisecond, and many tools used in audio processing are able to manipulate volume and tone in relation to time. Therefore, being cognizant of the nuances of the bassoon's transient could alter certain recording decisions based on the desired outcome.

⁷³ Meyer et al, *Acoustics and the performance of music*, 81.

Summary

Just like in a live performance, the unique acoustic characteristics of the bassoon are permanently linked to the way instrument performance is translated to the recorded medium. Every component of how the bassoon and the player produce sound defines the nature of its musical expression. But while these components may not require conscious consideration (at least quantitatively) by the performer or listener in a live setting, recording engineers are often required to measure these qualities in order to make appropriate decisions with the recording technology.

The bassoon's unique formant, dynamic tendencies across different registers, sound propagation, and transient behaviors may all contribute to different choices of microphone or recording technique. It is the author's opinion that an accurate and detailed representation of the bassoon's tone color is paramount to capturing the performer's expression. In addition, engineers must take care to not exacerbate the issues of the uneven resonances across the instrument, as well as the potential spatial issues caused by the resonances open tone holes, with poorly distanced microphones. Lastly, because the sound propagation of the instrument is unique due to its bell pointing at a different angle, it is important to not think of the woodwind family of instruments in a "one size fits all" recording approach. Chapter 4 will uncover the potential outcomes of combining the acoustic qualities of the bassoon with a myriad of commonly used recording techniques.

CHAPTER 4

RECORDING PRACTICES CONCERNING THE BASSOON

Introduction

As previously mentioned in the introduction of this paper, the bassoon is seldom discussed in the context of being performed and heard in the recorded setting (at least when compared to instruments like the guitar, violin, or the voice). This lack of discussion has made it difficult for musicians and engineers interested in recording the instrument to find a comprehensive collection of ideas and resources to utilize in their own practice. On the rare occasion that the recorded bassoon is discussed, the conversation lacks the acoustic considerations discussed in Chapter 3, making some approaches to recording less viable depending on the circumstance. This chapter aims to provide a comprehensive collection of the recording practices relevant to the bassoon that have been mentioned in different audio engineering publications and sources.

Overview Of Modern Recording Technology

In order to understand the common techniques used when listening to a bassoon recording, it is important to have some grasp of how modern-day recording works. This information will be far from exhaustive and is only meant to provide enough overview so that someone with no prior experience of recording might get their feet wet. As discussed in Chapter 2, the shift into utilizing electricity for the purpose of recording advanced the quality and capabilities of recording production tremendously, even for less obvious instruments like the bassoon. Professionals and recording enthusiasts still rely on

the innovations of electrical recording from the 20th century to this day (with some modernizations that have come from 21st century digital technology). The method for recording any sound, including the bassoon, can be generalized in the following pattern.

First, a device (typically a microphone) detects the changes in air pressure created by a sound. Those vibrations are then sent as an electric signal to an amplifier, known as a preamplifier, or preamp, which strengthens the voltage of the signal to a useable level. It is possible to then alter the qualities of that signal with other electronic equipment. This manipulation could change the tone, the volume with respect to time, the spatial quality, or dozens of other characteristics of the sound. Once the desired amount of processing has been done (which might be none), the signal can then be sent to a recording device like a tape machine.

Nowadays, electric audio signals are often converted to digital signals so that they might be recorded by computer software. There are many advantages to converting and recording audio digitally, including precision editing, nearly endless amounts of data for audio, and the ability to process the audio digitally in the same ways that were previously discussed. Once recorded, the audio can be processed and rerecorded as often as necessary to achieve the desired result, potentially being incorporated with multiple audio signals (known as mixing) in a way that produces a cohesive musical experience. The finished audio will then either be reconverted to an audio signal and sent through a speaker for listening or sent to whatever medium the recording will be distributed (vinyl, CD, audio file, etc.). Every point on this very brief and broad overview of the recording

process involves decision making that can impact the quality of the recording. Therefore, recording engineering is as much of an artform as playing an instrument.⁷⁴

Microphones

Decisions revolving around the microphone can have a critical impact on the quality of a recording. In a classical music environment, it is often (though not always) desirable to avoid a lot of post-processing and retain an authentic recreation of what it would sound like to hear the performance in-person. Therefore, a massive amount of time and energy is often put into properly choosing and implementing microphones.⁷⁵ Simply put, a microphone is a transducer that is used to convert changes in air pressure (acoustic energy) into voltage changes (electrical energy). Based on their construction, microphones can be categorized into three different types: dynamic, ribbon, and condenser.⁷⁶ Each of these types of microphones will capture sound differently.

A dynamic microphone is constructed similarly to a speaker only in reverse. A diaphragm moves back and forth with the changes in air pressure and converts that movement into electrical energy via a coil and magnet creating a magnetic field. These microphones are generally less fragile, less expensive, and ultimately less sensitive than the other two. Condenser microphones rely on an external power source, commonly 48 volts and known as “phantom power,” in order to create an electric charge across the microphones pick up when acoustic energy is detected. This design allows for more

⁷⁴ Dittmar, *Audio engineering 101*, 57-69.

⁷⁵ King, *Recording Orchestra and Other Classical Music Ensembles*, 214-215.

⁷⁶ Moulton, *Total Recording*, 198.

sensitivity in their performance, an ability to capture the frequencies across the audible range more evenly, and often a higher price tag than dynamic microphones. Condensers can come in either a large or small diaphragm model and behave slightly differently depending on which one is chosen. Ribbon microphones work similarly to dynamic microphones but often with a more sensitive diaphragm and one that receives air movement from both the front and back, lending itself to a unique pickup pattern (which will be discussed later). Ribbon microphones are often described as having a warmer sound than their other counterparts and can be extremely fragile.⁷⁷

While two microphones made by different companies might both be condenser microphones, it is likely that they will sound different if they were to capture the same source in the same position. Although both would behave similarly when compared to the other types of microphones, their components, dimensions, and the quality of their assembly will impact their performance in areas such as frequency response, or their signal-to-noise ratio. This explains why engineers inevitably prefer one microphone to another for certain circumstances despite the fact they share the same general behaviors.⁷⁸

In addition to their construction, microphones are categorized as having different types of three-dimensional patterns, also known as polar patterns, that denote where in space the microphone will be receptive to sound. Again, there are three general types of microphone polar patterns, omnidirectional, bidirectional, cardioid. Omnidirectional is a

⁷⁷ Moulton, *Total Recording*, 197-199; King, *Recording Orchestra and Other Classical Music Ensembles*, 21-27.

⁷⁸ Moulton, *Total Recording*, 198.

pattern that receives sound in a sphere shape outward from the microphone's capsule. Bidirectional receives its sound from the front and back of where the microphone is pointing but rejects sound from the sides. This pattern has been given the nickname "the figure eight pattern" due to the shape that is created by the pickup areas. A cardioid patterned microphone picks up sound in the front and slightly to the sides of its capsule, creating a pattern that resembles a heart when it is illustrated two-dimensionally. A variant of the cardioid is the hyper-cardioid pattern, which creates a much narrower area of focus in the front, at the expense of creating a small lobe of pickup behind the capsule as well (essentially combining both the cardioid and bidirectional patterns).⁷⁹

Microphone Placement

Whenever a bassoon, or any instrument, is heard in a recording, it is important to take note of what context it is being heard in. Is it a sonata with piano, chamber piece, full orchestra? Depending on the context, the methods in which the sound is captured might become totally different. Many of the tools used in a recording can focus on or highlight certain sound elements, while taming or even avoiding hearing others. So, while it may be crucial to make a soloist the most prominent sound in a concerto, it might be best to make all parties equally important in a symphony.

Then, there is the question of aesthetics. Should the recording make the listener feel like they are in the back of a massive cathedral, or in the front row? Does the listener need an accurate sense of space, or an enhanced one? Is it important to capture the bassoon's sound just as it would have been heard, or offer an artificially refined version?

⁷⁹ Moulton, *Total Recording*, 200-206.

While there are many tools in the recording process that can accommodate the decisions made based on these questions, microphone positioning and placement can often be the most defining aspect, especially in the realm of classical recording. Metaphorically speaking, microphones behave similarly to cameras because their effectiveness in capturing sound is heavily dependent on their positioning and directionality. A certain angle, height, or distance from a sound source will greatly influence the quality of sound that is picked up by the microphone. This is due to several factors, such as the acoustic properties of the source, such as the characteristics of the bassoon discussed in chapter 3, the acoustic properties of the room, and the previously mentioned nature of the microphone's pickup pattern. King emphasized the importance of microphone placement saying:

... All previous descriptions of microphone techniques are meaningless unless they are positioned properly and with some informed opinion... The secret of recording-especially where classical music is concerned-is simply getting the microphones in the right place.⁸⁰

Later sections in this chapter will discuss a wide gambit of microphone placements for the bassoon based on different practical and aesthetic factors. In all likelihood, a bassoonist will interface with many different microphone placements across their career, and each of which will represent their playing differently.

⁸⁰ King, *Recording Orchestra and Other Classical Music Ensembles*, 76-78.

Microphone Selection

One of the first decisions that any audio engineer needs to make is which microphones to use to capture a performance. Microphones are not a 100% transparent component of the recording process, and selecting the correct microphone for a recording is circumstantial and based on personal tastes. Similar to the way different voices, instruments, and brands of the same type of instrument carry their own unique tonal qualities and sound propagation, microphones also carry their own qualities and characteristics which are audibly noticeable. For this reason, there are plenty of opinions floating around the internet and recording circles about which microphone will sound best to achieve a certain type of guitar sound in a rock album, the vocals in a hip-hop single, or for the soloist for a violin concerto. In his book *Total Recording*, renowned recording engineer and producer David Moulton is resigned to give his personal favorite mic selections. Rather, Moulton explains:

It would be handy if we could list a set of preferred microphone choices and placements. Unfortunately, such a selection recommendation isn't very realistic, as it depends greatly on the style of music, the performer, room and placement of performer and mic in the room.⁸¹

It isn't always easy to uncover which specific microphone was used in any given recording, since that information is not typically made public. It is especially rare for the microphone used on a bassoon to be mentioned. However, there are some notable professional instances in the that give insight into the industry's common practices.

⁸¹ Moulton, *Total Recording*, 207.

In an interview with Grammy-winning, film-score engineer Shawn Murphy in *Acoustics Today*, Murphy methodically lists the typical microphone used when recording a film orchestra. His example mentioned using Schoeps CMC3/MK8 condenser microphones to capture the woodwind section wholistically, and the DPA 4011 condenser microphone to capture individual instruments (including the bassoon).⁸² To compliment these selections, King included these two brands of microphones, as well as Neumann, Sennheiser, etc. as the industry standards in orchestral recording⁸³. While these are some of the more expensive brands on the market, a video demonstration by microphone manufacturer Audio Technica, features the AT4047 large diaphragm condenser as a useful, more budget-friendly, close microphone on the bassoon.⁸⁴ Beyond the formal promotional content, it is also possible to find several videos of bassoonists testing and comparing microphones as well.

All the previous microphone examples were condenser microphones. In fact, King champions the condenser microphone as a good choice for classical recording, especially when compared to dynamic microphones, due to its high sensitivity (in terms of volume), a generally flat frequency response, and fast transient response⁸⁵. Based on the acoustic properties discussed in chapter 3, it makes sense that condenser microphones would

⁸² Murphy, “Motion Picture Scoring Stages,” 26.

⁸³ King, *Recording Orchestra and Other Classical Music Ensembles*, 41. King also gives honorable mentions to AEA, AKG, Beyer Dynamic, Microtech Gefell, Royer Labs, Shure, and Sony.

⁸⁴ Audio-Technica, “Basic Recording Techniques: Woodwinds.”

⁸⁵ King, *Recording Orchestra and Other Classical Music Ensembles*, 26-27.

complement the bassoon nicely. A fast transient response would capture the detail in articulation that helps identify the bassoon's sound. Also, since the bassoon relies on tone color shifts to give the impression of dynamics perhaps more than changes in sound intensity, having a flat frequency response that does not distort the tone of the instrument would be to the benefit of transparently representing the players artistic expression.

This is not to say that there isn't a place for other types of microphones in the world of bassoon recording. Just like music making, it is a matter of taste. For example, Haigh et al. recommends using ribbon microphones like the Royer R-121 if high-frequency key noise is becoming a distraction.⁸⁶

Stereophonic Microphone Techniques

Hearing a recording in stereo gives a listener the illusion of spaciousness and grants them the ability to localize voices, instruments, or any noises within that imagined space. Using multiple channels of audio, Stereo recordings can offer a great sense of dimension that is pleasing to our binaural hearing. For classical recordings (and by extension, for bassoon recording), microphones are often utilized in setups designed to efficiently capture a stereo sound image.⁸⁷

The most basic approach to recording in stereo involves placing two microphones on a single sound source (one for each speaker/ear). The differences that are captured between the two sources will provide the ear with the information needed to create the illusion of space. There are several established stereo microphone techniques, and they

⁸⁶ Haigh et al, *Classical recording*. 20-21, 61.

⁸⁷ Moulton, *Total Recording*, 158.

achieve a stereo field of imaging when the ears notice differences in time, differences in intensity, or a combination of these two differentials between the two microphones. Recording in stereo is a mainstay for classical music, and for the purpose of this research, it is important to know that each setup will have positive and negative effects on things such as image clarity and sense of depth. In general, stereo techniques that rely on intensity differences, also known as coincident pairs, involve two microphones placed on top of one another with different angles and pickup patterns.⁸⁸ These techniques offer a very clear sound image but lack a sense of depth and spaciousness. Techniques that rely on time differences, also known as spaced pairs, are created when the microphones are spaced a measured distance apart.⁸⁹ This creates a delay in the time it takes for a sound to reach the microphone. These pairs offer a greater sense of width and space, but can struggle to provide clarity. Techniques that rely on both differentials, called near-coincident pairs, require the two microphones to be placed relatively close, but not on top of, on another and facing outward at measured angles.⁹⁰ Near-coincident pairs inherit some of the positives and negatives of the previous types. To address the shortcomings of a specific stereo technique, some techniques utilize more than two microphones and additional microphones, or mix multiple stereo pairings, into one main sound.⁹¹

⁸⁸ Examples include the XY, Blumlein, and Mid-Side techniques.

⁸⁹ Examples include the AB pair and the Decca Tree.

⁹⁰ Examples include the Office de Radiodiffusion Télévision Française (ORTF) and Nederlandse Omroep Stichting (NOS) techniques.

⁹¹ King, *Recording Orchestra and Other Classical Music Ensembles*, 33-40.

There are other, more involved, recording techniques such as Surround Sound and Dolby Atmos that are designed to create an auditory spatial image. However, stereo recording remains a widely used approach. It is beneficial to consider how the stereo image that is created impacts the musical experience, considering that a recorded bassoon is most often enjoyed (or at least captured) within a stereo environment. Spaciousness, or the illusion of space in the case of recordings, is itself an aesthetic element that can either enhance or deteriorate the expressiveness of a performance. Recording in stereo can give the listener a sense of place relative to the music they are hearing, and that place can either be representative of reality, or altered to create a different environment. Later sections in this chapter will discuss specific recording practices for common ensembles and scenarios for the bassoon. In these cases, the chosen stereo technique plays an important role in how the instrument will be captured.

Spot Microphones

Spot miking, or close miking, is a technique that dedicates a microphone (or microphones) to an individual player or instrument, often while it performs within a larger ensemble. This technique is used in a wide range of circumstances and appears in the many playing environments where a bassoon is recorded. The purpose of spot miking is to provide an isolated source of sound, often used in conjunction with microphones dedicated to capturing a more wholistic depiction of the room/ensemble, to improve qualities such as balance, directionality, and potentially tone quality in the gestalt of a recording.⁹² Careful placement is involved when using spot microphones, as Moulton suggests:

Instruments don't sound particularly natural up close, and the variation in sound quality can change dramatically with positioning changes of just a few inches. The specific on-axis and polar response of microphones play into this as well.

For this reason, several of the often-cited textbooks in this paper have offered detailed instructions and recommendations for how they would place spot microphones for various instruments. In the case of the bassoon, these recommendations are simultaneously sparse and various. The following paragraphs will address some of the more notable recommendations.

In the previously mentioned promotional video produced by Audio Technica, the bassoon is recorded by a large-diaphragm condenser microphone placed 2 feet away from the instrument and at a height of 4 feet. This puts the microphone below the bell of the instrument by assumedly about a foot, and the diaphragm of the microphone appears to

⁹² Moulton, *Total Recording*, 359; Haigh et al, *Classical recording*, 43.

be angled towards the bocal. The speaker notes that when miking woodwinds, it is inadvisable to only focus on the sound coming from the bell since a fair amount of sound production comes from the tone holes as well.⁹³

In reference to how might the individual woodwind groups be close miked in an orchestra recording, King says:

Bassoon should be captured from the side rather than above the instrument, at around 1.5 or 5 feet. The sound coming from the hole at the top is mostly reed, without the core of the tone.⁹⁴

Among these examples, King is the only one to mention “reed” sound being a by-product of the sound coming from the bell. It is possible that the sound being referenced here is the high-frequency content that inherently radiates out of the bell. It is worth noting that, in his example, the microphone would be shared between the principal and second bassoon players. King also suggests that either cardioid or bi-directional microphones could be used in this case, in order to achieve different levels of isolation versus coverage. In the case of spot miking a solo instrument for a concerto or other solo work, King recommends two microphones placed in a “narrow stereo.”⁹⁵

While not specifically addressing bassoon or classical music recording, Moulton recommends placing the microphone midway down the instrument and off to the side when recording woodwinds. He mentions to avoid pointing the microphone directly on-axis with the keys, but to place the microphone to the side to be off-axis. Later, Moulton

⁹³ Audio-Technica, “Basic Recording Techniques: Woodwinds.”

⁹⁴ King, *Recording Orchestra and Other Classical Music Ensembles*, 97.

⁹⁵ King, *Recording Orchestra and Other Classical Music Ensembles*, 97, 122.

suggests that cheating the microphone up towards the mouthpiece and reed can provide a bit a breathiness and mechanical noise that the listener might appreciate as more humanistic.⁹⁶

In complete contrast to this, Haigh et al stress the importance of avoiding any sort of reed or mechanical noise whenever possible. Therefore, they recommend a height much taller (between 7 ½' to 8 ½') than the earlier examples, with a distance between 3' and 3' 4" from the player.⁹⁷ A real-world example of a higher setup like this can be seen in the promotional video for Gustavo Nunez' album "Capricho" produced by Chanel Classics. There are visuals throughout the video that make it obvious that the spot microphone, seen directly to the left of the conductor from the audience perspective, is well above Nunez' head as well as the bell of the instrument.⁹⁸ Haigh et al mention that ribbon microphones may be preferable to condensers, since their sound characteristics may help to reduce these noises. Their recommendations for bassoon are combined with the oboe and clarinet, without giving many specifics to the individual instruments. They mention it is not advisable to place any microphones directly on axis with the bell, and it is also alluded to that the bassoon may benefit from some of the same techniques used on violin to tame the high frequencies that radiate in an upward and perpendicular fashion from the body, which include slightly altering height, angling, and side-to-side placement

⁹⁶ Moulton, *Total Recording*, 361.

⁹⁷ Haigh et al, *Classical recording*, 52-61. Haigh et al note that these height recommendations are for standing performers, and a seated performer could be adjusted lower.

⁹⁸ Chanel Classics, "Gustavo Núñez Speaks about His New Release Capricho."

to taste. Haigh et al note how high frequencies radiating upward is not so much an issue with the oboe and clarinet, since their bells are facing downward and reflected off the floor. Like King, Haigh et al also suggest the use of pairs of microphones for instrument spot microphones, which would give a sense of instrument width (so long as it compliments an already-existing stereo field).⁹⁹

The Recording Engineer's Handbook by Bobby Owsinski offers a handful of microphone placements for the bassoon without providing much explanation about how they might perform or any objective in mind. These include placing the microphone 3-4 feet away at eye level, at bell height but 45 degrees to the player's right, and simply above and in front of the player based on how it sounds to the ear. Owsinski also recommends a 3-microphone setup along the length of the instrument, with microphones placed at the top (assumedly bell height), the middle at the bocal, and near the bottom (assumedly at the boot of the horn). It is possible that this microphone setup is intended to capture as much of the tone propagating from the tone holes as possible, while other recommendations from this book and from other sources are aimed at capturing the sound as the different radiation points along the instrument coalesce. One last recommendation advises mounting a microphone onto the bocal or the F# trill key on the wing joint of the instrument (both of which would be around the area of the players left hand). This is worth noting as the most up close and intimate spot miking among all the examples.¹⁰⁰

⁹⁹ Haigh et al, *Classical recording*, 43.

¹⁰⁰ Owsinski, *The Recording Engineer's Handbook*, 103-104.

The previous microphone setups do not amount to an exhaustive list of all the ways a bassoon could be close-miked, since there are infinite possibilities. However, many of these recommendations share common goals, practices, and insights that uncover core principles of recording the bassoon (for close-miking and beyond). These include the following:

- Microphone placement for the bassoon shares many of the same general concepts as other woodwind instruments, specifically the oboe and clarinet.
- Traditional close-microphone placement avoids being on-axis with the bell of the bassoon. Instead, some effort should be made to capture the sound coming from the tone holes of the instrument.
- The elimination or inclusion of mechanical noise is a matter of taste but is commonly considered when placing microphones on the instrument.
- Sometimes it is advantageous to use multiple microphones in the close setup to either create a sense of “instrument width” or to capture a better coverage of the sound radiating from the tone holes.

Arguably, the most important takeaway from these methods is that there is no one-size-fits-all approach to how to close mike a bassoon. Notice how both the height and distance from the player vary by as much as 5’ between examples. Differences in microphone type and pickup pattern also allude to the artistic nature of recording practices. As Moulton puts it “In fact, the choice and placement of microphones is much more an art than a science, and each situation is both new and unique.”¹⁰¹

¹⁰¹ Moulton, *Total Recording*, 361.

In the historical summary of the bassoon's relationship with recording from Chapter 2 there were numerous examples of how evolutionary moments for recording technology throughout the 20th and 21st centuries resulted in transformations in recorded bassoon performance. The existence of so many different philosophies and practices for close-miking the instrument implies that this relationship is reciprocal, and that the nature of the bassoon and its use transform the art of recording as well.

Orchestral Recording

One of the more common circumstances to hear a bassoon in a recording would be within an orchestra. Traditional orchestral seating would arrange a two-rowed woodwind section in the center of the stage, behind the strings, and in front of the brass. Within the woodwind section, the bassoons are seated in the second row with the oboes directly ahead of them and the clarinets on their right. This means the bassoons are placed slightly right of center and roughly 2/3rds back on the stage from the audience's perspective.¹⁰²

As the bass voice of the woodwind section, the bassoon's role within the orchestra will often shift within the course of a piece. The bassoons may double the low strings or low brass one moment, to then be the only instrument providing the bass line, to then carrying the melody with the violins and flute. Like the rest of the instruments, the bassoon's role has also shifted throughout the course of history. Overall, the bassoon's function within the orchestra can vary wildly depending on the composer, piece, and

¹⁰² King, *Recording Orchestra and Other Classical Music Ensembles*, 52-53.

orchestration practices of the time. Therefore, the way the instrument is (or should be) presented in the context of a recording is not static either.¹⁰³

As mentioned previously, microphone placement has a great impact on the way sound is captured. Because of this, there are standard microphone placements that are designed to capture a standard orchestra in an effective manner. At the heart of these setups is the “main” microphones. These microphones are easily recognizable as the formation of microphones that tend to ominously float overtop and flank the conductor at the podium. Traditionally, this arrangement of microphones will make up most of the sound heard in the recording because of the way they, metaphorically speaking, paint a wholistic picture of the entire ensemble and performance space.¹⁰⁴

These microphone setups are typically designed with stereophonic recording in mind. The consensus among orchestral recording professionals is that spaced pairs and setups based on intensity differences are often preferred to their coincident pair counterparts. This form of stereo technique will often strike the right balance between properly covering the sound of the ensemble, both in width and frequency response, while also capturing the spaciousness of the room as well¹⁰⁵. But even among this category of technique, there are plenty of variations such as the standard AB pair, versus

¹⁰³ Schlesinger, 1910, 24.

¹⁰⁴ King, *Recording Orchestra and Other Classical Music Ensembles*, 70-76.

¹⁰⁵ King, *Recording Orchestra and Other Classical Music Ensembles*, 71; Haigh et al, *Classical recording*, 128.

the Decca Tree,¹⁰⁶ versus a “small ab, big AB” setup,¹⁰⁷ and more. Additionally, microphone placement is just as integral to the success or failure of the main microphones as is the chosen technique. For example, King notes how changes in microphone distance to the ensemble can easily impact the focus of the winds and brass versus the strings. Height also changes the makeup of the sound, with microphones that are placed higher up over the ensemble tending to have more reverberance.¹⁰⁸

While the main microphones might not be the only microphones utilized in a recording session, they will certainly be an integral part of how the bassoon is heard in a recording. As previously mentioned, in an orchestral setup, the bassoon section will always be positioned a considerable distance away from the main microphones. This seating, in combination with the main microphone setup and placement, could greatly impact the clarity, imagined distance, volume, and overall impression of the performance.

It is also common that other microphones beyond the main pair are involved in a typical orchestral recording session. These microphones are utilized to capture a section of the orchestra, allowing for the engineer to add focus and improve the balance between the sections as needed. Working with these section microphones means striking a balance between proper coverage of the section, a stereo image that compliments the main pair,

¹⁰⁶ Haigh et al, *Classical recording*, 128-149. The Decca Tree is the flagship technique used by Decca Recordings and involves an array of microphones typically used on large orchestras.

¹⁰⁷ This setup involves two spaced pairs, one narrowly spaced and one widely spaced, to capture the ensemble.

¹⁰⁸ King, *Recording Orchestra and Other Classical Music Ensembles*, 77-78.

insulation from inadvertently capturing other sections, and of course a pleasing tonal quality.¹⁰⁹ Haigh et al Discusses the importance of ancillary microphones for the woodwinds, saying:

In classical music, the woodwinds form the next most important musical dialogue in the orchestra after the strings, and this detail must not be lost. There are only a few of them, they are relatively quiet, they do not radiate as efficiently as the brass do, and they are seated behind the strings. Their individual tone colours are very distinctive, and they need the punctuation that is provided by the use of ancillary microphones to support them against the whole body of strings. The aim is to highlight the woodwind section, not to pick them out singularly.¹¹⁰

King identifies several different approaches to how the woodwind section has often been captured. These approaches involve cardioid or bi-directional microphones and range from the use of traditional stereo techniques, to modified stereo techniques, to individual microphones dedicated to each sub-section of woodwinds. The first two ideas are an efficient way to provide necessary reinforcement, while maintaining the integrity of the main pairs stereo image. The third approach is an effective way to provide coverage for each of the woodwind sub-sections and makes it easier to achieve an even balance across the entire section.¹¹¹ In each case, the object of these microphone setups will be to offer the clarity that may be lost in the main pair.¹¹² This can explain why a bassoonist might notice their sound being more present and forward in a recording when

¹⁰⁹ King, *Recording Orchestra and Other Classical Music Ensembles*, 93.

¹¹⁰ Haigh et al, *Classical recording*, 155.

¹¹¹ Haigh et al, *Classical recording*, 156; King, *Recording Orchestra and Other Classical Music Ensembles*, 95-96.

¹¹² Haigh et al, *Classical recording*, 151.

otherwise there would be much more reverberance and loss of definition when their section is heard live in a concert hall, or when solely relying on the main pairs sound.

Concert Band and Wind Ensemble Recording

The concert band is another well-known setting to hear a recorded bassoon as an equal player in a large ensemble. Unlike the symphony orchestra, concert bands do not have a standardized setup and positioning, and very rarely will a seating place the bassoons comfortably centered and two-thirds back like an orchestra. In King and Haigh et al.'s depictions, the bassoon section is placed in either the second or third row from the podium and more on the stage left side of the podium. This upfront and off-center positioning inevitably alters the relationship the instrument has with the main microphone setup.¹¹³

King recommends a pair or a centered microphone behind the conductor coupled with a pair of “outrigger” or widely spaced microphones flanking the conductor as the main microphone system. The use of these outrigger microphones is also echoed in Haigh et al.'s recommendations as well. What is interesting to consider about this method is how the outrigger microphone placed on stage left would interact with the bassoons. Unlike an orchestra, where the main microphone system is relatively far away from the bassoon section, this stage left microphone is much closer. Furthermore, with the angling of the instrument, there is the possibility that this microphone is closer to, or completely on axis with the bell. Therefore, this microphone setup, especially with the absence of any spot

¹¹³ Haigh et al, *Classical recording*, 231; King, *Recording Orchestra and Other Classical Music Ensembles*, 57.

microphones, could create an entirely different tone color for the instrument than what would be heard in an orchestra.¹¹⁴

Solo Bassoon with Orchestra or Other Large Ensemble

Another common setting to hear a bassoon in a recording would be in a concerto or any solo work with ensemble accompaniment. There are countless recordings of standard bassoon concerti by Mozart, Weber, Hummel, etc. featuring a litany of bassoonists both past and present. New works for bassoon and orchestra are also being regularly recorded as well. No matter the repertoire, it is appropriate to appreciate how different recording a bassoon solo is from being recorded as a section bassoonist.

In terms of the techniques implemented to capture the full ensemble, not much has changed. The same microphone setups should be expected for the main pair, although modifications like the distance between microphones can be made to allow more room in the stereo image for the soloist.¹¹⁵ The dramatic changes appear when examining the soloist themselves. Instead of being placed near the back of the stage, the bassoonist is placed prominently in front of the entire orchestra. This in turn places the bassoon sound “front and center” in the mix, a perspective which is not familiar to the instrument when sitting in the section.

This change in perspective comes from how much closer the bassoon is to the main microphones, and/or from the prominent use of soloist spot microphones. In modern

¹¹⁴ Haigh et al, *Classical recording*, 231-232; King, *Recording Orchestra and Other Classical Music Ensembles*, 83-84.

¹¹⁵ King, *Recording Orchestra and Other Classical Music Ensembles*, 121.

stereo recording tradition, the object is to place the soloist exactly center in the stereo image. This could mean placing the soloist right in line with the conductor, either in front of them or behind them within the string section, shifting the main microphones to center the soloist (possibly making the ensemble slightly lobsided), and/or relying more on the spot microphones to keep the soloist in the center. There are also different configurations depending on whether it is a concert or studio setting. In the latter case, the bassoonist may be situated to face the ensemble in order to have more isolation in their spot microphones and a better line-of-sight with the conductor/ensemble.¹¹⁶ Although spot microphones would follow some of the same principles that have been previously discussed, both King and Haigh et al strongly recommend pairs of microphones spaced close together in order to achieve full coverage and a sense of natural width over the instrument's sound.¹¹⁷

In terms of microphone placement, Haigh et al acknowledges that in a concert setting, the audience's line-of-sight may present challenges for the spot microphones. From their perspective, the preferred placement would be some of the overhead spot microphones previously mentioned. But in the case of a concert setting, the microphones may need to be placed lower. It is interesting to compare how the implementation of lower microphones would affect the bassoon versus the other reeded woodwind instruments. With the oboe, clarinet, and saxophone, the challenge with having lower

¹¹⁶ King, *Recording Orchestra and Other Classical Music Ensembles*, 118; Haigh et al, *Classical recording*, 206.

¹¹⁷ King, *Recording Orchestra and Other Classical Music Ensembles*, 122; Haigh et al, *Classical recording*, 204-206.

microphones would be avoiding any on-axis interaction with the bell, especially if the soloists are standing and prone to movement. The bassoon, as seen from the varying recommended spot-microphone heights, would not have to worry so much about its bell with lower microphones, and placing the microphones lower would only result in better coverage of the sound coming from the tone holes. Therefore, it is theoretically possible that lower microphone placement might be preferable for both studio and concert settings. The existence of other examples of spot microphones that are placed lower than Haigh et al's heights seem to support this theory.

The result of these microphone configurations can result in a much different sound than what is heard from the bassoon within an ensemble setting. The successful implementation of these techniques would give the soloist prominence in the overall sound, an obvious departure from a lot of section bassoon playing. Additionally, the sound may achieve a fuller quality, as more direct sound would be heard from both the spot microphones and the main pair. The change in musical context from a section instrument to the featured soloist results in dramatic changes in how the instrument is picked up by the microphones and therefore can completely alter the characteristic of how the bassoon is heard in a recording.

Bassoon with Piano

Unlike the previous situations, the guidance that exists for recording a sonata or other piece for bassoon and piano diverges from the dominance of a main pair and subservience of all other microphones and instead focuses on finding a balance between the microphones dedicated to the piano, bassoon, and ambience of the hall. This is due to several factors, not least of which is the disparity between the characteristics of a large, powerful, polyphonic instrument such as the piano, and the bassoon. Therefore, it is important to recognize that the approach to recording the piano might impact how the bassoon and overall impression of the recording is heard.

While King does not offer any insight into how to specifically record any woodwinds with piano, he mentions the difficulty in balancing an instrument as powerful and reverberant as the piano with other instruments, such as the bassoon, in order to create a sense of homogeneity in the recording. To this end, positioning of the bassoonist in relation to the piano becomes key, in order to find a balance in volume and resonance in the hall that agrees with both instruments in the main microphone system.¹¹⁸ Haigh et al uses a different approach for better balance by relying mainly on pairs of close microphones on each instrument and a pair of ambient microphones for the room rather than an entire main system. Creating the stereo image involves panning the pair of piano microphones as wide as possible, while letting the soloist's sound sit more narrowly centered. This would give the listener a sense of intimacy and closeness, even if there is

¹¹⁸ King, *Recording Orchestra and Other Classical Music Ensembles*, 180.

plenty of reverberation in the sound, since the piano itself would feel larger in the stereo image than if someone were to hear it farther away in the concert hall. With proper balancing, the solo bassoon would then share in that sense of up-front closeness as well.¹¹⁹

Haigh et al mentions the same factors involved in audience sight lines that were present in solo recordings with orchestra, as well as the need to subdue the amount of key noise picked up by the microphones. The placements for the solo bassoon microphones are like what was previously used in spot miking and for solos with orchestra, depending on whether the recording occurs in concert or in the studio. Specifically, they suggest using 4' high spot microphones when sightlines are a concern. But the bassoon is not at the forefront of this recommendation when Haigh et al continues saying: "If the microphone is still too high from the audience point of view, the microphone is better moved to one side rather than lowered in height to avoid being on-axis to the bell."¹²⁰

This would clearly not be a concern for the bassoon since the instrument's bell is at the top rather than the bottom. It is then possible that moving the microphones lower than 4' would be perfectly adequate if it produces a pleasing sound quality. Alternatively, Haigh et al suggests using a pair of omnidirectional or wide cardioid microphones suspended 9' high and 3'- 4' feet in front of the player. For the bassoon, the front spacing would become critical, since having these microphones too close might mean the bell lands on-axis with the stage-left microphone. In addition, they note that some of the low

¹¹⁹ Haigh et al, *Classical recording*, 110.

¹²⁰ Haigh et al, *Classical recording*, 123.

frequencies may resonate from the piano, causing spillage into the soloist spot microphones. The recommendation is to potentially filter out these low frequencies from the microphones during the mixing process (known as a high-pass filter). However, this may not be practical for the bassoon, since its fundamental frequencies sit much lower than the other woodwind instruments with its lowest note being at 60 Hz.¹²¹

Small Wind Ensembles and Other Chamber Music

Albums produced by wind quintets and other chamber groups are another staple of the bassoon's recording repertoire. Based on Haigh et al's explanation, these ensembles will traditionally be recorded using stereo microphone configurations, with the potential for added spot microphones if necessary. Specifically, a Decca tree in the case of larger chamber groups, with one microphone or pair of microphones to spot each section, with a near-coincident pair angled at 110° (aka the Office de Radiodiffusion Télévision Française or ORTF technique), mixed with a spaced pair of microphones. For smaller groups, the same techniques are recommended in a smaller form to adjust for the size of the ensemble, with the possibility of removing the spot microphones as well.¹²²

¹²¹ Haigh et al, *Classical recording*, 123.

¹²² Haigh et al, *Classical recording: a practical guide in the Decca tradition*, 227-228.

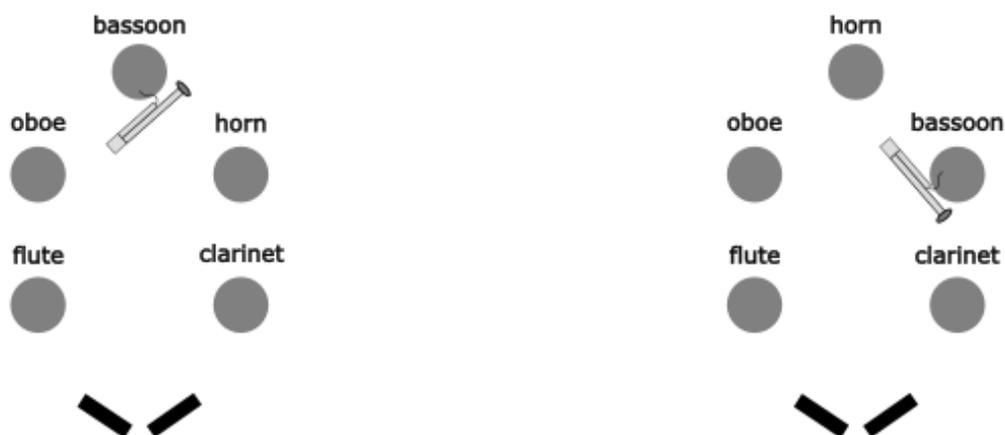


Figure 4.1. Seating Arrangements for a Woodwind Quintet in Relation to a Stereo Pair of Microphones

Like the setup for large wind ensembles and bands, the seating for the bassoon could have a large impact on how the main microphones capture the tone of the instrument. For example, two common seatings for a wind quintet are presented in figure 4.1 with a generic near-coincident stereo setup to illustrate the mains. In the first example, the bassoon would be centered in the stereo image, and both microphones would be well off-axis to any part of the instrument, including the bell. In the second example, where the horn and bassoon have switched seats, the right microphone (audience perspective) is situated closer to the instrument. Not only would this pull the instrument towards the right of the stereo image, but depending on its distance from the

bassoon, the microphone may capture more sound from the bell of the bassoon since it approaches being more on-axis with the instrument.

Do-It-Yourself (DIY) Recordings

Thanks to the modern advancements in digital recording technology, it has become easier than ever for anyone with a desire to record themselves. There are several reasons for a bassoonist to want the ability to record including publicization, audition tapes, critical feedback, personal archival, and simply for fun. Although not as stalwart as some of the more professional and scholarly recommendations, there have been some notable trends and preferences amongst DIY recording bassoonists in terms of equipment and setups. In addition to sound quality, these techniques also consider the constraints of the bassoonist-turned amateur recording engineer, such as knowledge, experience, budget, and the physical space available.

While it is certainly possible for someone to make a DIY recording using the same techniques and equipment previously mentioned, the logistics of such a project would pose a difficult barrier to overcome for the average person. To help bridge this gap, audio companies, such as Zoom and Tascam, have created all-in-one digital devices containing microphones, analog-to-digital converters, and rudimentary digital processing software that let the user to make and playback a recording quickly and easily. Some of these recorders, like the Zoom Q series of recorders, have built-in cameras as well, allowing for simultaneous video recording.¹²³

¹²³ Bartlett & Bartlett, *Practical Recording Techniques*, 38-39; Zoom, “Musicians.”

A bassoon demonstration of the popular Zoom H4n recorder can be found on the Recordclassicalmusic YouTube channel. This device is equipped with a pair of cardioid microphone capsules, arranged in an XY coincident pattern, to allow the user to capture a stereo recording without the need for any additional equipment. In recordclassicalmusic's video example, the microphone has been placed 1 meter away (~ 3' 4") from the player and 1.5 meters high (~ 4' 11"). In another, more extensive video, bassoonist Dr. Dillon Meacham demonstrates performance of the H4n in multiple different placements. Following some of the same practices and principles outlined in this paper, Meacham analyzes the implications and effectiveness of each placement, noting how things like key noise can be heard with a setup that is too close, or how a nasal quality can come from having the device placed too close or on-axis to the bell. His preferred setup places the Zoom H4n 4' 9" off the ground, 5' 4" away from the bell, slightly off to the side toward the left hand/long joint and aimed towards the boot of the instrument. Meacham's comparisons prove that while these devices will appear more accessible and easier to use for the layman, they are still subject to the same recording principles that have led to the level of specificity that the previous professionals have written about.¹²⁴

The portability and convenience of these personal recording devices make it possible for bassoonists to be recorded in a variety of settings such as at home, in lessons, or anywhere they might find themselves. But aspiring DIY recording enthusiasts are not limited to using on-board microphones on a digital 2-track recorder.¹²⁵ Nowadays, there

¹²⁴ Meacham, "How to Record the Best Bassoon Sound on Your Own."; Recordclassicalmusic, "How to Record a Bassoon."

is an abundance of recording equipment coming in a variety of forms to meet the needs and budgets of amateur recorders. To start, the Zoom H4n, and several other digital recorders, are equipped with microphone preamplifiers that can be used with whatever external microphone is desired. Software developers have created applications that resemble Digital Audio Workstations (DAW) for Apple iOS and other mobile devices that allow users to turn their phones and tablets into fully-fledged recording devices. These applications can either utilize the on-board microphones or be paired with microphones and audio interfaces meant to be paired with mobile devices. Additionally, affordable DAWs for personal computers and laptops are widely available and are easily utilized with consumer level audio interfaces made by companies like Mackie, Onyx, Focusrite, and Presonus. There are even microphones, such as the Blue Yeti Microphone, that can be plugged directly into the computer since they use built-in digital converters. When paired with the previous knowledge of the bassoon's sound characteristics and traditional methods of recordings, this equipment can theoretically record the bassoon at a satisfactory quality that would be expected of a DIY project.¹²⁶

¹²⁶ Bartlett & Bartlett, *Practical Recording Techniques*, 37 – 49.

Miscellaneous Recording Techniques

While microphones can capture sound pressure changes in the air at a distance from the bassoon, there are other ways to capture vibrations that emanate from bassoon playing as well. Pressure transducers, like the piezo pickup commonly used on acoustic guitar, can convert surface vibrations of instruments into audio signals.¹²⁷ This type of pickup has also been designed for wind instruments, and, after modification of the instrument, manage to capture the vibrating column of air within the bore itself. An example is the PiezoBarrel[®] by Steve Francis.¹²⁸ Obviously, wind instruments are not typically heard by putting an ear against its body or inside its bore, and therefore using a pickup like this will alter the listening experience. However, these pickups excel at only capturing the intended sound and rejecting any other noises. Additionally, the sound will not be altered due to the position of the player. This makes it a viable option for when isolation is crucial and allows the audio signal to be easily processed by amplifiers, effects pedals, and other audio manipulation.

For the bassoon, these transducers open the gateway for the instrument to be utilized in genres that heavily rely on this type of manipulation, and since the sound has already been converted into an audio signal, it can easily be recorded. Another notable pickup is the “Little Jake” designed by bassoonist Dr. Trent Jacobs. This device requires an adapter to be mounted to the bassoon’s bocal and, after preamplification, can be recorded as-is or processed by effects such as distortion, reverb, etc... Notable users of

¹²⁷ Dailey, *Electronics for guitarists*, 33.

¹²⁸ Francis, “PIEZOBARREL[®] Products.”

the “Little-Jake” include jazz bassoonists Paul Hanson, Mark Rabinowitz, Mark Ortwein, and Krista Wodelet. Bassoonist Christopher Pawlowski uses a transducer to emulate the sound of electric guitars and sounds of rock/metal genres, producing several covers of popular songs on his YouTube channel.¹²⁹

After the Microphone (Post Processing)

There are all sorts of ways to make alterations to a previously recorded sound with the various audio tools and technologies currently available. Beyond simple volume manipulation, processing audio through equipment like equalizers, reverb machines, compressors, distortions, etc. can have such a great impact on the original sound that it is no longer recognizable compared to the way it was captured. Moreover, the ability to easily edit multiple audio clips together in the digital realm can synthetically craft a perfect-sounding performance, even if one never occurred in the live setting. All these processes are readily available in a bassoon recording. However, the use of these tools can vary significantly depending on the context.

King exhaustively discusses techniques and recommendations for how to edit a commercial classical ensemble recording, considering scenarios where a single measure or even note needs to be spliced from another take.¹³⁰ For mixing classical ensembles, the general goal is to capture a high-quality sound directly from the mics that can remain largely unaltered. King mentions how equalization (which alters the makeup of the

¹²⁹ Jacobs, “The Little-Jake.”; Pawlowski, “Christopher Pawlowski.”

¹³⁰ King, *Recording Orchestra and Other Classical Music Ensembles*, 201-208; Haigh et al, *Classical recording*, 301-312.

frequency spectrum) and compression (which alters volume on a minute scale) should be used sparingly.

However, there are instances of using processing tools to enhance the classical listening experience. For example, Haigh et al recommend panning (a term for altering a sounds location within a spatial image) ancillary microphones in a way to offer a greater sense of closeness than what would be accurate to the original circumstances.¹³¹

Additionally, they also mention modifying the volume levels of ancillary microphone audio throughout the music to “alter the static balance” of the ensemble.¹³² Artificial reverberation can be implemented to greatly enhance the color, spaciousness, and perceived loudness of the sound.¹³³ In his presentation, Meacham also concurs that the use of artificial reverb can improve the room sound of a DIY recording as well.¹³⁴

These ideals should not be considered universal for every bassoon recording. In contrast with the commercial realm, many ensembles prohibit the use of any editing when accepting recorded tapes for auditions. In order to keep the candidate honest, the ensemble will often require video submissions. For the purpose of a jazz or contemporary album, the heavy use of editing and effects might be entirely justifiable, since the aesthetic of an “electronic” bassoon is different from the instrument’s acoustic nature. A

¹³¹ Haigh et al, *Classical recording*, 154.

¹³² Haigh et al, *Classical recording*, 304.

¹³³ King, *Recording Orchestra and Other Classical Music Ensembles*, 208-218.

¹³⁴ Meacham, “How to Record the Best Bassoon Sound on Your Own.”

recent example of this being Mark Ortwein's album *It Was Time*. In summation, bassoonists should expect a variable amount of post processing based on the project.¹³⁵

Summary

In order to understand and better appreciate the recording environment, this chapter has compiled some of the documented common recording practices, both in the commercial industry and at the consumer level, that bassoonists might expect to interface with or use for their own purposes. These have included the traditional setups of main-pair microphone systems for a variety of ensembles, as well as the use of close microphones to capture a more isolated bassoon sound. Additionally, instances beyond the large ensemble environment, such as DIY projects and chamber ensembles, were also explored, and comparisons were made based on how the microphone setups and the potential interactions with the instrument change. Since there are a wide variety of performing environments and scenarios, it is only natural that recording techniques will also vary to best complement each environment.

Whether the bassoonist is being recorded by a professional or they are recording themselves, being able to recognize the techniques and equipment used, and how those decisions might impact musical expression, will only be of benefit. Understanding these different practices helps to explain why and how the bassoon may take on a different sonic aesthetic when being recorded as a section instrument versus a solo instrument or chamber instrument. Additionally, players can develop a sense of how their sound might translate between one type of main system versus the next or be able to see the warning

¹³⁵ Ortwein, *It Was Time*.

signs of when an engineer is unfamiliar with how to spot mic the instrument. For a bassoonist interested in DIY recording, understanding these fundamental recording principals, and how their instrument will be captured by them, will help to make informed decisions for equipment and implementation based on the characteristics of the music and setting.

For the current or aspiring recording bassoonist, especially those who are motivated to record themselves or have a solid working relationship with an engineer, it is the author's recommendation to acquaint themselves with the sources found in this chapter that relate to their type of project. However, it is worth recognizing that many of these practices are simply guidelines and not steadfast rules. If it is true that recording is just as much of an artform as musicmaking, then there will always be opportunities to subvert expectations. It is entirely possible that a technique not mentioned in this chapter is perfect for achieving a certain sound quality that is preferrable in a certain musical circumstance. This once again proves that a dynamic interaction exists between bassoon playing and the recording environment when producing any type of music in that medium. Unlike the concert hall, which remains static and leaves little room for adaptation or adjustment, microphones and the recording process at large offers the opportunity to mold and craft a new listening experience based on the inherit and desired qualities of the bassoon and its player.

CHAPTER 5

ANALYSIS

Introduction

Like many other components of music making, learning the principles of recording technology, bassoon acoustics, and how these two areas intertwine is a meaningless exercise without appreciating how it affects the expression of the music and experience of the listener. Luckily, it is very easy to appreciate the different executions of these principles because of the permanence of a recording. Recordings allow for a performance to be heard and repeated the same way multiple, if not an infinite, number of times (provided the materials used for playback have not changed or degraded).¹³⁶

Therefore, comparing recordings of the bassoon is a useful exercising for uncovering how performance qualities have been altered by the different recording techniques used for its capture, and how those qualities impact the overall impression of the performance. The following examples will analyze some of the characteristics of the instrument's sound as heard across several different recordings. In all cases, the recording equipment and techniques used are not known, although some theories might be presented. Oftentimes, the techniques used for a recording are not common knowledge, and the aim of this paper is not to correctly guess them. Rather, this exercise is meant to

¹³⁶ While this paper will not discuss the nuances of different pieces of playback equipment such as headphones, speakers, and digital to analog converters, it is important to note that these devices can influence the listener's impression of a musical experience just as much as the recording equipment/techniques.

challenge listeners to become consciously aware of how the bassoon's sound and musical experience is translated into the recorded space.

Bassoon Recordings of the Philadelphia Orchestra

As explained in chapter 4, different ensembles will require different microphone configurations and recording techniques, and therefore the bassoon will be prioritized differently in the context of the recording. The difference in these techniques will significantly alter the way the instrument and playing is heard, affecting the expression of the music. An easy way to notice this impact is by comparing the playing of an individual in different contexts. When a bassoonist performs a solo work, it is safe to assume that the way they are captured by microphones and other recording equipment will vary greatly from the way they would be captured when playing within the orchestral wind section. This is most likely due to the bassoonist interfacing with a different setup that is tailored to the setting, such as a solo microphone versus section microphones. Even if the recording setups were identical, simply changing physical positions on the concert stage and therefore changing proximity to the respective microphones would be enough to impact tone, dynamics, the impression of articulation, and the sense of closeness or distance. Considering that all of these (and other) attributes are also meticulously considered by the performer themselves, it is crucial to recognize how the chosen recording technique may compliment or subvert them.

An example of this can be heard by listening to bassoonist Bernard Garfield's recorded performance of Carl Maria von Weber's *Andante und Rondo Ungarese* with the Philadelphia Orchestra conducted by Eugene Ormandy and comparing it to his playing of

“The Kalendar Prince” bassoon solo in Nikolay Rimsky-Korsakov’s *Scheherazade* recorded by the same orchestra and conductor.¹³⁷ When listening to *Scheherazade* in stereo, there is a clear sense of perceived distance felt between the listener and the bassoon solo. This is particularly noticeable when compared to the closeness of the violin solo that starts the movement. The listener can imagine the bassoon being seated slightly right of center and well behind the low strings holding their pedal during the solo. This sense of space correlates with the way one might expect to hear a live performance of an orchestra, with the bassoon positioned farther back in the hall. Therefore, it is worth noting that a sense of realism is prioritized in this recording, since it could have easily been altered with competent engineering. Achieving this positioning impacts the perception of Mr. Garfield’s performance as well. Since there is likely less emphasis on the direct sound coming from the instrument, possibly due to less reliance on spot mics and more reliant on the main pair for the bassoon’s sound, any note changes or rearticulations are smoothed over with the help of reflected/reverberant sound in the hall, giving the performance a terrific legato quality. Likewise, there is no presence of key noise, breathiness, or reed sound to represent the mechanical nature of playing the instrument. Capturing the sound this way compliments the way Rimsky-Korsakov has written the solo with the markings of *Capriccioso*, *Quasi Recitando*, and *dolce ed espressivo*. Additionally, one could argue that the sense of distance and reverberation

¹³⁷ Discogs, “Town Hall, Philadelphia.” Although the Weber recording does not disclose the details of where it was recorded, presumably both albums were recorded in Town Hall/Scottish Rite Cathedral, Philadelphia, which was still in existence and being used for recording by the orchestra when Garfield’s performance was originally produced.

makes the solo feel like a long-forgotten memory, which compliments the narrative of Scheherazade having to recall these different stories over a thousand and one nights.¹³⁸

The image shows a musical score for a Bassoon Solo. It consists of three staves of music. The first staff begins with the tempo marking "Lento. Recit." and a 3/4 time signature. The second staff is marked "Andantino." with the instruction "dolce espressivo" and a 3/4 time signature. The third staff is marked "A a tempo" and includes the instruction "rit. assai." at the end. The score is written in bass clef with a key signature of one sharp (F#). The music features various rhythmic patterns, including triplets and slurs, and dynamic markings such as "Solo." and "Viol. Solo. Capriccioso, quasi recitando".

Figure 5.1. Bassoon Solo from “The Story of the Kalendar Prince”¹³⁹

These qualities are represented very differently in the *Andante un Rondo Ungarese* despite it being a recording by the same bassoonist. In this recording, the bassoon is situated front and center in the stereo image with a sense of closeness that makes the listener feel like they are sitting mere inches away from the performer. From this vantage point, there is a noticeable increase in finger and reed noise. Also, there is an

¹³⁸ Philadelphia Orchestra. “The Story of the Kalendar Prince.”

¹³⁹ Rimsky-Korsakov, *Scheherazade*.

audible difference in tonal quality as well, with the Weber performance exhibiting a more detailed and fuller resonance than in the Rimsky-Korsakov. Figures 5.2 and 5.3 compare the frequency content of each recording using spectrograms of the first 13 seconds of each bassoon entrance. Despite both these excerpts living in very similar registers on the instrument, these figures illustrate that the bassoon sound of the Weber has much more defined resonant peaks (outlined in bluish purple) that correlate to the formants of the instrument than the *Scheherazade* solo. It is even possible to follow the ascensions/descensions in the shape of the Weber's melody because of how well defined these resonances appear.¹⁴⁰

¹⁴⁰ Garfield, "Andante e Rondo Ungarese Per Il Fagotto Principale, Op. 35. J. 158."

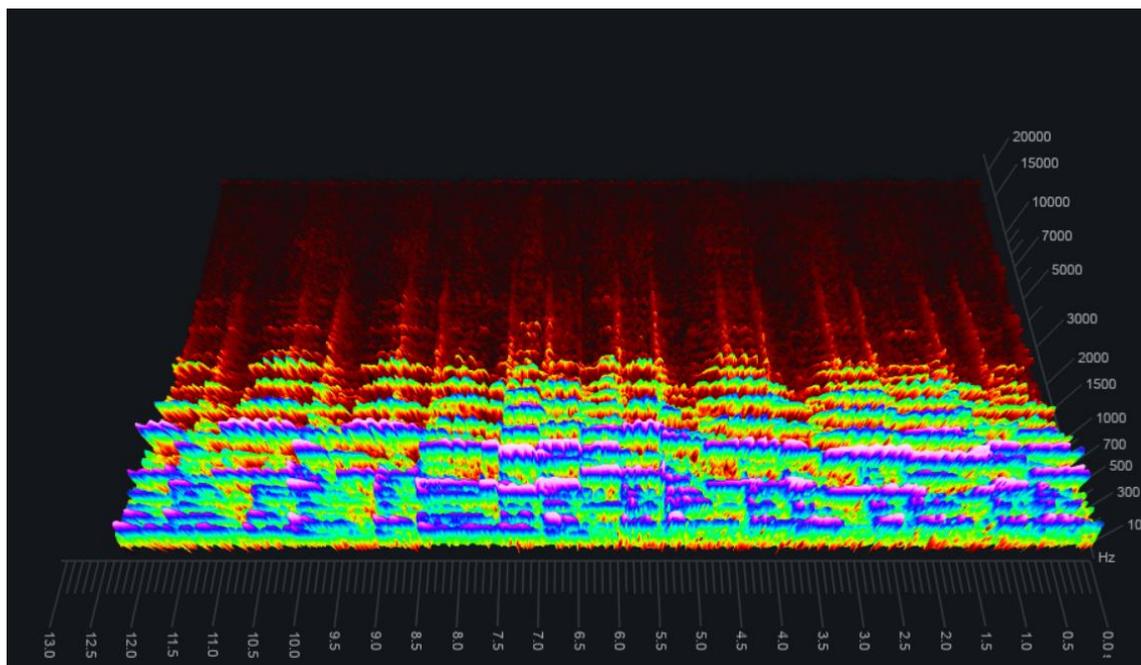


Figure 5.2. Spectrogram of the beginning of Weber's *Andante un Rondo Ungarese* performed by Bernard Garfield and the Philadelphia Orchestra

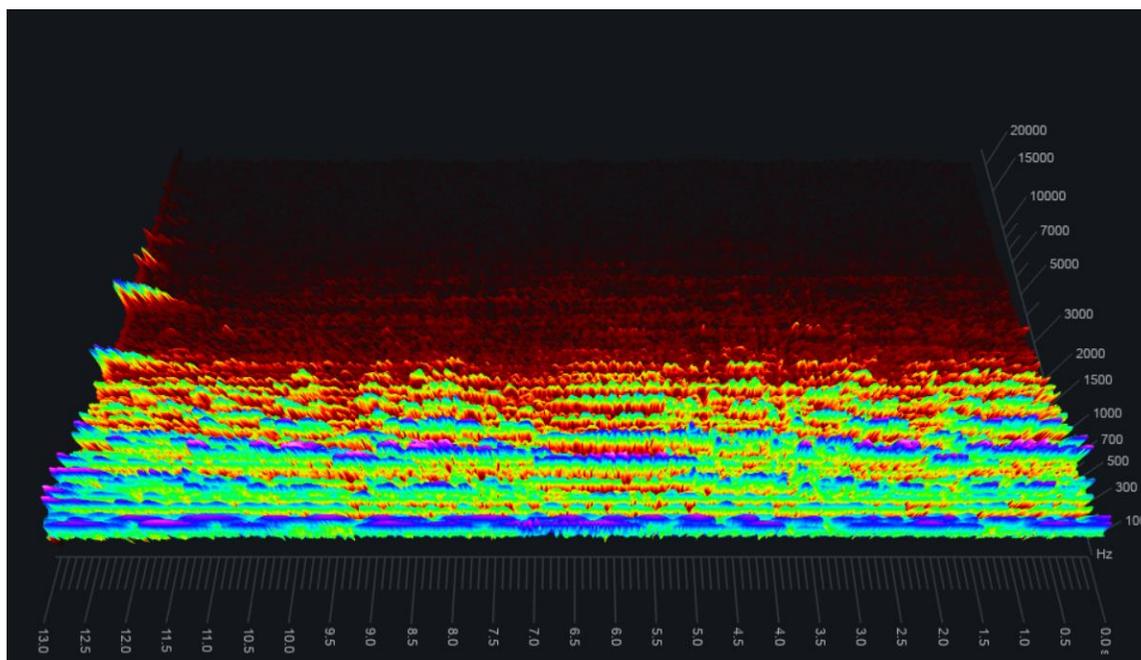


Figure 5.3. Spectrogram of the bassoon solo *Scheherazade* movement 2 performed by the Philadelphia Orchestra

From this comparison, it becomes clear that the bassoon was prioritized quite differently in the recording depending on the musical context. It is plausible that Mr. Garfield and Maestro Ormandy were entirely responsible for these sonic changes, and the audio engineers made the effort to make the recording process as sonically transparent as possible. On the other hand, it is also possible that these albums sound nothing like the experience of hearing it live, and it was up to the engineers to drastically alter the listening experience. For example, the sound quality of the bassoon in the Weber performance could have been achieved with a different microphone or post-processing just as easily as it could have with a different reed or different playing approach on Mr. Garfield's part. The sense of closeness or depth could be attributed to different microphone placements and balancing that alter the ratio of the direct bassoon sound vs the acoustics of the room or the implementation of artificial reverb. The previous chapters have proven that these alterations are entirely possible through different recording techniques, and while it is impossible to say for certain how much of these characteristics were achieved through performance decisions versus engineering decisions, what does matter is that these differences are audibly noticeable in this permanent representation of this bassoonist's performances. Listening to these two examples demonstrates the aesthetic possibilities that arise when a bassoonist's performance interfaces with the medium of recording.

Tchaikovsky's 4th Symphony

As the previous example suggests, it isn't always possible to know how much of the sound on a recording can be credited to the engineering work, or the live sound itself. While musicians can certainly alter their sonic aesthetics as they see fit, the artform that surrounds microphones, mixing, and audio engineering in general can make just as much of an impact. Additionally, the recording process does offer some unique opportunities to enhance the musical experience in ways that would be traditionally inaccessible to the musician alone. Chief among these opportunities is the ability to create a sense of auditory space.

Although it is not often thought about as an "aesthetic," positioning within the spatial auditory image can define the experience of hearing a piece of music. Otherwise, there wouldn't be differently priced concert seats. But recordings are special in the sense that they can tailor the positioning of the listener to give them the best listening experience. While the instrumentalists may be restricted to standard seating, microphones and audio processing tools can easily be utilized in such a way to provide depth, width, and other directional characteristics (as explored in Chapter 4). Therefore, spatial imagery becomes a factor in recorded bassoon performance, since the perceived location of the instrument in a recording could impact the impression of the music.

The following example compares the 2nd movement bassoon solo in Pyotr Ilyich Tchaikovsky's *Symphony No. 4 Op. 36* from three different recordings. First is the 1978 recording by the Royal Concertgebouw Orchestra led by Bernard Haitink and recorded by Decca. The second is by the San Francisco Symphony from 2009 conducted by

Michael Tilson Thomas and recorded under the SFS Media label. The third from 2019 is performed by the London Symphony Orchestra under the LSO Live label and is conducted by Gianandrea Noseda.

Figure 5.4. Bassoon Solo from Movement 2, “Andantino in modo di canzona”. from Tchaikovsky’s *Symphony No. 4 Op. 36*¹⁴¹

Upon playback, it is obvious that the San Francisco and Royal Concertgebouw recordings offer a wider stereo image in terms of the direct sound from the stage. As the movement progresses, there is a clear sense in these recordings that the violins are defined on the far left of the imagined stage while the cellos and basses are markedly off to the right. In the LSO recording, these sections seem to be put farther in the center of

¹⁴¹ Tchaikovsky, *Symphony No. 4 Op. 36*.

the listener's hearing. This sense of width changes the impression of the bassoon's performance when the solo comes in near the end of the movement. In the first two recordings, the bassoon feels more clearly defined in its own space and does not seem to occupy the same area of sound as the violins or low strings during their pizzicato or arco moments. This gives the solo a more solitary effect, especially in the Royal Concertgebouw recording, as the bassoon feels disjointed from the countermelody in terms of space. To contrast this, the strings in the LSO recording seem more glued to the center and partnered with the bassoon solo.

Although the San Francisco recording puts the bassoons in a more solitary and distant space, the ensemble is allotted more reverberation from the hall (or from artificial reverb). The impact on the bassoon solo can be heard as the player phrases the slurred passages which have any potential jagged edges smoothed over thanks to the compounding reverberation. As the bassoonist reaches a peak phrasing moment in a slurred grouping, the reverberance reinforces the gesture with volume, sounding as if the hall resonates more intensely to match the bassoon's intensity. This reinforcement is not heard as much throughout the other recordings, with the LSO taking the opposite approach with a drier sound that avoids any exaggeration in the phrasing.¹⁴²

While there is nothing in the score to determine whether Tchaikovsky would have preferred the aesthetic in one recording over another, the sounds achieved by these albums yield very different interpretations of the solo. The impact of space is not usually

¹⁴² London Symphony Orchestra, "II. Andantino in modo di canzona"; Royal Concertgebouw Orchestra, "Symphony No. 4 in F Minor, Op. 36: 2. Andantino in modo di canzone"; San Francisco Symphony, "Symphony No. 4 in F Minor, Op. 36: II. Andantino in moto di canzone."

associated with bassoon performance, yet in a recording it can make all the difference in achieving a certain aesthetic. This is yet another instance of the recording process not being a transparent method of auditory capture, but instead an opaque filter that molds and shapes the listening experience. This filter of recording dynamically combines with the acoustic characteristics of the bassoon and space, the intentions and skills of the performer, and the character of the music itself to create a unique interaction that shapes bassoon performance in a wholly different way from its in-person counterpart.

Saint-Saëns Sonata

One of the more widely recorded pieces in the bassoon's solo repertoire is the Sonata Op. 168 by Camille Saint-Saëns. This piece has been recorded by a healthy number of world-renowned professionals, with performances spanning across both the 20th and 21st centuries. As a staple of the bassoon's standard repertoire, it seems that many players are eager to have their interpretation of the work recorded and distributed, regardless of how many times it has been previously recorded. Recordings of the piece make for a great opportunity to analyze and hypothesize the different ways that the recording environment, coupled with the players execution, impacts the expression of the work.

Two of these albums demonstrate expressive extremes in multiple areas that can be credited to the recording practices; Klaus Thunemann's 1991 album *Saint-Saëns & Poulenc: French Music for Oboe & Bassoon* and Judith LeClair's recording from her 2010 album *Works for Bassoon*. In LeClair's recording, the bassoon feels front and center in the auditory image. This sensation comes from the reduced presence of reverberation

as well as the increased presence of key noise and breathiness. In addition, the piano sounds like it surrounds the listeners from both left and right, providing the feeling of being right on top of the players while simultaneously leaving a gap in the center of the image for the bassoon to be clearly heard. The result leaves the listener with a very intimate experience. In contrast, Thunemann's recording feels much more distant. Much more reverberation is captured, and the piano feels like it occupies the same central space in the stereo image. Unlike LeClair's recording, which seems to synthesize an intimate aesthetic, Thunemann's recording sounds much more realistic to the experience of attending a performance in a recital or concert hall.¹⁴³

It is safe to assume that different microphone techniques played an important role in achieving these two effects. In LeClair's recording, the close microphones might have been more heavily relied upon, or a more directional stereo technique was used. For Thunemann's recording, the main microphones might have been a farther distance back and were a larger portion of the final sound. Both approaches have pros and cons as it pertains to recording the bassoon and this piece specifically. For example, a listener may find that the extra key and breath noise in LeClair's recording becomes a distraction to hearing her beautiful phrasing. After all, a bassoon performance is not often heard that close. On the other hand, beginning with a dynamic of piano and a legato articulation, the piece lends itself to an intimate setting that can be reinforced through this closeness. Thunemann's recording offers an experience in a more organic environment, but often

¹⁴³ LeClair, "Sonata for Bassoon and Piano in G Major, Op. 168: Allegretto moderato"; Thunemann, "Sonata for Bassoon and Piano in G-Major, Op. 168: I. Allegretto moderato."

compromises the same level of intimacy for a constant need to project into the hall. It is possible that LeClair's microphone setup allowed her to explore more docile sounds and dynamics, while Thunemann's setup required a more robust level of output in order to balance with the piano.

LeClair's recording also seems to feature a width to the bassoon as well. This would not only confirm the prioritization of the close microphone but also the use of a close stereo pair. This can be observed in the bassoon's very first phrase, starting with the G4, which resonates slightly to the left of the image. Afterward, the resonance of the descending line sounds as if it is shifting more towards the right, particularly when the phrase reaches C4 and the resolving B3. Coincidentally, this phenomenon can be heard in other recordings that feature a closeness and a width to the bassoon. Benjamin Kamins' recording of the Sonata from the album *Benjamin Kamins, Bassoon*, and Sophie Dervaux's recording from her album *Impressions*, also demonstrate this resonant movement. Thunemann's recording on the other hand remains stable and centered.

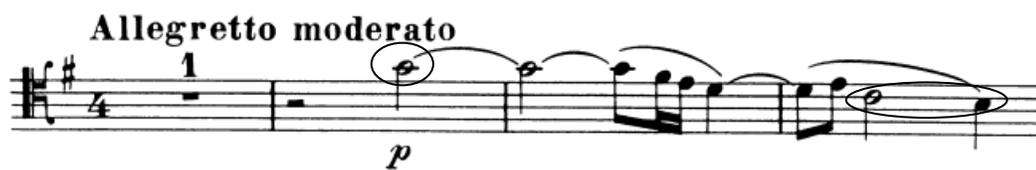


Figure 5.5. Measures 1-4 of Camille Saint-Saëns Sonata for Bassoon and Piano Op. 168¹⁴⁴

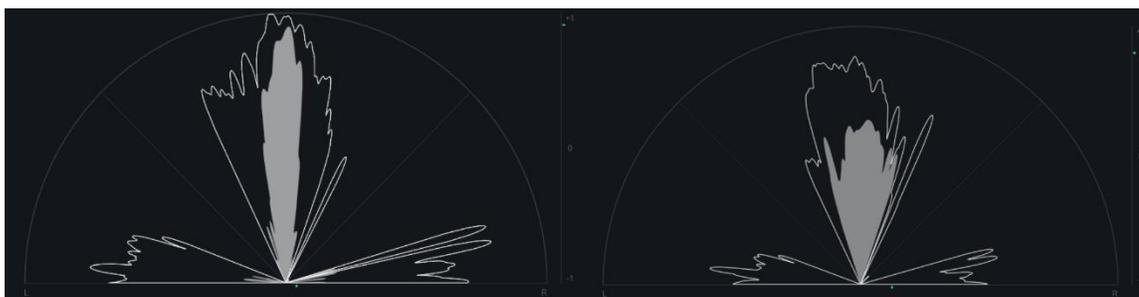


Figure 5.6. Thunemann's Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively

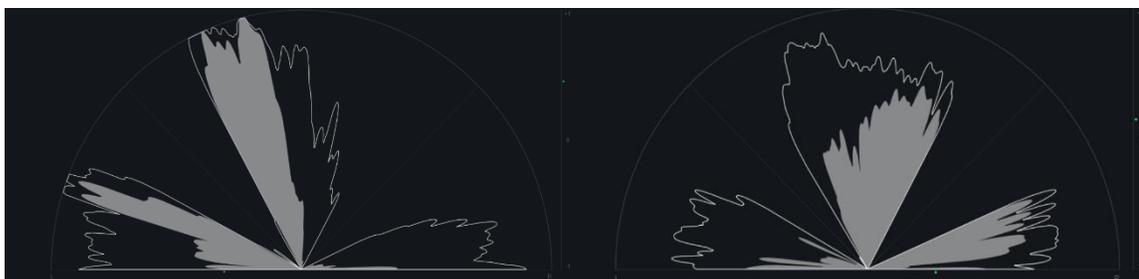


Figure 5.7. LeClair's Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively

¹⁴⁴ Saint-Saëns, "I. Allegretto moderato."

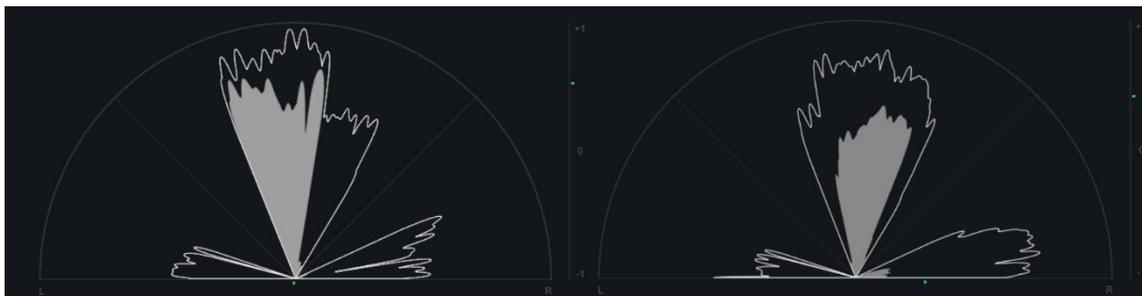


Figure 5.8. Kamins' Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively

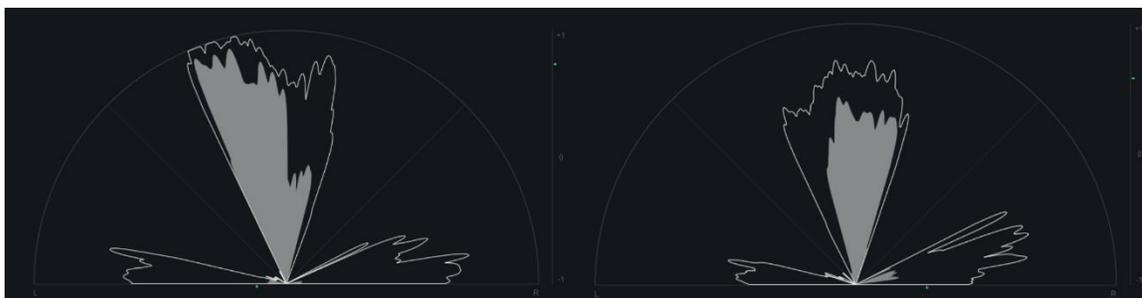


Figure 5.9. Dervaux's Recording: Depiction of LR Sound Field of the Opening G4 and B3 respectively

Although it is not a perfect measurement considering there is no way to perfectly isolate the bassoon sound from the piano sound, the figures above outline the resonant peaks of both G4 and B3 from the opening phrase and their positioning in the stereo image. Compared to Thunemann's recording, the trend of G4 starting on the left, and B3 appearing more to the right on the other three recordings is unmistakable. It seems that the distance between the correlating open tone holes and the differences in sound propagation between notes can be audibly noticeable when using close-microphone pairs.

Grothe's findings discussed in Chapter 3 add another layer of intrigue as well.

When one relatively close microphone is used to capture the sound (such as in Grothe's experiments), the unevenness in resonance that is inherent in the instrument is noticeable only in changes to volume and tone. When two microphones are used to capture a spatial/stereo image, as demonstrated in the three later Saint-Saëns recordings, it becomes clear that the instrument's resonance between notes is also a matter of positioning.¹⁴⁵

This analysis highlights the importance of deciding what type of close microphone setup, if any, will be used for a bassoon solo recording. The size and resonant nature of the bassoon interacts differently with each method and must be carefully considered. In some cases, a single close microphone may be the right decision when it is paramount that the positioning of the bassoon stays fixed. However, there would be noticeable unevenness in resonance if the close microphone was too heavily relied upon in the final mix. On the other hand, using a two-microphone approach that creates width in the bassoon's sound provides more adequate volume and tonal coverage of the instrument, but with the byproduct of a potentially moving spatial image. Any preference between these different approaches is entirely subjective. However, as heard in the previous examples, the results of either decision ultimately color the impression of the recorded performance.

¹⁴⁵ Dervaux, "Sonata for Bassoon and Piano in G Major, Op. 168.>"; Kamins, "Sonata Op. 168: I. Allegretto Moderato.>"; LeClair, "Sonata for Bassoon and Piano in G Major, Op. 168 : Allegretto moderato.>"; Thunemann, "Sonata for Bassoon and Piano in G-Major, Op. 168: I. Allegretto moderato."

Conclusions

Through the practice of critical listening, it becomes clear that the technical decisions surrounding a recording have great impact on the impression of bassoon performance and dynamically interact to the nature and use of the instrument itself. The bassoon's formant qualities, traditional stage positionings, and sound propagation, will all be conveyed differently in a recording environment depending on the methods used. To prove this, the previous musical examples explained changes in aesthetics like color, distance, and realism with differences in recording techniques. There is ample opportunity to tailor recording techniques to the unique characteristics of the instrument and impact the musical interpretation. This is no different than a bassoonist carefully crafting their reed based on the music they are tasked with playing. Even the most granular decisions made in recording can interface with bassoon performance in a way to alter musical expression, making it critical to study the distinctive relationship that exists between the two artforms.

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