BREATHING SOLUTIONS FOR WOODWIND PRACTITIONERS

RYAN GRIST

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ABSTRACT

Instruction methods for playing woodwind instruments often inadequately address breathing. There is no standardized approach. It is often described imprecisely, thus resulting in a poor understanding and application of breathing concepts.

This project first offers a clear definition of how the human body breathes to remove common misconceptions and correct language used in pedagogy. The most applicable concepts to playing a woodwind are highlighted. Instrument histories, limited to the flute, clarinet and saxophone, are then given to inform our understanding of how they have evolved to our present-day instruments. Subsequently, the connection between our body's physiology and wellbeing is explored through current research into the power of the breath. Finally, this leads to an amalgamation of these concepts and a practical methodology is presented. This aims to enhance learning and practice through the integration of established breathing and wellness concepts.

Keywords: breathing, wellness, flue, clarinet, saxophone, stress, anxiety, pedagogy, diaphragm

DEDICATION

This work is dedicated to my two children Wesley and Sophie, and my wife Natalie. I'm blessed to have had a year of remote learning as a family. I hope that being a part of this journey births a love for learning as we grow together. Natalie, your constancy and support is incalculable. I love you all deeply.

It is hoped this work will offer instrumentalists a resource to explore their woodwind practice as it relates to wellbeing. I have experienced profound personal benefit by doing so, and hope this research shortens the path to more fulfilling musical experiences.

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INTRODUCTION

Music teachers, particularly elementary band instructors, are faced with addressing many challenges in a short time. Often, in the early stages of learning, precious time is wasted dealing with the assembly of woodwind instruments. Flutes, clarinets, and saxophones each present their own unique set of requirements for readiness—careful instruction and practice help to speed this along and maximize rehearsal time. Many method books offer assembly instructions for reference, and it quickly becomes integrated and automatic. Unfortunately, unlike assembly, breathing is not addressed in a standardized manner and is too often left for the student to decode independently. Wind instruments rely *entirely* on the player's breath to create sound. Other factors are important, but the breath is essential. This paper offers a solution to this deficit by illuminating *how* humans breathe to inform our understanding of its relation to instrumental performance. Historical context of the flute, clarinet and saxophone is explored to trace their evolutions to our modern-day equipment. By uncovering the similarities and differences between these instruments, we gain a nuanced understanding of their demands on the performer's breath and, perhaps, deeper appreciation for the mechanics of breathing, realizing the body as an instrument itself. Our growing self-awareness is likened to the discovery of a breakthrough material or key for an instrument. Finally, we arrive at a practical methodology to enhance our wellbeing and the experience of playing woodwinds.

Instrument histories, for this paper's purposes, are not intended to be exhaustive. Instead, the author sets out to explain the beginnings of each respective instrument and highlight significant turning points and advances that have led to the modern-day woodwinds found in classrooms and music stores. The available materials and inventiveness of instrument makers,

along with improvements in technology and societal demands, have contributed significantly to the expressive potential of the woodwind family of instruments.

Repertoire and composers are referenced in the context of how they influenced and drove innovation, but focus is given more to the physical natures of the flute, clarinet and saxophone. These are explored based on today's standard C flute, B♭ soprano clarinet, and the E♭ alto saxophone. Investigating the extended families for each of these instruments is outside the scope of this project.

The author's goal for this research is to gain the resources to deliver masterclasses on the instrument's histories and then relate a new understanding of how best to breathe in performance and practice, discover the wellness benefits of doing so intentionally, and then offer practical instruction on how to implement these realizations. The goal is to gain clarity and simplify practice.

CHAPTER 1: BREATHING

1.1 Overview of the Breath

Breathing is an action that signals both the beginning of life and, in its absence, the conclusion. It is constant throughout our existence and shared universally among humans. This process is known medically as *pulmonary ventilation,* generally described as air movement between our lungs and the atmosphere.[1] Breathing goes largely unnoticed as a function of the autonomic nervous system until there is cause for concern or need to adjust. It is a bodily function that is also accessed consciously. However, life-sustaining systems override voluntary control to maintain survival.[2] Regarding the performance of wind instruments, the role of the breath is paramount and proper instruction on how best to perform this action is equally important. As we explore the evolution and innovations of woodwind instruments in coming chapters to gain a deeper appreciation for their construction and development, it is also vital to gain knowledge of the human body and how its systems work. The following paragraphs will explain the respiration process with the aim to remove any fundamental misunderstandings on how a human body breathes.

1.2 The Respiration Cycle

The breath has two components, inhaling and exhaling. These two independent actions happen separately and together create a respiratory cycle. Inhaling, or *inspiration* is the act of drawing air into the lungs and exhalation, or *expiration*, the act of expelling it. Our body draws fresh oxygen into the lungs and expels carbon dioxide. This gaseous exchange is kept in balance

[1] J. Gordon Betts, et al, *Anatomy & Physiology*, (Houston, Texas: OpenStax, 2017).

[2] Carl Freudenrich, "How Your Lungs Work," *HowStuffWorks.com,* (October 2000), https://health.howstuffworks.com/human-body/systems/respiratory/lung.htm.

by sophisticated biological processes, explanations of which are beyond practical use for this essay. However, a concrete understanding of the physical components involved is prudent. This aids in creating a context for breathing. Contemporary pedagogy often falls short in accurately describing how to breathe for woodwind performance.

Inspiration is dominated by the diaphragm and external intercostals. The diaphragm is a thin, dome-shaped layer of muscle and connective tissue. It separates the abdominal and thoracic cavities. The abdominal cavity does not change in volume, only shape. The thoracic cavity contains the lungs and heart and *does* change in volume as we breathe. External intercostal muscles are responsible for moving the ribcage up and out and are located between the ribs. When the brain signals the body to breathe, the diaphragm contracts, flattening downwards to increase volume in the thoracic region. This motion of the diaphragm pushes the internal organs down and forwards, expanding the belly. The external intercostals also contract with the diaphragm to move the rib cage upwards and outwards, further increasing volume in the lungs. The diaphragm is responsible for seventy-five percent of the volume increase within the lungs.[3] Here, we see the importance of the diaphragm as it contracts to create volume in the thoracic cavity, drawing air into the lungs.

During exhalation, the primary movers of inspiration relax and return to their neutral positions, allowing the air to be passively exhaled. The type of breathing will dictate the muscle groups involved and the intensity of their participation. Quiet breathing, occurring at rest, requires little energy and no cognitive thought. Deeper breathing, or diaphragmatic breathing, requires a stronger contraction of the diaphragm. Shallow breaths require intercostal

[3] Brian Frederiksen, *Arnold Jacobs: Song and Wind*, ed. John Taylor (Gurnee: Windsong Press Limited, 1996), ch. 11.

contractions, known as costal breaths. Most relevant to wind playing is *forced breathing*, also known as hyperpnea.

1.3 Forced Breathing

Forced breathing happens during exercise or activities that require the manipulation of the breath, such as singing or playing a wind instrument. A medical definition is vital here, to emphasize the importance of each group of muscles as the roles they play in this mode of breathing are most applicable to woodwind performers. In the textbook *Anatomy & Physiology*, forced breathing is described:

> During forced breathing, inspiration and expiration both occur due to muscle contractions. In addition to the contraction of the diaphragm and intercostal muscles, other accessory muscles must also contract. During forced inspiration, muscles of the neck, including the scalenes, contract and lift the thoracic wall, increasing lung volume. During forced expiration, accessory muscles of the abdomen, including the obliques, contract, forcing abdominal organs upwards against the diaphragm. This helps to push the diaphragm further into the thorax, pushing more air out. In addition, accessory muscles (primarily the internal intercostals) help to compress the rib cage, which also reduces the volume of the thoracic cavity.[4]

To reiterate and emphasize; the accessory muscles of the abdomen contract and push upwards against the diaphragm. This reference sheds light on a crucial misconception promulgated in wind instrument discourse on breathing – the diaphragm is *passive* on exhalation. However, other characteristics of the diaphragm bear mentioning to realize this misconstruction fully.

The diaphragm is equipped with few sensory receptors and cannot be felt directly. What *is* directly felt are the supporting muscles of expiration, namely the abdominal muscles and

[4] J. Gordon Betts, et al, *Anatomy & Physiology*, (Houston, Texas: OpenStax, 2017), 1052.

accessory muscles (obliques and intercostals).[5] It has been shown under x-ray, using fluoroscopy, that *the diaphragm cannot be independently controlled*. It is, in fact, the supporting muscles that produce forced exhalation.[6]

1.4 Where Pedagogy Falls Short

Breathing instruction given to wind instrumentalists, then, is fundamentally incorrect when emphasizing the diaphragm in exhalation. This point cannot be understated. As we now appreciate, the diaphragm is relaxing on exhalation. Common phrases like *push* or *support* from the diaphragm suggest actions that are physically impossible to execute with a muscle beyond our conscious control and uninvolved in the process.[7] These directives associate a feeling with a desirable musical outcome, namely a supported sound. However, in this author's opinion, it is more constructive to accurately describe the physical process involved from the beginning.

The use of language does not conclusively prevent a good result but depends mainly upon the student's interpretation and perhaps their natural ability. As exhalation is taught, it is imperative to correctly connect the active muscle groups humans consciously feel and influence. This awareness is known as having an accurate body map. A frequently cited method for this understanding is the *Alexander Technique*. The Alexander Technique "is not about release of tension per se, but about efficiency of muscle use (i.e. the appropriate use of the appropriate muscles for whatever is the task at the moment). It is not a relaxation technique, but about balanced strength, coordination, and ease of movement."[8] F.M. Alexander was a vocalist who struggled with recurring vocal hoarseness. Medical advice of the day offered only temporary

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[5] Amy Likar, *The Breathing Book Flute Edition,* (Flagstaff: Mountain Peak Music, 2018), 24.

[6] Claude Gordon, *Brass Playing Is No Harder Than Deep Breathing*, (New York: Carl Fischer, 1987), 16. Professional trumpet players were observed under x-ray while performing.

[7] Another example would be, "breathe into your belly." Air only enters the lungs.

[8] Jane Ruby Heirich, *Voice and the Alexander Technique*, (Berkely: Mornum Time Press, 2005), 7.

relief of the symptoms. Alexander's frustration led him to realize that how he was using (or misusing) his body was the cause of his hoarseness and set to correct these problems through his self-observation and correction.

A performer cannot feel their diaphragm, or in fact, push with it and teaching breathing as such inspires confusion. Dependant on individual understanding, this leads to unnecessary tension in the body, limiting effective breath support. If the breath is ineffective, the goal of musical expression cannot be fully realized.

To summarize, many instructional books use misleading language for teaching how to blow into a woodwind instrument or neglect the subject altogether. If pedagogy omits the abdomen and accessory muscles from exhalation, the learner is left to approximate the desired result with inaccurate misgivings regarding the mechanics of breath. It is necessary to have a correct body map when assigning responsibility to muscle groups. These groups must be physically able to perform the obligatory task. Progress is made through informed training as the learner is equipped with instructions that align with the body's capabilities.

INTRODUCTION TO WOODWIND HISTORIES

The flute, clarinet, and saxophone have intertwining histories that leave much for a curious investigator to uncover. Remarkably, human beings had musical impulses long before recorded history. Researchers working at a pair of Stone-Age sites in Germany discovered flutes made from bird bone and mammoth tusks. Carbon dating places these at between 35,000 and 40,000 years old.[9] These are the oldest known instruments in the world, made from materials found readily available in the natural environment, in this case, a vulture's forearm and ivory tusks. As humans evolved and refined their ability to use tools to shape their resources, so did the potential of the instruments they were creating.

Throughout each woodwind instrument's evolution, the pursuit of an even, pleasing sound and extended expressive range is an over-arching theme. At times this was driven by musical demands and, at others, technical innovation. This essay traces the beginnings of the end-blown reed flute, the ney, in ancient iconography and follows its shift to the transversely played instrument more common today. A vibrating reed plays a defining part in the early beginnings of the clarinet. We see both the flute and end-blown reed instruments, forebearers to the oboe and clarinet, in similar scenarios throughout ancient history. Often these instruments were present in ceremonial rituals and were used by humans to honour and connect to a power perceived as greater than themselves.

In a broader scope, beginning with the flute, we follow it and, subsequently, the clarinet's development in the courts and orchestras of the west. A narrower view is taken at a remarkable stage of intense innovation in woodwind history during the 19th century.

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[9] Bruce Bower, "Oldest Known Instruments Found: ivory, bone flutes date from 35,000 to 40,000 years ago," *Science News* 176, no. 2, (2009): 13.

Arriving at the mid-1800s, we realize a profound turning point in instrument making. From a seemingly simple innovation, the ring key, a world of possibility is born. Both the flute and clarinet grew swiftly in refinement, resulting in the instruments we are mainly familiar with today. When the saxophone patent was filed in 1846, the instrument already had the advantage of this innovation and the craftsman's skill in application.[10]

A multitude of the available resources on these instruments was assessed in preparation for this project. Many of the general comments made hereafter are based on this body of knowledge and the author's professional training and experience.

[10] Stephen Cottrell, *The Saxophone,* (New Haven and London: Yale University Press, 2012), 343.

CHAPTER 2: THE FLUTE

2.1 Early flutes

The flute is an edge-type aerophone. An aerophone is a musical instrument that produces sound by setting up vibrations in a body of air and is one of the four original classifications of instruments, along with idiophones (struck instruments such as a bell or gong), membranophones (drums), and chordophones (vibrating strings).[11] Aerophones are further delineated into sub-groups to accommodate for many variations. Early examples like the *ney* are described as a single tubed, ductless, end-blown flute with finger holes. These flutes originated in ancient Egypt. They are most often held obliquely in front of the body when played and an aspirated stream of air produces the sound. The player focuses this airstream directly at a sound-producing, rimmed edge to achieve a tone.

Transverse flutes are generally depicted being held to the body's right, sometimes resting on the player's shoulder and horizontal. However, early portrayals of Chinese flutes called the *chi*, first recorded in the ninth century B.C.E.*,* were principally used for ritual ceremony and held to the left of the player's body. Indian examples of transverse flutes include the *bansuri,* a northern Hindustani instrument roughly twice the length of its southern cousin the *menali* or *pulangoil*. Surviving depictions in medieval illustrations show similar instruments to those in use today. Although it is not known how closely today's instruments resemble those of over one thousand years ago, their simplicity suggests they have not changed drastically.[12]

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[11] Howard Mayer Brown, Frances Palmer, "Aerophone," *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

[12] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 11.

2.2 Flutes in the Spirit World

The flute is often used in blending the spirit world with reality. It is not until the 12th century that a transverse flute appears in western art and literature. In the manuscript entitled *Hortus Deliciarum*, a compendium of sermons containing religious images and teachings from both pagan and Christian doctrine, one example shows the flute being played by a siren in a trio of voice and drum.[13] The sermon that the illustration depicts is instructive, to a ship's crew, not to fall prey to the seductions of the world and become shipwrecked in shallow, rocky waters. Psalters (books that contained the psalms) used in religious office were the most common books of the Middle Ages. They were decorated elaborately with large initial capitals showing scenes and figures of daily life with the transverse flute often played by shepherds in pastoral contexts, symbolizing innocence and perfect love.[14] Much historical musical knowledge from this era comes from the writings of monks, nuns, and priests.

Perhaps one of the most beautiful writings in flute lore is given by the Persian poet and founder of Sufism's Mevlana order, Rumi (1207-73). Rumi used his poetry and parables to instruct his followers in divine secrets and love. His magnum opus, the *Masnevi,* was written between 1250 and 1273, holding more than twenty-five thousand couplets in six volumes.[15] The opening parable, *The Song of the Ney,* tells of a reed being cut from its reedbed and yearning to be reconnected to its source. With its music, the ney sings and laments that it has been separated from its 'real ground,' the riverbed, the source of life. The ney symbolizes humankind's separation from God and the original place where the soul was in happy union with its creator. Expressing this detachment, the earthly human now plays music seeking reunification with

[13] Ardal Powell, *The Flute,* (New Haven and London: Yale University Press, 2002), 15.
[14] Powell, *The Flute*, 15.
[15] Dale A Olsen, *World Flutelore: Folktales, Myths, and Other Stories of Magical Flute Power,* (Baltimore: University of Illinois Press, 2013), 150.

God's supernatural power. The flute's sound touches a universal feeling of being alone and provides a sonic path back to the divine.

2.3 Military Use

In contrast to spiritual uses, the latter half of the 14th century finds the flute becoming a military asset in Swiss infantry squadrons.[16] The fife (a small transverse flute) and drum were used to great advantage as a signalling tool for the coordinated movement of troops in battle. Because of the military successes, other national armies employed the Swiss to adapt and learn their use of the fife and drum in battle. Germany, France, Spain and Italy hired Swiss flutists to learn their playing style. Its widespread use made it a permanent part of European military culture and became commonly used in more formal settings like weddings and banquets.

2.4 The Evolution of the Flute:

The history of the modern transverse flute is often traced only as far back as the 17th century, but we see already that it has a far richer lineage that can be explored. Because of space limitations, the author has selected historical highlights to bring us closer to innovations seen in the mid 1800s.

The emergence of more varied chamber ensembles at the end of the 16th century gave rise to a new musical composition, the solo sonata. This song form drew influence from a progressive style of singing that emphasized a solo instrument in the dominant role and the ensemble in a supportive one. Manuscripts often did not specify the instrumentation and could be adapted to what was available. Some of these included fingering charts and instructions on how to play the

[16] William White, Crystal Lee, and William Parks, "The virtuosic fife: Not just a simple signal instrument," *The Flutist Quarterly* 41, no. 3 (2016): 20-26.

flute. This contributed to the musical literacy of the population and a growing body of amateur musicians. However, although flutes were difficult and costly to make and remained hard to sell, they were becoming more commonplace. Music of this nature began first in the Republic of Venice due to the city's flourishing printing industry. Composers there were able to print and sell their own music because the area lacked ecclesiastical and political censorship.[17]

Philibert Rebillé (1667-1717) and René Pignon Descoteaux (1645-1732) were renowned singers of their time who were also famous for their flute playing. The personal reputations of these musicians did much to elevate the status of the flute. Before this time, the best prospects for reliable employment as an instrumentalist were oboe, violin, lute and keyboards. The obituary notice for Descoteaux gives further evidence of his contribution,

> He had great talents for music in general, with an admiral taste for singing and for instruments, above all the transverse flute, from which he drew an admirable tone, at a time when that instrument was hardly known at all in France. He was one of the first to make it fashionable. He scarcely played anything but little delicate airs [*petits airs tendres*] but with charming taste and neatness.[18]

This, and writings like it, establish the importance of the virtuoso performer to the visibility and growing reputation of the flute.

2.5 Baroque Flutes and *Corpes de Rechange*:

At the beginning of the 18th century, the baroque flute was coming into broad appeal. Many of the essential sound-producing mechanisms had evolved from the flute used one hundred years previous. Flutes of this earlier type were typically a solid piece with six finger holes. As they evolved, the cylindrical bore became wider at one end, the embouchure and finger holes

[17] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 55.
[18] Powell, *The Flute*, 62.

began to have altered shapes and sizes and the tube wall's thickness increased. Significantly, they were built in multiple sections.

Flutes were in most cases made from wood and subject to the environmental influences that different climates and moist, aspirated air from the player inflicted on them. Over time they warp and require adjustments to the bore to maintain the accuracy of its scale and quality of tone. Only so much alteration can be made before the instrument's walls are too thin and it is unplayable. To mitigate this difficulty, flute makers began to construct them in sections to minimize warping and cracking, allowing the player to replace only a portion of the instrument if necessary.

Flutes made in four sections, with one key, were utilized during this time. Instrument builders like Jacob Denner often provided an interchangeable joint to allow for variance in the instrument's tuning. This style of flute emerged early in the 18th century, during the third and fourth decades.[19] The flute divides into four pieces: a head joint with the embouchure hole, two middle joints with three tone holes each, and a lower foot joint with a seventh tone hole, covered by a key that could open to produce the lowest semitone on the instrument. The upper middle joint could exchange for a longer or shorter section to adjust the tuning and allow the instrument's use in various locations and differing pitch values. There was no standardized pitch from city to city, and even the flutes themselves varied between makers. This system of multiple sections is referred to as *corps de rechange*.[20]

Johann Joachim Quantz (1697-1773) rose to unprecedented eminence in Europe as one of the first flute specialists and was employed by King Frederick II of Prussia 'the Great' (1712-

[19] Jane Bowers, "Mozart and the Flute," *Early Music* XX, no. 1 (1992): 31-42.

[20] Jeremy Montagu, Howard Mayer Brown, Jaap Frank, and Ardal Powell, "Flute," *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

86).[21] Quantz demonstrates a close connection between performance technique, composition and the instrument. He began his career as an oboist in the Polish Chapel of King Augustus II. Quantz soon found that he could advance more quickly as a flautist and began studying with the French-born Gabriel Pierre Buffardin, who was the principal flute player of the *Hofkapelle* at Dresden.[22]

During this time, good instruments were difficult to come by. Quantz devoted much time to perfecting the flute and became a renowned innovator. In 1726 he added a second key for D-sharp, to improve intonation. Quantz used flutes with a 'register foot joint' (described as a telescoping tube) and a screw-cork in the head joint. These designs helped finely tune the intonation. Quantz adopted the screw cork in the head joint to his flutes but not the extendable foot. He found the intonation problematic when using different components of the *corps de rechange*. Instead, he developed a tuning slide in the head joint and preferred only the longest section of the *corps de rechange*.[23] Quantz held a strong concept for the sound he wanted his instruments to achieve and modelled this after the Italian vocal style.

Quantz was exposed to visiting Italian singers while in Dresden and built his flutes to realize this style preference. Quantz authored one of the most influential musical instruction manuals of the 18th century entitled *Versuch einer Anweisung die Flöte traversiere zu spielen*, or as translated by Edward R. Reilly, *On Playing the Flute*. In it, he states,

> In general the most pleasing tone quality (sonus) on the flute is that which more nearly resembles a contralto than a soprano, or which imitates the chest tones of the human voice. You must strive as much as possible to acquire the tone quality of those flute players who know how to produce a clear, penetrating, thick, round, masculine, and withal pleasing sound from the instrument.[24]

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[21] Mary Oleskiewicz, "The Flutes of Quantz: Their Construction and Performing Practice," *The Galpin Society Journal* 53, no. 53 (2000): 201-220.

[22] A *Hofkapelle* is a court's musical establishment.

[23] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 95.

[24] Johann Joachim Quantz, *On Playing the Flute,* (Boston: Northeastern University Press, 2001), 50.

To achieve such a tone, flutes were constructed with a wider bore and thicker wood. His instruments were also tapered more sharply, and an elliptical embouchure hole was used instead of the common round shape. These attributes produced a tone with more weight and sonority.[25]

Quantz is a significant contributor to the advancement of the flute. His work, *On Playing the Flute*, gives essential insight into performance practices of the 18th century. During this time flats were played sharper than sharps, they were not enharmonic equivalents, and a different key was needed for D-sharp and E-flat. Music in sharp tonalities was generally avoided for the flute until Quantz, and other German flute makers, addressed it with an additional key. This addition helped the instrument play more in tune. Quantz elevated the flute's status to unprecedented heights with his position and substantial salary as the highest-paid flautist of the time. Quantz eventually earned double that of court officials.[26] He was a prolific composer who contributed over 300 concertos and 200 sonatas to the repertoire of the flute.[27]

Quantz speculated that the higher tuning standard in Italy favoured stringed instruments and preferred the German tuning of A=410 for mixed ensemble use. Because the Italian pitch put the flute's intonation at a disadvantage, the instrument wasn't as commonly used there.[28] Quantz built his flutes to sound and play their best tuned as low as A=385.[29] This low tuning standard fell out of favour within two decades of his death in 1773. His flutes and compositions became obsolete, and few remained who could do justice to their true art. The performance practice and music were tightly bound to the characteristics of the flute created to execute them.[30] This

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[25] Ardal Powell, *The Flute,* (New Haven and London: Yale University Press, 2002), 95.

[26] Powell, *The Flute*, 98.

[27] Joyce Kennedy, Michael Kennedy, and Tim Rutherford-Johnson, "Quantz, Johann Joachim," *The Oxford Dictionary of Music,* (Oxford: Oxford University Press, 2012).

[28] Powell, *The* Flute, 97.

[29] Mary Oleskiewicz, "The Flutes of Quantz: Their Construction and Performing Practice," *The Galpin Society Journal* 53, no. 53 (2000): 201-220.

[30] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 88.

highlights Quantz's dramatic influence on flute performance. However, without his presence as its ambassador, the aesthetic fell quickly out of favour.

2.6 Advancement of Keyed Flutes

The one-key flute was also advanced by an English flute maker, Richard Potter, who devised a two-piece head joint with a metal tuning slide that allowed the pitch to be lowered by simply pulling it out. His 1785 patent also included a screw cork in the head joint and a slide at the end of the foot joint. These additions allow further adjustment to the length of the instrument. By changing the length of the vibrating air column, the flute could be tuned at different pitch levels as Potter had them numbered to correspond to each other optimally.[31]

Johann George Tromlitz (1725-1805) was another important figure in the refinement of the transverse flute. His text, the *Kurze Abhandlung vom Flötenspielen* (1786), introduced his instrument-making ideals and refusal of mediocre standards. Context is gained, regarding its influence, from Ardal Powell's *Grove Music* entry,

> He introduced the elements at the core of his ideal: clarity of articulation and expression; perfect intonation in a system having both large … and small … semitones, for which the E♭ and D# keys invented by J.J. Quantz in 1726 were essential; the appropriate choice of music for the hall and audience; and the total technical control an emotional involvement of the performer.[32]

Tromlitz added keys to the flute, including arrangements for the left thumb adapted later by Theobald Boehm. His instruments were able to play chromatically in all keys without the use

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[31] Jane Bowers, "Mozart and the Flute," *Early Music* XX, no. 1 (1992): 31-42.

[32] Ardal Powell, "Tromlitz, Johann George," *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

of complicated fork fingerings.[33] However, Tromlitz's *approach* was perhaps more important than the mechanical innovations. He believed advancement was better made by completely rethinking the flute's design than making marginal additions to the existing ones.[34] The contributions that Tromiltz made were better understood after his death. His flutes were reputed to have a strong and cutting tone. They were important catalysts for the more elaborate key systems that followed in the 19th century.[35]

2.7 The Ring Key

Heinrich Wilhelm Theodor Pottgiesser (1766-1829)[36] a German physician and amateur flute maker, wrote an essay in 1803 proposing numerous modifications to the flute. These suggestions were not broadly accepted so he pursued other interests for 20 years. In 1824 he proposed a new design for the flute that introduced, arguably, the most critical mechanical advancement to woodwind instruments. He had returned to the flute and found the instruments more elegantly made with increased low register authority but with no improvement to the upper range. His newly designed flute had six keys with innovative mechanisms (conceivably, in response to symphonies like Beethoven's 6th and their more significant demand for control in the upper register). Pottgiesser's design offered eight equal-sized tone holes and included ring keys and crescent touch pieces.[37] These mechanisms allowed the finger to open or close more than

[33] Fork fingerings are complex combinations needed to achieve the best tone and intonation. They are much more challenging to perform and can limit the execution of technical passages.

[34] Ardal Powell, "Tromlitz, Johann George," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[35] Powell, "Tromlitz, Johann George."

[36] Karl Ventzke, "Pottgiesser, Heinrich Wilhelm Theodor," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[37] Powell notes that a patent was taken out earlier for the ring key in 1808, by Rev. Frederick Nolan, predating Pottgiesser's design.

one tone hole at a time. This novel conception set the stage for intense design innovation by Theobald Boehm in the years leading up to 1832.

J.C.G. Gordon was another important craftsman who built on Pottgiesser's design and in 1826 refined mechanisms to facilitate the opening and closing of a hole beneath a finger, while concurrently operating another key some distance away. The exact nature of these flutes is somewhat uncertain as reliable documentation is scarce.[38]

2.8 Theobald Boehm

Theobald Boehm (1794-1881) was the son of a goldsmith. At a young age he worked alongside his father, developing his manual skill, while also studying the flute. He was a German flautist, inventor and composer responsible for advancing the mechanism and proportions that form the basis of the modern flute.[39]

Boehm applied for a royal licence in 1829 to make flutes. The law required him to establish an invention or novelty to justify such a licence, as he had no background as an instrument-maker. He had procured a collection of flutes from the most famous makers, established his shop, and compiled a list of improvements his flute achieved over the others. Boehm's claims for the new instrument included improved purity of intonation, evenness of tone, facility of operation, secure speaking of the highest *and* lowest notes, a beautiful profile and thoroughly neat and robust workmanship.[40] Boehm devised a device for setting the pillars that carried the keywork and used rod axles instead of the simpler lever axles.

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[38] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 166.

[39] Philip Bate, and Ludwig Böhm, "Boehm, Theobald," *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

[40] Powell, *The Flute*, 165.

Sophisticated mechanisms were employed to achieve a more robust and commanding tone. Rod axles, "unlike the simple lever axles in common use at the time, carried the motion of the touch piece along a pivoted tube running along the length of the flute to a key-cover on a remote part of the body," allowing tone hole placement in the best acoustical positions.[41] Ring keys allow the finger to seal a tone hole while depressing a mechanism that activates an additional key. Boehm's 1832 flute marked the first time all the keys (excepting the D# key) stood open in their default positions. Therefore, "every note was now produced by its own tone hole which, when opened, had no closed holes below it on the tube, so that all the artificial fingerings in the flutes chromatic scale had been eliminated."[42] As a result of the keys resting open in their default position, tone holes could be larger, increasing the power of the instrument's tone.

Boehm was compelled to improve his flute after attending a performance by Charles Nicholson in 1831 while travelling on business in England. In correspondence to a friend, Boehm recalled, "I did as well as any continental flautist could have done in London in 1831, but I could not match Nicholson in power of tone, wherefore I set to work to remodel my flute. Had I not heard him, probably the Boehm flute would never have been made."[43] Nicholson played flutes with a wide bore and large tone holes. In, *An Essay on the Construction of Flutes*, Boehm explains that the largeness of the holes gives more unrestricted development to the notes but requires a talented musician to overcome other inherent defects in intonation and evenness of tone. Boehm decided that a complete change in the system of fingering was necessary to improve the flute. He states in his essay,

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[41] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 166.
[42] Powell, *The Flute*, 170.
[43] Theobald Böhm, *An Essay on the Construction of Flutes.* (London: Oppenheimer Bros., 1847), 59.

> I resolved to adopt neither the large-holed ordinary flute, nor other mere mechanical changes, but rather to spend time and trouble upon the construction and practice of a *totally new flute*, in which the quality of tone and pure intonation should be united with the means for executing every possible combination of notes by a *new kind of key mechanism*.[44]

The changes were substantial and not well received by players unwilling to learn a new system of fingerings. Boehm noted that younger artists gained an advantage in their performance using the new instrument. It was not until he presented his flute at the French Academy of Sciences in Paris in 1837 that it received broader acceptance and was adopted exclusively by high-profile artists in France, England, Germany and Italy. The newly designed flute achieved more precise intonation with a more powerful tone.

The Boehm system flute at this time was still manufactured from wood and constructed in a conical fashion. The 1832 Boehm model of flute was made in three pieces instead of four as the *corps de rechange* was becoming less common due to the sliding head joint, improved mechanism and tone hole placement that aided in tuning.[45] Theobald Boehm was still not satisfied with the third octave of his flute. In 1845 he retired from his ironworks business and studied acoustics under Prof. Karl von Schafhäutl, an acoustician, whom he had befriended.[46] Boehm's studies led him to revise fundamental aspects of flute design.

Boehm's philosophy likely led to his tireless passion for refining his flutes. Boehm believed, "The instrument is to the artist what the voices to the singer, the organ for the transmission of his sentiments, and for the manifestation of his taste and skill. But more this organ is perfect, the more of the genius of the performer, as well as of the composer, will be

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[44] Theobald Böhm, *An Essay on the Construction of Flutes*, (London: Oppenheimer Bros., 1847), 12.

[45] www.oldflutes.com is an excellent resource for pictures of these instruments and for visuals of technical aspects being discussed.

[46] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 180.

supported."[47] The newly designed flute abandoned the conical bore for a cylindrical one and narrowed the head joint in a parabolic (curved) fashion to be smallest at the end furthest from the foot - essentially reversing the flute's traditional orientation. Metal was chosen to facilitate even larger tones holes. Metal fifes had been constructed for hot climates as early as 1810. However, no other maker had considered a metal tube for decades. Metal allowed for the largest possible tone holes to be utilized and resulted in the musician's finger being too small to cover them. Padded keys that sealed the holes and a mechanism that built upon his 1832 design resolved this challenge. The very nature of its tone was also of great debate among flutists, composers and conductors.[48] His innovation in fingering system, material and apparatus proved revolutionary and controversial.

2.9 The Modern Flute

Boehm's designs are the chief advancements responsible for our modern-day flute. The most important innovations of the 1832 flute design were the correct positioning of the tone holes and the application of the new key system, using refined ring keys, that allowed for 14 tone holes to be operated simultaneously with nine fingers.[49] This flute is referred to as the Boehm Flute. His 1847 design built upon these improvements and is referred to as the *ring key* flute. Based on his study of acoustics, this latter design boasted increased precision of tone hole placement and maximized tone hole size. These larger tone holes were sealed with keys and pads. A cylindrical bore, constructed from metal, with a narrowing (parabolic) head joint, was

[47] Theobald Böhm, *An Essay on the Construction of Flutes*, (London: Oppenheimer Bros., 1847), 16.
[48] Ardal Powell, *The Flute*, (New Haven and London: Yale University Press, 2002), 183. Wagner, for example, rejected it and preferred the blend of the wooden model within the orchestra.
[49] The tenth finger, the right-hand thumb, supports the flute's weight and does not operate a key.

used.[50] These improvements provided the third octave of the flute with better dynamics and tuning. Although many refinements to the flute have been made since 1847, the essence of the design has remained unchanged. This period of invention had far-reaching implications for not only the flute but woodwind instruments in general.

[50] Ludwig Böhm, "Theobald – Böhm – Archive," accessed July 6, 2021, https://theobald-boehm-archiv-und-wettbewerb.de

CHAPTER 3: THE CLARINET

3.1 Early Clarinets

The earliest clarinets are traced back to origins common with the flute. Clarinets are instruments that create sound when the player's airstream causes a thin piece of wood or cane to vibrate. This vibrating piece of wood is called a reed and places the clarinet in a different category of aerophones than the flute. Like the flute, early examples were cylindrical tubes constructed from cane. Contrasting to producing a sound with air blown across a hole, as with edge type aerophones, these clarinets use a single beating reed to vibrate the column of air. They fall into two categories: *idioglots* and *heteroglots*.

To create a sound, the player places the end of the instrument in the mouth and seals the lips around it when blowing both *idioglots* and *heteroglots*. Idioglot instruments are constructed from a piece of cane blocked at the top end by a node in the plant body. A notch is cut across the top, allowing a tongue (or reed) of cane to vibrate freely when the player blows into it, causing it to sound.[51] The vibrating end of the reed can point either towards the player or away from them. The earliest reference to this wind playing technique is found in the writings of Aristotle (384-322 BC), who described the entire reed entering the player's mouth in his *Problemata*.[52] Iconographical evidence of idioglots has been traced to as far back as 2700 B.C. in Ur, Mesopotamia and the third dynasty of the Old Kingdom of Egypt. These were often shown played, in tandem, as a double piped instrument and seen as reliefs in stone and vases.[53] Images are abundant, but no instruments from this time survive. The second pipe could provide a drone as an accompaniment to the melody played on the first.

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[51] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 11.
[52] Hoeprich, *The Clarinet,* 11.
[53] Hoeprich, 12.

3.2 The Chalumeau and Mock Trumpet

The earliest European single-reed instrument is the *chalumeau.* Chalumeau comes from the Latin word *calamus*, or the Latin word *calamum*, from the Greek origin *kalamon*. Each of these terms refers to a reed pipe.[54] Many early instruments are called chalumeau. Idioglot instruments made with single pipes predate 18th century chalumeaux. Instruments from the 1700s sharing the characteristic features of a vibrating heteroglot reed and a cylindrical bore are the closest relatives to the modern clarinet. *Heteroglot* denotes that the reed is fashioned separately from the instrument and held against an open window cut in the mouthpiece. The ligature is the most ubiquitous way of holding the reed today and became standard after its invention in the mid 19th century. Before its general acceptance, a string was most often used. Definitions of these reed instruments are repeated in books and dictionaries throughout the 17th and early into the 18th century. No evidence of other reed wind instruments (idioglot or heteroglot) is recorded until the mock trumpet appeared late in the 17th century.

The mock trumpet resembles a recorder and utilizes an idioglot reed. It was designed as a toy and became popular with amateur musicians throughout Great Britain. There were numerous method books published that suggest its use in substitution for a trumpet. The trumpet had a much higher status in the orchestra. The mock trumpet was limited in compass and mostly played simple duets.[55]

Eastern European bagpipes share a surprising commonality with the chalumeau with the use of the chanter. A *chanter* is a small drone (pipe) fitted with a heteroglot reed tied to a small piece of wood, much like a clarinet mouthpiece. It can be detached and played separately from the

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[54] Albert R. Rice, *The Baroque Clarinet and Chalumeau,* (New York: Oxford University Press, 2020), chap. 1.

[55] Albert R. Rice, *The Baroque Clarinet and Chalumeau,* chap. 1.

bagpipe. Eastern European chanters often used heteroglot reeds as opposed to idioglots. The required tools and expertise to construct a chanter closely align with the skills needed by the earliest clarinet makers. Craftspeople equipped to build instruments like bagpipes were often officially *Wildruf- und Horndreher* (see below) as well.[56]

3.3 Wildruf- und Horndreher

Johann Christoph Denner and his family were members of the Nuremberg guild of hunt-lure and bone turners, or *Wildruf- und Horndreher,* and prospered making both woodwind instruments and hunting lures. The term Wildruf refers to small instruments that imitate animal calls to lure them as prey. Significantly, the duck call sounds with a single reed attached to a small wooden tube and a cut window, resembling a clarinet mouthpiece.[57] The design is that of a heteroglot reed instrument. In 1730, Johann Gabriel Doppelmayr authored the *Historical Reports of Nuremberg's Mathematicians and Artists*.[58] A biography of Denner was included, crediting him with improvements to the chalumeau and the invention of the clarinet. Denner owned several houses and thrived as a business owner. He was a member of the city's council and considered one of the best instrument makers in Europe. Wildruf workshops were equipped with the necessary tools and expertise to create woodwind instruments alongside hunting lures.[59]

3.4 Innovation and Added Keys

The addition of the speaker key to the chalumeau circa 1700 enabled the instrument to overblow a twelfth and presented a new type of instrument, the earliest clarinet. A speaker key is

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[56] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 15.

[57] Organ pipes also employed a heteroglot reed system of metal construction.

[58] Martin Kirnbauer, and Peter Thalheimer, "Jacob Denner and the development of the flute in Germany," *Early Music*, 23, no. 1 (1995): 82-101.

[59] Hoeprich, *The Clarinet,* 16.

a small hole fitted with a metal tube that extends into the bore of the instrument. This tube helps prevent condensation from blocking the hole and allows for more reliable performance. The key, operated by the left-hand thumb, covered the hole with a pad and is also referred to as a register key. This key gives access to the register above the limited range of the chalumeau and today is called the clarion register. The range extended to exceed three octaves with this innovation.[60] As the instrument continued to be improved, the clarinet slowly replaced the more restricted chalumeau.

The clarinet faced challenges much the same as the flute regarding construction. The clarinet was primarily made from boxwood and subject to the same considerations of warping and cracking that the flute was. The instrument was also built in sections to minimize the environmental influences of temperature changes and moisture from the player's breath. Rings were often fashioned from bone, metal or ivory to protect the end of the joints and aid in stability. The clarinet's construction in sections also allowed for *corps de rechange,* much like the flute, to exchange the middle sections to adjust for standard pitch variances.

3.5 The 1800s - Accelerated Advancement

As they moved further away from the chalumeau, instruments from the early 1800s were made in as many as six pieces (depending on the maker). In 1802, Xavier Lefèvre authored his *Méthode de Clarinette,* depicting a six-piece clarinet with five keys that would have been a common configuration at that time.[61] Clarinets consisted of a mouthpiece, barrel, left-hand joint, right-hand joint, stock, and bell. To facilitate easier adjustments to the mouthpiece interior, makers began to separate the mouthpiece from the barrel and use harder, more stable woods like

[60] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 19.
[61] Hoeperich, *The Clarinet*, 71.

grenadilla, cocus or ebony.[62] These, particularly grenadilla, became a preferred material for mouthpieces. Making a seal between the reed and mouthpiece is crucial for playability. Fine adjustment to the table (the flat surface of the mouthpiece that the reed is held against) is problematic on softer wood more prone to warpage and wear. The denser wood increased reliability and had desirable resonance and tone.

Again, in the early 1800s, the middle section was divided, and the stock section was eliminated by integrating it into the bell as will be discussed shortly. This progression resulted in the five-piece configuration of a mouthpiece, barrel, left and right-hand sections and bell, which is today's standard.

3.6 Five Keys

Clarinets with five keys represented a landmark in the instrument's progression. With the addition of two left-hand keys and three right-hand keys, the clarinet could now play an extended range to three octaves and navigate semitones more easily. Although five keyed clarinets were common, they didn't necessarily represent the most advanced keywork available. Xavier Lefèvre was the first professor of clarinet at the Paris Conservatory and played instruments made by the craftsperson Jean-Jacques Baumann (who established a workshop in Paris circa 1800). Lefèvre wrote, in his *Méthode*, that with Baumann's addition of a *sixth* key, it was now possible to play in each tonal center with a pair of clarinets, tuned in C/B and B♭/A, and their *corps de rechange*.[63] This innovation allowed composers to write in keys outside of C and F, which were common for clarinet. Remarkable developments in performance and design began in the early part of the 19th century.

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[62] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 66.

[63] Hoeprich, *The Clarinet,* 71. Often, orchestral musicians have two instruments at different pitches to facilitate more effortless playing in difficult key centers.

Problems with the clarinet were still present despite the exceptional gains made with added keys and improved materials. In 1821 the French musicologist Castil-Blaze wrote, "The principal problems of this instrument are that the sound changes in character and timbre in each octave, that certain tones are muffled or out of tune, and that the position of the keys forces the player to displace several fingers, and even the entire hand, to jump from one tone to the other, rendering certain passages runs and trills unplayable."[64] Makers and performers worked to overcome these shortcomings. Beethoven consulted with Joseph Friedlowsky, the first clarinettist at the Vienna Conservatory, demonstrating that composers were also interested in the latest possibilities and how to best write for the instrument's merits. Clarinet virtuoso Iwan Müller consulted with the instrument maker Heinrich Gresner to create a new thirteen key clarinet that had major impact on design and playability.[65]

Müller's new design included a key that allowed for tone holes to be placed more optimally for resonance and intonation. This placement, depicted circa 1812, was made possible by integrating the stock and bell into one piece. The use of *corps de rechange* was no longer possible because of this integration. However, the new key system allowed the clarinet to play in all tonalities with confidence and exactness. These advancements marked the arrival of the previously mentioned five-piece clarinet in use today. The need for multiple sections and instruments had been eliminated, though some performers still preferred the tonal colour of the old system.[66]

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[64] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 124. Castil-Blaze was the first to use the term *tonality*.

[65] Hoeprich, *The Clarinet,* 132 .

[66] F. Geoffrey Rendall, *The Clarinet*, (London: Ernest Benn Limited, 1971), 89.

3.7 Ring Keys

In Brussels, Charles Sax was an instrument maker with a talented and competent son. Adolphe Sax (1814-1894) was a skilled clarinettist with an acute mind for innovation and the advantage of his father's workshop at hand.[67] Adolphe set his sights on addressing the limitations of the clarinet that Castil-Blaze described. He submitted patents in 1840 and 1842 with progressive designs.[68] Sax extended the clarinet's range lower to an E flat and thus provided the fundamental tone for B flat in the middle of the horn. The previous model descended only to E natural. Without its fundamental a 12th below it, the B flat in the middle of the horn was one of the worst sounding notes on the instrument. This note is at the transition from the clarinet's low to high range, or its *chalumeau* to *clarion* registers, and made evenness of scale difficult to achieve until Sax's innovation.[69] Additional mechanisms also made the fingerings easier and helped smooth out the uniformity and pitch throughout the instrument's range. Sax's 1842 patent would suggest that he may have been first to apply ring keys to the clarinet.[70] As realized with Theobald Boehm's 1832 flute, the ring key mechanism was ground-breaking. Adolphe Sax would have been aware of the flute's advancements and skilled enough, as an instrument maker, to adapt them to the clarinet.

The application of ring keys to the clarinet eliminated the need for the player to use the same finger for numerous notes. Passages of music, previously unfeasible, could now be played with great fluency and speed. French composer, critic and conductor Hector Berlioz (1803-1869), in his *Grand traité d'instrumentation*, commented on Sax's advancements.[71] Writing in

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[67] Philip Bate, and Wally Horwood, "Sax Family," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[68] F. Geoffrey Rendall, *The Clarinet*, (London: Ernest Benn Limited, 1971), 96.

[69] This area of the clarinet's range is also referred to as 'the break.'

[70] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 144.

[71] Hugh Macdonald, "Berlioz, (Louis-)Hector." *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

1843, he states, “A considerable number of diatonic progressions, arpeggios and trills, formerly impractical on the clarinet, are no longer so thanks to the ingenious mechanism of the keys attached to the instrument. They will become even easier as soon as the system of Sax is generally adopted.”[72] Adolphe made other improvements, among them changed bore dimensions and contoured keys. Sax was also the first to use gold, silver and brass to fashion metal mouthpieces. It is conceivable that the Louis-August Buffet and Hyacinth Klosé designed *clarinette à anneaux mobiles* owes much to the Adolphe Sax clarinet.

3.8 Clarinette à Anneaux Mobiles

C*larinette à anneaux mobiles* refers to the progressive 1843 patent application for a ‘clarinet with moving rings’ by maker Louis-Auguste Buffet and his partner Hyacinth Klosé. Klosé was well known as a principal clarinettist at the *Opera Italien* and a professor at the Conservatoire. He was highly regarded and much-loved as a teacher.[73] The patent for the Boehm clarinet was awarded in 1844, later named as such for the application of Boehm’s ring keys and not for the inventors. This system further advanced Sax’s contribution by applying the 1832 flute’s fingering system to the clarinet and solved many of the remaining cross-fingerings to improve the ease of playing. The prototype won an award at the Paris Exhibition in 1839. Sax was first to obtain a patent but may have appropriated the idea from Buffet’s prototype as he, “was not above producing his own version of the ideas of others.”[74]

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[72] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 144.

[73] Pamela Weston, "Klosé, Hyacinth Eléonore," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[74] Philip Bate, and Wally Horwood, "Sax Family," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

3.9 Buffet and Klosé

Klosé released the first method book for the new system in tandem with the patent application in 1843. It was titled *Mèthode Complète de Clarinette* and is still in use today. Buffet chose an excellent partner for the collaboration on this new clarinet. Klosé was both a respected performer and teacher, also holding influential positions teaching at the Conservatoire and *Ecole Militaire de Musique*.[75] Berlioz wrote of him, "The human voice, to my taste, does not even have the soft and tender melancholy of the sound of his clarinet."[76] Klosé is credited as co-inventor of the *clarinette à anneaux mobiles.*[77] His reputation and influence helped the new instrument become widely accepted.

The Buffet and Klosé partnership also developed the needle spring, a tempered steel rod, to activate the keys. Boehm had used English sewing needles to achieve this function. The *clarinette à anneaux mobiles* keywork consisted of 17 keys and 24 holes, the same used today with standard Boehm system clarinets. Buffet and Klosé moved away from making the clarinet body from boxwood. The complex keywork required more stable material, less prone to warpage, to maintain the alignment of the keys. Grenadilla became the choice wood for the entire clarinet body. Also known as African Blackwood, Dalbergia melanoxylon and Mpingo, grenadilla is highly prized for its resonant characteristics and resistance to moisture. African Blackwood is challenging to work with due to its hardness and tendency to splinter. Once dried and stable, it is very reliable.[78] Many innovations by instrument makers built upon the Boehm

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[75] Pamela Weston, "Klosé, Hyacinth Eléonore," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[76] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 146.

[77] Weston, "Klosé, Hyacinth Eléonore."

[78] Sir Ghillean Prance, and Mark Nesbitt. *The Cultural History of Plants*, (New York: Routledge, 2004), 317.

system clarinet. By 1900 two main systems had prevailed, the Boehm system and the German *Oehler-system*.

3.10 Systems Emerge

The Oehler-system clarinet built upon the work of Theobald Boehm to achieve similar outcomes. Carl Baermann (1810-1885) established the foundations of this system with the design of the Baermann-system clarinet. Carl was the son of the virtuoso Heinrich Baermann and became a respected performer and teacher in Munich. He describes his partnership with instrument maker Georg Ottensteiner and the goal of his design:

> I worked for a long time with Ottensteiner, and at last we succeeded in producing the clarinet … in which Theobald Boehm's system of fingering is to some extent utilized … the problem I undertook to resolve was in no way to lose any of the character of the instrument, but to overcome the weaknesses of imperfect intonation through an improved location of the tone holes, and to lighten and simplify the key-mechanism.[79]

These clarinets were the building block for Oskar Oehler (1858-1936), a skilled performer and craftsman.[80] Oehler-system clarinets supplanted the Baermenn model and became the preferred system in Germany and Austria.[81]

Major reconstructions to the clarinet's key system became less common in the 20th century than the refinement of existing ones. The overarching theme of contemporary instrument makers, and those of the past, is the pursuit of improved tone and playability through new innovations and technology.[82]

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[79] Eric Hoeprich, *The Clarinet*, (New Haven: Yale University Press, 2008), 176.

[80] Nicholas Shackleton, "Oehler, Oskar," *New Grove Dictionary of Music and Musicians*, (Oxford University Press, 2001).

[81] F. Geoffrey Rendall, *The Clarinet*, (London: Ernest Benn Limited, 1971), 105.

[82] For example, Bacun is a Canadian clarinet maker that has created the world's first carbon fibre/wood hybrid instrument. www.bacunmusical.com

CHAPTER 4: THE SAXOPHONE

4.1 Not Like The Others

The saxophone is unlike the flute and clarinet regarding its historical evolution – it is a recent invention with an identifiable beginning. Throughout its life span, it has not had mechanical transformations like that of the flute and clarinet. The saxophone appears much the same as its original design, whereas a contemporary silver flute hardly bears any likeness to its early beginnings as a hollowed-out reed. The saxophone's mass acceptance began in the 20th century with close ties to popular music, particularly jazz in America. This caused the saxophone to become both adored *and* criticized. Music outside of the Western Classical tradition was often regarded as inferior, and because the saxophone became associated with these styles of music, it too was marginalized.

The instrument's potential was also not readily appreciated. Competing woodwind makers, perhaps feeling that their businesses may be threatened, often aggressively spoke against it and its inventor. However, positive reviews praised its tonal compass and variety of nuance.[83]

4.2 Adolphe Sax

The saxophone was patented in 1846 by Adolphe Sax (1814-1894), whom, as we have already discovered, was the prodigious son of Charles Sax, an established instrument maker in Brussels. Adolphe studied both clarinet and flute at the Royal School of Music (later to become the Conservatoire) in his youth and developed into a virtuosic clarinettist.[84] His intimate

[83] Claus Raumberger, Karl Ventzke, and Stephen Cotrell, "Saxophone," *The Grove Dictionary of Musical Instruments*, (Oxford University Press, 2014).

[84] Stephen Cottrell, *The Saxophone,* (New Haven and London: Yale University Press, 2012), 12.

knowledge of the clarinet informed his drive to overcome the limitations of available instruments.

Sax's first recognized successes came from his work on improvements to the bass clarinet. Adolphe patented his design in 1838.[85] The resulting instrument was well received and established Sax's reputation as a talented innovator. The new design produced a much richer tone and played better in tune than the previous versions. Sax achieved this by increasing the bore size and placing the tones holes correctly, sealing them with pads in covered cups similar to those in use today on both the bass clarinet and the saxophone. A second speaker key improved the top register. The instrument's improvements caught the attention of the composer Berlioz. He wrote in 1842, "the new bass clarinet of M. Sax preserves nothing of the old one except the name […]. What distinguishes it above all is its perfect intonation and its uniform temperament in all degrees of the chromatic scale."[86] Adolphe's frustration with instruments of the time and his successes, built on his father's experience and resources, led him to inspired work on a new instrument.

In the patent application for the saxophone, Sax lists many of the shortcomings he felt he could overcome with his new invention. He lists the characteristics of many instruments as being either too loud or too soft, describing the bassoon as "so feeble that one cannot use it except to fill out the accompaniment. And for particular loud orchestration effects it is perfectly useless." Sax continues:

> Note that this last instrument is the only one which blends with string instruments. It is only the brasswind instruments that give the most satisfying effects in the open air. Also a wind group composed of these instruments is the only orchestral combination that has the power to be used in such circumstances. As for stringed instruments, everybody knows

[85] Philip Bate, and Wally Horwood, "Sax Family," *New Grove Dictionary of Music and Musicians,* (Oxford University Press, 2001).

[86] Stephen Cottrell, *The Saxophone,* (New Haven and London: Yale University Press, 2012), 14.

> that, in the open air, their effect is useless because of the feebleness of their sound. This makes them nearly impossible to use in such conditions. Struck by these various drawbacks, I have sought a way to remedy this by creating an instrument which, by the character of its voice, can blend with string instruments, but which possesses greater strength and intensity than these. This instrument is the saxophone. Better than any other, the Saxophone can finely modify its sounds to give them the qualities just mentioned and to preserve a perfect evenness throughout its range. I have made it from brass in the shape of a parabolic cone.[87]

Supremely confident and opinionated, it is perhaps not surprising that Adolphe Sax was challenged and litigated against by his competitors, an occurrence that plagued him throughout his lifetime. Sax pursued military contracts for his instruments. These were lucrative bonds and threatened the security of those makers already holding them. Sax's description of the open-air advantage hints at his interest in military applications.

Cottrell notes that Sax's most significant contribution to woodwind design may have been his realization of the relationship between bore size and tone hole size and placement. This allowed him to create families of instruments with uniformity. A performer who became proficient on one member of the saxophone family could quickly transfer this knowledge to another.

4.3 Military Aspirations

The French military's music program was unsatisfactory, and Sax hoped to improve this by having his instruments adopted. This application resulted in a live comparison with thirty-two of the army's existing musicians and nine musicians playing Sax's instruments. The advantage was given to Sax's ensemble, despite the numerical disadvantage. Sax was successful in winning the contract, and his instruments were adopted, including the saxophone. This agreement allowed

[87] Stephen Cottrell, *The Saxophone,* (New Haven and London: Yale University Press, 2012), 38.

Sax to continue his business manufacturing saxophones and other instruments. In addition to projection, the added goals of blend and nuance gave the saxophone's sound remarkable flexibility.

4.4 An Individual Voice Within Jazz

As jazz grew in popularity, the saxophone found acceptance. Performers in the early 20th century gravitated to the instrument as it became more prevalent in jazz, a style of music steeped in African vocal traditions. These traditions emphasized tonal concept, vocalization, improvisation and the social function of performance.[88] The saxophone gave an instrumental expression to the human voice. The inventor could not have anticipated that a new form of music would profit his invention with worldwide acceptance.

The saxophone, arguably, has the broadest tonal scope for developing a personalized sound. In his book *The Devil's Horn*, Michael Segell interviews Dave Liebman, a noteworthy saxophonist (a Miles Davis and Elvin Jones alumni) and the respected author of *Developing a Personal Saxophone Sound*. Liebman explains the process involved in creating an individual voice and sound on the saxophone, he states:

> And that's determined by your anatomy, your bones, the shape of your throat, the size of your vocal cords and larynx, where your tongue is, the density of tissues in your head. The nuance comes from how you typically express yourself, your background, where you emphasize, inflect, or bend a word when you're talking, how you feel about the content. The saxophone is the only instrument capable of reflecting those personal characteristics. But first you have to get to neutral. You have to remove all encumbrances, any tension that inhibits you from being who you are. Everyone has a personal sound. It's just a matter of being able to let it out.[89]

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[88] Doug Miller, "The moan within the tone: African retentions in rhythm and blues saxophone style in Afro-American popular music." *Popular Music* 14, no. 2 (May 1995): 155-174.

[89] Michael Segell, *The Devil's Horn,* (New York: Farrar, Straus and Giroux, 2005), 202.

The degree to which a saxophonist can develop their sound will determine how effectively they will connect with an audience. These ideas align with the inventor's intentions.

The relative lack of dramatic mechanical innovations to the saxophone, compared to the flute and clarinet, does not exclude evolution to the instrument's voice. It is instructive to examine an individual saxophone player to understand where the influence of the physical instrument intersects with the performer.[90]

4.5 Breath as Expression

Ben Webster was an American saxophonist renowned for his use of breath as an expressive device. However, before developing this characteristic sound, he gained a reputation as a fiery tenor soloist that could increase a band's energy level. Webster's recordings before joining Duke Ellington's band in 1940 found him largely preoccupied with playing fast lines, achieving varying degrees of success as a developing soloist. In an early 1934 picture of Ben Webster (in Andy Kirk's 12 Clouds of Joy ensemble), he is shown with a saxophone made by Conn. By 1939, Ben Webster is known to have played a Selmer tenor saxophone that he purchased before joining Ellington.[91] Instrument repair, at that time, was not as nuanced as today, and many makeshift solutions were applied to underperforming instruments. It is probable that an updated and better working saxophone was purchased out of necessity.

On July 29th, 1938, Webster was recorded for the last time on his Conn saxophone with Teddy Wilson and his Orchestra.[92] Webster is heard soloing on this session for 16 bars on the

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[90] Many combinations of reed strength and mouthpiece configurations can also be used to influence the saxophone's tone. These variations are outside the purposes of this paper.

[91] The Kansas City Public Library, "The Pendergast Years: Kansas City in the Jazz Age & Great Depression," n.d, https://pendergastkc.org/collection/9704/umkc-1213/andy-kirk-and-his-twelve-clouds-joy (accessed April 27, 2020).

[92] Jan Evensmo, "Ben Webster Part 1," *JazzArcheology.com,* (April 13, 2018), http://www.jazzarcheology.com/artists/ben_webster_part_1.pdf.

song "A Tisket, A Tasket" at minute 1:26.[93] The saxophone sounds brittle and squeezed in the high register, and the upper and lower ranges of the horn are uneven in tone. Months later, in the fall of 1938, Webster purchased his Selmer Balanced Action tenor sax.[94] A subsequent Teddy Wilson recording in the spring of 1939 reveals the sonic difference between the Conn and Selmer, heard in a brief five bar solo on "Why Begin Again" at 0:36.[95] During a July 26th recording session two months later, Webster plays at the ten-second mark on the tune "This is the Moment," demonstrating a new dimension to his tone. Continually, his playing became smoother, with more presence and evenness to his sound in all registers with a deep richness in his tone. It is lush, assured and confident. Compared to Conn saxophones, Selmer had made advances in balancing the action between each hand (hence its namesake). The high and low registers were also more uniform. The Balanced Action was a more ergonomic saxophone that facilitated technical smoothness, representing the highest standards of the day. The quality and refinements of the instrument had a direct impact on the player's performance.

As Webster matured as a soloist, he was regarded as one of the greatest ballad players in jazz and became less known for fast technical passages. His breathy tone was instantly identifiable. A profound example of Ben Webster's use of breath as an expressive device is the recording of "Danny Boy" from the album *King of the Tenors* (Verve MGV 8020), recorded in 1953 for *Norgran* records. His phrasing blends sound and air, disguising where one begins and the other ends. If performed on flute or clarinet, this amount of air present in the tone would be unacceptable, especially in classical traditions. On saxophone, however, it has a dramatic effect.

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[93] Teddy Wilson. *The Complementary Works – Teddy And The Girls – Volume 3. 1938-1939*, Media 7 MJCD 135, (CD), Track 18.

[94] Frank Büchmann-Møller, *Someone To Watch Over Me: The Life and Music of Ben Webster,* (Ann Arbor: University of Michigan Press, 2006), loc. 1087 of 8695, Kindle.

[95] Teddy Wilson. *The Complementary Works – Teddy And The Girls – Volume 3. 1938-1939*, Media 7 MJCD 135, (CD), Track 19.

Webster's performance emphasizes the malleable nature of the saxophone's tone. Flute and clarinet performance standards were well established within the Western Classical orchestra at the time of the saxophone's invention. Its timbral potential being much broader, the expressive compass was welcomed in the freer, unconstrained context of jazz where it developed alongside the music. Many of the jazz tradition's major innovators, like Coleman Hawkins, Charlie Parker and John Coltrane, played saxophone.

4.6 Hybrid System

The saxophone had the advantage of Adolphe's expertise as a woodwind instrumentalist and apprentice, gained from work in his father's shop. His combination of the flute and clarinet into an innovative woodwind system was also informed by his early successes with the bass clarinet. It was constructed from the start out of metal, avoiding any need for *corps de rechange* and facilitating the placement of tone holes in their acoustically correct positions. Tone holes on this new instrument were at times almost two inches in diameter, requiring the need for metal key cups with pads, like those used previously on his bass clarinet. Holes of that size could not be sealed with a finger and ring key. However, the principle of the Boehm flute's ring key, closing or opening multiple tone holes with a one finger mechanism, was used to advantage. The instability of wood for the heavier keywork was also circumvented. Like the flute, it overblew an octave instead of the clarinet's twelfth. The fingering systems are comparable to the flute (and clarinet's second register), using much of Boehm's system. The clarinet's mouthpiece and reed were adapted to the saxophone, and the initial patent application shows a similar appearance to those in use today.[96] These applications of existing knowledge from the flute and clarinet

[96] Stephen Cottrell, *The Saxophone,* (New Haven and London: Yale University Press, 2012), 61-62.

traditions gave the saxophone a head start in the evolutionary process and primed it for application to new musical expressions.

CHAPTER 5: BREATH AND WELLNESS

5.1 New Understanding and Integrative Practice

As we appreciate the long history of innovation in woodwind instruments, we can now draw a comparison to the human body. Innovations to fundamental human physiology have not occurred. Instead, our self-awareness and scientific advancements confirm and enable our best use of the bodies we inherit. Breathing traditions are ancient and vast, well beyond the scope of this research project. However, current research suggests that breathwork is an untapped resource with formidable potential for increasing our sense of well-being and mitigating health challenges. The following chapter highlights research that is easily implemented into woodwind practice and the wellness benefits we can gain from these already proven practices.

5.2 Breathing for Wellness

Breathing interventions are often part of the discourse surrounding concepts like mindfulness and resilience. Mindfulness is a holistic philosophy that encourages us to live life in the present moment with curiosity and acceptance of our thoughts and feelings.[97] Resilience, in general, is the idea that a person can recover quickly from adversity or challenge without becoming overwhelmed or reliant on negative coping strategies. There is increasing awareness of anxiety and stress levels in youth and the general population. The present pandemic and concurrent restrictions of isolation and social distancing have greatly exacerbated these stresses. Breathwork can mitigate feelings of anxiety and be integrated into woodwind practice. The

[97] Diana Coholic, Tricia Goeldner, Amanda Hardy, Katarina Gligorijevic, Kathe Rogers, and Anita Sekharan, *Mindfulness-Based Programs for Youth,* (Canada: Youth Research & Evaluation eXchange, 2020), 5.

following sections will give context to the forces at play physiologically and set the stage for integrative practice.

5.3 Anxiety and The Nervous System

Anxiety and panic attacks are often characterized by a feeling of breathlessness that brings on the fear of suffocation from not being able to catch one's breath.[98] In *The Breathing Cure*, Patrick McKeown notes that while panic, anxiety and racing thoughts are grouped as psychological problems, a strong biochemical link has been found. People with these disorders have a strong sensitivity to the accumulation of carbon dioxide in the blood.

During an anxiety attack, sufferers breathe as quickly and as deeply as possible to get enough oxygen. Konstatin Buteyko, a Russian physician, also recognized this pattern in asthmatics.[99] This breathing mode is called hyperventilation and causes the body to lose (or shed) carbon dioxide. Respiration is controlled not by the level of oxygen in the bloodstream but by carbon dioxide. The further reduction of carbon dioxide exacerbates the impulse to breathe, creating a downward cycle. Additional symptoms of hyperventilation, or overbreathing, during an anxiety attack include light-headedness, numbness or tingling in the hands and fingers, a racing heart, a sense of terror or impending doom and loss of control.[100]

These symptoms are especially undesirable for a woodwind performer that relies on tactile feeling in their hands while playing an instrument, confident, refined breath control and mental acuity while expressing music. Often instrumentalists create these unfavorable conditions

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[98] Patrick McKeown, *The Breathing Cure,* (Galway: OxyAt Books, 2021), 10-11, 71.

[99] Jane E. Brody, "A Breathing Technique Offers Help for People with Asthma." *The New York Times,* November 2, 2009, https://www.nytimes.com/2009/11/03/health/03brod.html?smid=em-share.

[100] Melissa Conrad Stöppler, "Panic Attack Symptoms," *WebMD,* September 28, 2020, https://www.webmd.com/anxiety-panic/guide/panic-attack-symptoms.

with poor breathing habits during practice and performance. By rushing through the material, taking irregular gulps of air, performers neglect to adequately prepare the body for successful breathing and mimic the body's sympathetic, fight-or-flight, nervous system response.

In unsafe environments, the body mounts a natural response to a life-threatening situation and releases the hormone cortisol. Cortisol alters immune system function. This sympathetic nervous system response is necessary for survival against predators and enemies and ramps the body up in preparation for a fight, or escape. The sympathetic response constricts blood vessels, stimulates the muscles and increases heart rate, blood pressure and metabolic output. In our modern world, this carries forward into situations that are generally not life-threatening like giving a presentation, meeting a deadline or being bullied on social media. The sympathetic nervous system, half of the autonomic nervous system, takes over and shuts down parasympathetic responses to ensure survival. The parasympathetic system is responsible for the restorative and digestive functions of the body. The result of our bodies remaining in this state of heightened awareness is chronic stress. Breathing mindfully and intentionally can interrupt these effects.[101]

The connection between biochemistry, breathing, and the nervous system allows slow breathing to calm the mind. The parasympathetic nervous system balances out the survival mechanisms of the fight-or-flight response and promotes growth, relaxation, reproduction and the conservation of energy. It also balances hearts frequencies and is primarily driven by the vagus nerve.

[101] Patrick McKeown, *The Breathing Cure,* (Galway: OxyAt Books, 2021), 19.

5.4 The Vagus Nerve

The diaphragm connects to the vagus nerve. When stimulated, the vagus nerve releases a calming neurotransmitter that slows the heart rate. Breathing deeply at a rate of 4.5 to 6.5 breaths per minute activates this response and balances the nervous system.[102] Exhaling for a greater duration than inhaling is also shown to elicit a more robust parasympathetic nervous system response.[103] These are important insights as we move to enhance parasympathetic responses in woodwind practice.

The autonomic nervous system's two components, parasympathetic and sympathetic, constantly work to maintain a balance in our body. McKeown explains that stress responses are ideally self-limiting, and balance is restored after a threat has passed. He continues,

> However, when stressors are constantly present or stress is chronic (which is like signing up for a long-term fight or flight subscription) a cortisol imbalance occurs. Considering how many of the body's processes cortisol can suppress, it is hardly surprising that people who suffer from high levels of stress display a plethora of physical and mental conditions, including anxiety, heart disease, weight gain, digestive problems, depression, headaches, sleep disorders, poor memory, and decreased ability to concentrate.[104]

Avoiding cortisol imbalance is imperative. The additional symptoms of poor memory and decreased concentration add to the list of undesirable outcomes for an instrumentalist striving to achieve their best. Any opportunity to help balance the autonomic nervous system's branches bears consideration. Accessing the vagus nerve through the diaphragm releases hormones that balance the nervous system and mitigate physical symptoms that limit woodwind performance while encouraging desirable circumstances that enhance it.

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[102] Patrick McKeown, *The Breathing Cure,* (Galway: OxyAt Books, 2021), 129.
[103] McKeown, *The Breathing Cure,* 37.
[104] McKeown, 124.

5.5 Nose Breathing

The nose plays a crucial function in respiration and is often forgotten in discussion surrounding breathing pedagogy. The nostrils are significantly smaller that the mouth and breathing through the nose increases resistance by about 50% during waking hours.[105] McKeown notes that breathing through the nose conditions the air entering the lungs by warming and filtering it. The added resistance lets the body absorb 10-20% more oxygen and slows the respiration rate. This slower cadence allows for deeper breathing that engages the diaphragm, therefore calming the mind. Omitting the nose breath can be detrimental to the health of a woodwind player.

Mouth breathing increases nasal stuffiness that often leads to nasal blockage, thereby increasing mouth breathing. On exhalation, mouth breathing allows for 42% more water to be lost compared to nose breathing. Over time this scenario can unfortunately lead to the habitual pattern of breathing through the mouth. Nasal breathing helps to maintain lung volume, making respiration easier, and allows the lungs to utilize oxygen on both inhalation and exhalation.[106] The nose has the remarkable ability to create nitric oxide, a powerful ally for harmonizing our system.

Nitric oxide is fundamental for respiratory health. It facilitates the uptake of oxygen, prevents lung collapse and edema and is vital to lung elasticity. Nitric oxide instructs blood vessels in the lungs to open and relax to allow for increased blood flow. Generated in the nasal cavity, nitric oxide is necessary to regulate inflammation in the body's defense against airborne bacteria, pathogens and viruses.[107] Breathing through the nose allows nitric oxide to travel down

[105] Patrick McKeown, *The Breathing Cure,* (Galway: OxyAt Books, 2021), 104.
[106] McKeown, *The Breathing Cure,* 104.
[107] McKeown, 107.

into the lungs. Mouth breathing bypasses the nasal passages and nitric oxide created inside them is wasted.

5.6 In Practice

For a woodwind practitioner, nasal breathing and activating the diaphragm are valuable elements in coping with the detrimental effects of anxiety and the body's natural stress responses. The author recognizes that a nasal breath in performance is not always practical as the music dictates the available time to breathe. Long phrases or fast passages often give limited time for anything more than a swift catch breath through the mouth. However, during practice, one has complete control of their environment. The performer can practice allowing the body to engage the parasympathetic nervous system through diaphragm engagement and use nose breathing to optimize the nitric oxide in the nasal cavities.

CHAPTER 6: INTEGRATED PRACTICE

6.1 Flute, Clarinet and Saxophone Tendencies

The flute is the woodwind that requires the greatest amount of air with the least amount of resistance. The saxophone follows next, with more resistance, due to the mouthpiece and reed now in use. The clarinet offers the most resistance to the airstream due to its smaller bore and mouthpiece. With the same amount of air, longer phrases can (generally) be played on clarinet compared to flute. Reviewed method books reflect this in their emphasis on the breath.

In preparation for this project, dozens of woodwind methods were reviewed. The following are generalizations based on this research.

Flute methods offer much discourse around breathing. Without it, an aspiring player is left gasping with little success in creating a musical phrase or pleasing tone. Using the breathing mechanism to its full potential is crucial for successful expression on the instrument.

Saxophone methods place less emphasis on breathing than the flute. Their lack of consistency leads to negative habits as the learner struggles to achieve a good result. Incorrect body mapping is frequent, and phrases like “pushing from the diaphragm” and “breathing into the belly” are prevalent.

Clarinet methods surveyed were surprisingly void of any breathing instruction, especially in beginner and intermediate methods. The instrument’s natural backpressure perhaps makes it easier to employ sub-optimal breathing practices. After initial sound production is achieved, technique quickly becomes the focus.

The clarinet and saxophone both use a heteroglot reed and mouthpiece to create sound. Many adjustments to reed strength and mouthpiece dimensions can tailor the response to the

performer's preferences. It is conceivable that a saxophone player could achieve similar backpressure to the clarinet by using a hard reed and closed mouthpiece. Likewise, a clarinetist could employ a more free-blowing set up. However, this is not common practice.

6.2 Practice Methodology: Two Exercises

Based on research for this project (both in woodwind methods *and* breathing books) two exercises were composed. Appendix A provides an integrated exercise for the flute, clarinet and saxophone that satisfies the factors necessary for activation of the parasympathetic nervous system response.[108] The exercises are already transposed and should be performed as indicated for each woodwind. Played at a metronome marking of between 60 and 100 beats per minute, this study effectively reduces the respiration rate to the 4.5 to 6.5 breaths per minute range. As discussed previously, this activates the vagus nerve. To increase embouchure fitness and breathing efficiency, a tempo that is easy for the performer is preferable with the goal being a *slower* tempo as the body adapts to this practice. Playing four lines of the exercise (at 60 beats per minute) takes roughly one minute. Execution in all twelve keys takes three. Playing the exercise twice in all twelve keys, between the tempos of 60 and 100 beats per minute, takes between three and 7 minutes. This is a common minimum suggested to receive the benefits from a breathing exercise.

Additionally, the nose breath at the end of the phrase allows the nitric oxide in the nasal cavity to be carried into the lungs via warm, conditioned air. This also permits oxygen absorption on both inhalation and exhalation and prevents excess shedding of carbon dioxide. Practicing in

[108] The clarinet exercise includes space for *exhalation* to adjust for the instrument's added resistance and to fully empty the lungs.

this fashion creates favorable conditions to moderate unwanted effects, using the body's inherent physiology.

As this practice becomes a habit, these principles can be applied to performance. Timing a nose breath in advance of a phrase and during the music, where time allows, helps keep the body in an optimized state. In the stressful arena of performance, this is important in balancing the release of cortisol, the stress hormone, with the relaxing influence of the vagus nerve. Constructing a breathing map takes more focus initially, as does the execution of these principles. Intentional breathing in performance leads to a deeper presence in the music when one is *not* playing and sets up the best possible outcome when one is.[109]

The most significant benefit is gained from regular practice, focusing on the breath and sound. The exercise is a chromatic figure with sustained tones. The simple nature of the motif helps point the focus towards breath and sound, slowing the mind for a portion of practice instead of engaging it in technical execution. When beginning this practice, care should be taken to discover a tempo that allows the performer to finish the phrase with an empty air reserve. This will provide for a natural rebounding of the breath as it is taken through the nose. Do not strain or squeeze to finish the phrase. The inhalation should be taken with a tension-free breath that expands the abdomen (engaging the diaphragm) and ribcage (lungs).[110] Breathing through the nose naturally engages the diaphragm more deeply. Duration and repetition can be adjusted depending on the goals and capabilities of the performer, and conscious nose breaths can be used as a check in at any time to help re-center and focus the mind.

Appendix B contains a more straightforward exercise suited to beginning instrumentalists. The exercise has been placed in comfortable ranges for each of the clarinet,

[109] The insertion of an intentional nose breath into any exercise or repertoire can potentially help to create these conditions.

[110] See Recommended Resources & Future Research.

flute and saxophone. Often, concert B♭ is used as a default in beginning band methods before flute students can play a full octave in that tonality. This diminishes progress while encouraging detrimental compensations. An additional two beats are offered for exhalation in the clarinet part, accounting for the added back pressure inherent to the instrument. These two beats can be omitted if unneeded. Avoiding the extreme or more difficult ranges of the instruments helps the focus remain on the breath and sound.

CHAPTER 7: RECOMMENDED RESOURCES AND FUTURE RESEARCH

For breathing practice away from a musical instrument, the author emphatically recommends *The Breathing Cure* by Patrick McKeown. It was released during the last stages of this project's completion and is an invaluable resource. Uncovering seemingly every aspect of how breathing can influence our wellbeing, McKeown builds on his previous book *The Oxygen Advantage*, exploring the carbon dioxide relationship to our health and how to take practical steps to enhance it.

Wim Hof has gained fame for his expeditions in sub-zero climates and cold-water dives. *The Wim Hof Method* is a glimpse into the circumstances surrounding Hof's discovery of what cold water therapy and breathwork can do to push the limits of human potential. Hof has scientifically verified his claims of control over the autonomic nervous system and weaves this knowledge into a very accessible, proven practice.

Related to woodwind performance *The Breathing Book* Series from Mountain Peak Music is by far the most accurate methodology for learning how breathing works while performing on a woodwind instrument. Unfortunately, there is not yet a saxophone version but principles from the voice edition are an excellent complement to other methods like *Developing a Personal Saxophone Sound* by Dave Liebman (Liebman uses 'pushing from the diaphragm'). Correct terminology and body mapping are clearly laid out in Mountain Peak's flute and clarinet offerings. These books are more suited to advancing students as they are heavily conceptual.

The *Trevor Wye Practice book for Flute – Omnibus Edition* is a well laid out method for progression on the flute from the beginning stages right through to advanced players. Breathing is covered extensively with correct language and body mapping.

It is hoped that in the future, a controlled study will provide measurable results regarding the practice methodology offered. Research questions include whether this practice does, in fact, reduce anxiety in practitioners and over what time frame? Could this practice have measurable results on markers of overall wellness? Buteyko discovered that breath holds and lower breathing rates could reduce reliance on medication for asthmatics, in some instances by 90%.[111] Could asthma be improved in woodwind practitioners through integrated practices with focus on the nose breath, slowing down the breathing rate? What can be studied to understand if a practitioner is more resilient because of integrated breathwork? Furthermore, does the act of playing an instrument while breathing in this manner reduce or enhance the result of the exercise performed *away* from the instrument? Does the aural feedback from the instrument allow breathing exercises to be learnt more tangibly in practitioners?

Digital technology is playing a greater role in pedagogy. Can these principles be developed and learnt through an application designed for a smartphone? Many apps already exist - will learning breathing in this manner influence a student's life five years from now regardless of their continuation in music? Ten years from now? 15 years from now?

[111] James Nestor, *Breath,* (New York: Riverhead Books, 2020), 101.

CHAPTER 8: CONCLUSION

As research unfolded during this project, it became apparent that a guiding principle throughout human history has been crafting something that could give voice to musical impulses with ease and beauty. Striving for versatility and evenness of tone throughout registers, with improved intonation, led to incredible innovations and the advancement of the woodwinds in the 1800s, culminating with the saxophone's invention. Parallels can be drawn if the body is thought of as an instrument - our increasing awareness of our physiology, over time, simulating the advances of keywork and materials in instrument design, moving towards efficiency and expressiveness.

The discovery of a new application for these known breathing practices could conceivably change learning routines and impact the wellbeing of instrumentalists. The author hopes this methodology becomes a first step into new integrative practices. This can be achieved with a clear understanding of the breathing apparatus coupled with practical exercises that help musicians express themselves more fully while balancing their mind and body. It is the author's hope to produce research that irrefutably shows the value of music instruction, particularly breathing practices, as essential to the wellness and resilience of musicians for their lifetimes.

BIBLIOGRAPHY

Baines, Anthony. *Woodwind Instruments and their History.* New York: W.W. Norton & Company Inc., 1963.

Barks, Coleman. *The Essential Rumi.* New York: Harper Collins, 2004.

Bate, Philip, and Ludwig Böhm. "Boehm, Theobald." *New Grove Dictionary of Music and Musicians*. Oxford University Press, 2001.

Bate, Philip, and Wally Horwood. "Sax Family." *New Grove Dictionary of Music and Musicians*. Oxford University Press, 2001.

Bayley, Jonathan G. "The Pedagogy of Correct Breathing." *Canadian Music Educator*, no. 3 (2002): 35-37.

Betts, J. Gordon, et al. *Anatomy & Physiology.* Houston, Texas: OpenStax, 2017.

Böhm, Ludwig. *Theobald - Böhm - Archiv.* n.d. https://theobald-boehm-archiv-und-wettbewerb.de/ (accessed July 6, 2021).

Böhm, Theobald. *An Essay on the Construction of Flutes.* London: Oppenheimer Bros., 1847.

Bonade, Daniel, Larry Guy, ed. *The Complete Daniel Bonade.* New York: Rivernote Press, 2007.

Bower, Bruce. "Oldest Known Instruments Found: ivory, bone flutes date from 35,000 to 40,000 years ago." *Science News* 176, no.2, (July 2009): 13.

Bowers, Jane. "Mozart and the Flute." *Early Music*, 1992: 31-42.

Brody, Jane E. "A Breathing Technique Offers Help for People with Asthma." *The New York Times.* November 2, 2009. https://www.nytimes.com/2009/11/03/health/03brod.html?smid=em-share (accessed July 27, 2021).

Brown, Howard Mayer, and Frances Palmer. "Aerophone." *New Grove Dictionary of Music and Musicians*. Oxford University Press, 2001.

Brule, Dan. *Just Breathe.* New York: Enliven Atria, 2018.

Büchmann-Møller, Frank. *Someone To Watch Over Me: The Life and Music of Ben Webster.* Ann Arbor: University of Michigan Press, 2006.

Carney, Scott. *What Doesn't Kill Us.* New York: Rodale Books, 2017.

Castil-Blaze. *Dictionnaire de Musique Moderne.* Paris: Musique de la Lyre Moderne, 1821.

Cerra, Mario. *Doubling on Woodwinds.* Coral Springs: mDecks Music, 2015.

Coholic, Diana, Tricia Goeldner, Amanda Hardy, Katarina Gligorijevic, Kathe Rogers, and Anita Sekharan. *Mindfulness-Based Programs for Youth.* Canada: Youth Research & Evaluation eXchange, 2020.

Cottrell, Stephen. *The Saxophone.* New Haven and London: Yale University Press, 2012.

Deville, Paul. *Universal Method for Saxophone.* New York: Carl Fischer, 1908.

Doubleday, Veronica. "Rumi, Jalal al-Din." *New Grove Dicitonary of Music and Musicians*. Oxford University Press, 2001.

Draina, Bonnie. *The Breathing Book for Singers.* Flagstaff: Mountain Peak Music, 2019.

de Pascual, Beryl Kenyon. "A Unique Experimental Clarinet by Adolphe Sax." *The Galpin Society Journal* 42 (1989): 70-76.

Elligton, Edward Kennedy. *Music is My Mistress.* Garden City: Doubleday, 1973.

Evensmo, Jan. *JazzArcheology.com.* April 13, 2018. http://www.jazzarcheology.com/artists/ben_webster_part_1.pdf (accessed April 7, 2020).

Frederiksen, Brian. *Arnold Jacobs: Song and Wind.* Edited by John Taylor. Gurnee, Illinois: Windsong Press Limited, 1996.

Freudenrich, Carl. "How Your Lungs Work." *HowStuffWorks.com.* October 2000. https://health.howstuffworks.com/human-body/systems/respiratory/lung.htm (accessed July 27, 2021).

Galper, Avrahin. *Galper Clarinet Method.* Keswick: Mayfair Music Publications, 1995.

Gill, Denise. "Melancholic Modalities: Affect, Islam, and Turkish Classical Musicians." *Oxford Scholarship Online.* May 2017. DOI:10.1093/acprof:oso/9780190495008.001.0001.

—. "Separation, the Sound of the Rhizomatic Ney, and Sacred Embodiment." *Oxford Scholarship Online.* May 2017. DOI: 10.1093/acprof:oso/9780190495008.001.0001.

Gordon, Claude. *Brass Playing Is No Harder Than Deep Breathing.* New York: Carl Fischer, 1987.

Guy, Larry. *Hand & Finger Development for Clarinetists.* New York: Rivernote Press, 2007.

—. *The Daniel Bonade Workbook.* New York: Rivernote Press, 2004.

Heirich, Jane Ruby. *Voice and the Alexander Technique.* Berkely: Mornum Time Press, 2005.

Hoeprich, Eric. *The Clarinet.* New Haven: Yale University Press, 2008.

Hof, Wim. *The Wim Hof Method.* Louisville: Sounds True Inc., 2020.

Horvath, Janet. *Playing (less) Hurt: An Injury Prevention Guide for Musicians.* New York: Hal Leanord Books, 2010.

Joffe, Edward. *Woodwind Doubling for Saxophone, Clarinet, Flute.* New York: Joffewoodwinds, LLC, 2006.

Jordan, James, Mark Moliterno, and Nova Thomas. *The Musician's Breath: The Role of Breathing in Human Expression.* Chicago: GIA Publications, 2011.

Kelly, Kevin. "The Dynamics of Breathing with Arnold Jacobs and David Cugell, M.D." *Instrumentalist*, 1983: 6-12.

Kennedy, Joyce, Michael Kennedy, and Tim Rutherford-Johnson. "Quantz, Johann Joachim." *The Oxford Dictionary of Music*. Oxford: Oxford University Press, 2012.

Kirnbauer, Martin, and Peter Thalheimer. "Jacob Denner and the development of the flute in Germany." *Early Music*, 1995: 82-101.

Kleinman, Judith, and Peter Buckoke. *The Alexander Technique for Musicians.* London: Methuen Drama, 2013.

Klose, Hyacinth, and Simeon Bellison. *Celebrated Method for the Clarinet.* Edited by Stanley Drucker, & Naomi Drucker. New York: Carl Fischer, 2015.

Leibman, Dave. *Developing a Personal Saxophone Sound.* Massachusetts, 1994.

Library, The Kansas City Public. "The Pendergast Years: Kansas City in the Jazz Age & Great Depression." Accessed April 27, 2020. https://pendergastkc.org/collection/9704/umkc-1213/andy-kirk-and-his-twelve-clouds-joy.

Likar, Amy. *The Breathing Book Flute Edition.* Flagstaff: Mountain Peak Music, 2018.

Lorenzino, Lisa. "Spotlight on Woodwinds: Jazz Flute: A Proud Heritage." *Canadian Winds* 7, no. 2 (2009): 92-95.

Macdonald, Hugh. "Berlioz, (Louis-)Hector." *New Grove Dictionary of Music and Musicians*. Oxford University Press, 2001.

McBirnie, Bill. *The Technique and Theory of Improvisation. A Practical guide for flutists, doublers and other instrumentalists.* Toronto: Bill McBirnie, 2019.

McKeown, Patrick. *The Breathing Cure.* Galway: OxyAt Books, 2021.

—. *The Oxygen Advantage.* New York: William Morrow, 2015.

Merrell, Allyson J., and Gabrielle Kardon. "Development of the Diaphragm - a Skeletal Muscle Essential for Mammalian Respiration." *The FEBS journal* 280, no. 17 (2013): 4026-4035.

Miller, Doug. “The moan within the tone: African retentions in rhythm and blues saxophone style in Afro-American popular music.” *Popular Music* 14, no. 2 (May 1995): 155-174.

Montagu, Jeremy, Howard Mayer Brown, Jaap Frank, and Ardal Powell. “Flute.” *The Grove Online.* January 20, 2001. https://doi.org/10.1093/gmo/9781561592630.article.40569 (accessed 06 09, 2021).

Nair, Garyth. *The Craft of Singing.* San Diego: Plural Pub, 2007.

Nestor, James. *Breath.* New York: Riverhead Books, 2020.

Oleskiewicz, Mary. “The Flutes of Quantz: Their Construction and Performing Practice.” *The Galpin Society Journal* 53, no. 53 (2000): 201-220.

Olsen, Dale A. *World Flutelore: Folktales, Myths, and Other Stories of Magical Flute Power.* Baltimore: University of Illinois Press, 2013.

Olson, Mia. *Musicians Yoga.* Boston: Berklee Press, 2009.

O'Shea, Anna Belle. “Flutes, Recorders, Clarinets, and More: The Role of Woodwind Instruments in Liturgy.” *Pastoral Music* 32, no. 6 (2008): 23-25.

Pearson, Bruce. *Standard of Excellence Enhanced Comprehensive Band Method.* San Diego: Neil A. Kjos Music Company, 2017.

Pereira, Shane N. “A New Religious Movement in Singapore: Syncretism and Variation in the Sathya Sai Baba Movement.” *Asian Journal of Social Science* 36, no. 2 (2008): 250-270.

Pimentel, Bret. *Woodwind Basics.* Cleveland: Meaty Fresh Press, 2017.

Powell, Ardal. *The Flute.* New Haven and London: Yale University Press, 2002.

—. “Tromlitz, Johann George.” *New Grove Dictionary of Music and Musicians*. Oxford University Press, 2001.

Prance, Sir Ghillean, and Mark Nesbitt. *The Cultural History of Plants.* New York: Routledge, 2004.

Quantz, Johann Joachim. *On Playing the Flute.* Boston: Northeastern University Press, 2001.

Ramacharaka, Yogi. *Science of Breath.* Rooksley: Parchment Books, 2011.

Raumberger, Claus, and Karl Ventzke. “Saxophone.” *New Grove Dictionary of Music and Musicians.* Oxford University Press, 2001.

Rendall, F. Geoffrey. *The Clarinet.* London: Ernest Benn Limited, 1971.

Rice, Albert R. “Clarinet.” *New Grove Dictionary of Music and Musicians.* Oxford University Press, 2013.

—. *The Baroque Clarinet and Chalumeau.* New York: Oxford University Press, 2020.

Rice, Albert R., and Colin Lawson. “The Clarinet and Chalumeau Revisited.” *Early Music* 14, no. 4 (1986): 552-556.

Schuller, Gunther. *The Swing Era.* New York: Oxford University Press, 1989.

Segell, Michael. *The Devil's Horn.* New York: Farrar, Straus and Giroux, 2005.

Sehmann, Karin Harfst. “The Effects of Breath Management Instruction on the Performance of Elementary Brass Players.” *Journal of Research in Music Education* 48, no. 2 (2000): 136-150.

Senay, Banu. “Artists, antagonisms and the ney in the popularization of 'Sufi Music' in Turkey.” *European Journal of Cultural Studies* 18, no. 1 (2015): 52-69.

—. “Masterful Words: Musicianship and Ethics in Learning the Ney.” *Journal of the Royal Anthropological Institute* 21, no. 3 (2015): 524-541.

Shackleton, Nicholas. “Oehler, Oskar.” *New Grove Dictionary of Music and Musicians.* Oxford University Press, 2001.

Spaniol, Douglas E. *The New Weissenborn Method For Bassoon.* Wisconsin: Hal Leanord Corporation, 2010.

Stöppler, Melissa Conrad. “Panic Attack Symptoms.” *WebMD.* September 28, 2020. https://www.webmd.com/anxiety-panic/guide/panic-attack-symptoms (accessed July 29, 2021).

Stein, Keith. *The Art of Clarinet Playing.* U.S.A.: Summy-Birchard Inc., 1958.

Teal, Larry. *The Art of Saxophone Playing.* Florida: Summy-Birchard Inc., 1963.

Toff, Nancy. *The Flute Book.* New York: Oxford University Press, 2012.

Valk, J. de. *Ben Webster: His Life and Music.* Berkely: Berkeley Hills Books, 2001.

Ventzke, Karl. “Pottgiesser, Heinrich Wilhelm Theodor.” *New Grove Dictionary of Music and Musicians.* Oxford University Press, 2001.

Vinning, David. *The Breathing Book. Bass Trombone Edition.* Flagstaff: Mountain Peak Music, 2009.

Weisberg, Arthur. *The Art of Wind Playing.* New York: Macmillan Publishing Co., Inc., 1975.

Weston, Pamela. “Klosé, Hyacinth Eléonore.” *New Grove Dictionary of Music and Musicians.* Oxford University Press, 2001.

Westphal, Frederick. *Guide to Teaching Woodwinds. Third Edition.* Iowa: Wm. C. Brown Publishers, 1980.

White, William, Crystal Lee, and William Parks. “The virtuosic fife: Not just a simple signal instrument.” *The Flutist Quarterly* 41, no. 3 (2016): 20-26.

Wilson, Rick. “Rick Wilson's Historical Flutes Page.” Accessed June 30, 2021. https://www.oldflutes.com.

Wolak, Kornel. *Embouchure Drills: Clarinet.* Toronto: Music Mind Inc., 2019.

Wye, Trevor. *Trevor Wye Practice Book for the Flute, Omnibus Edition.* London: Novello Publishing Limited, 2014.

Yücel, Mehmet. “neyzen.com.” Accessed December 8, 2020. https://www.neyzen.com.

Yakovleva, Sasha, K.P. Buteyko, and A.E. Novozhilov. *Breathe To Heal.* USA: CreateSpace Independant Publishing Platform, 2016.

Zaccaro, Andrea, Andrea Piarulli, Marco Laurino, Erika Garbella, Danilo Menicucci, Bruno Neri, and Angelo Gemignani. “How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing.” *Frontiers in Human Neuroscience* 12 (2018): 353.

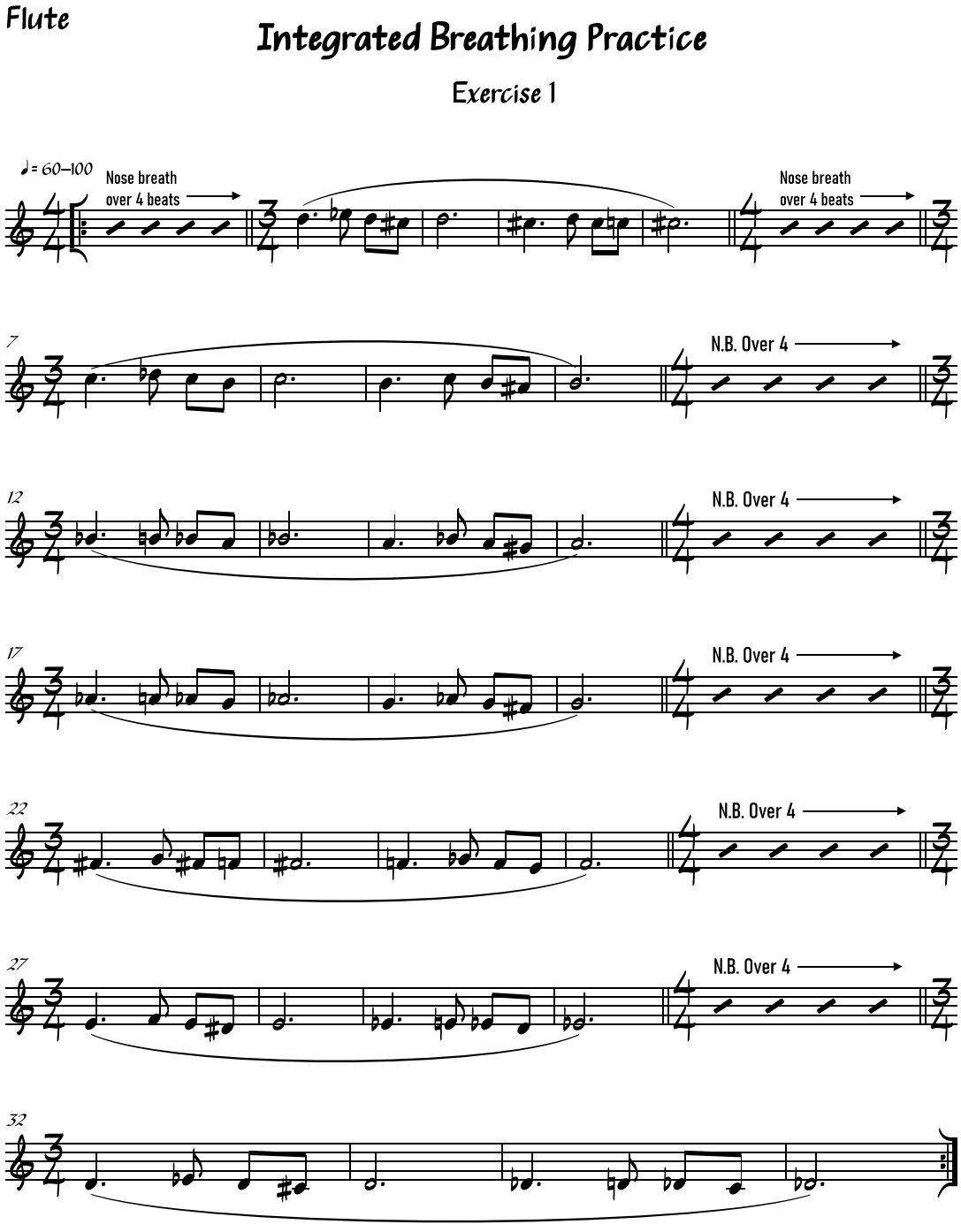
DISCOGRAPHY

"A-Tisket, A-Tasket." (Ella Fitzgerald, Van Alexander). Teddy Wilson. *The Complementary Works – Teddy And The Girls – Volume 3. 1938-1939*. Media 7 MJCD 135. (CD). Track 18.

"Danny Boy" (Frederic Weatherly). Ben Webster. May 21, 1953. From: *King of the Tenors.* Verve MGV 8020. (CD). Track 8.

"Why Begin Again" (Artie Shaw, Charlie Shavers, Don Raye). Teddy Wilson. *The Complementary Works – Teddy And The Girls – Volume 3. 1938-1939*. Media 7 MJCD 135. (CD). Track 19.

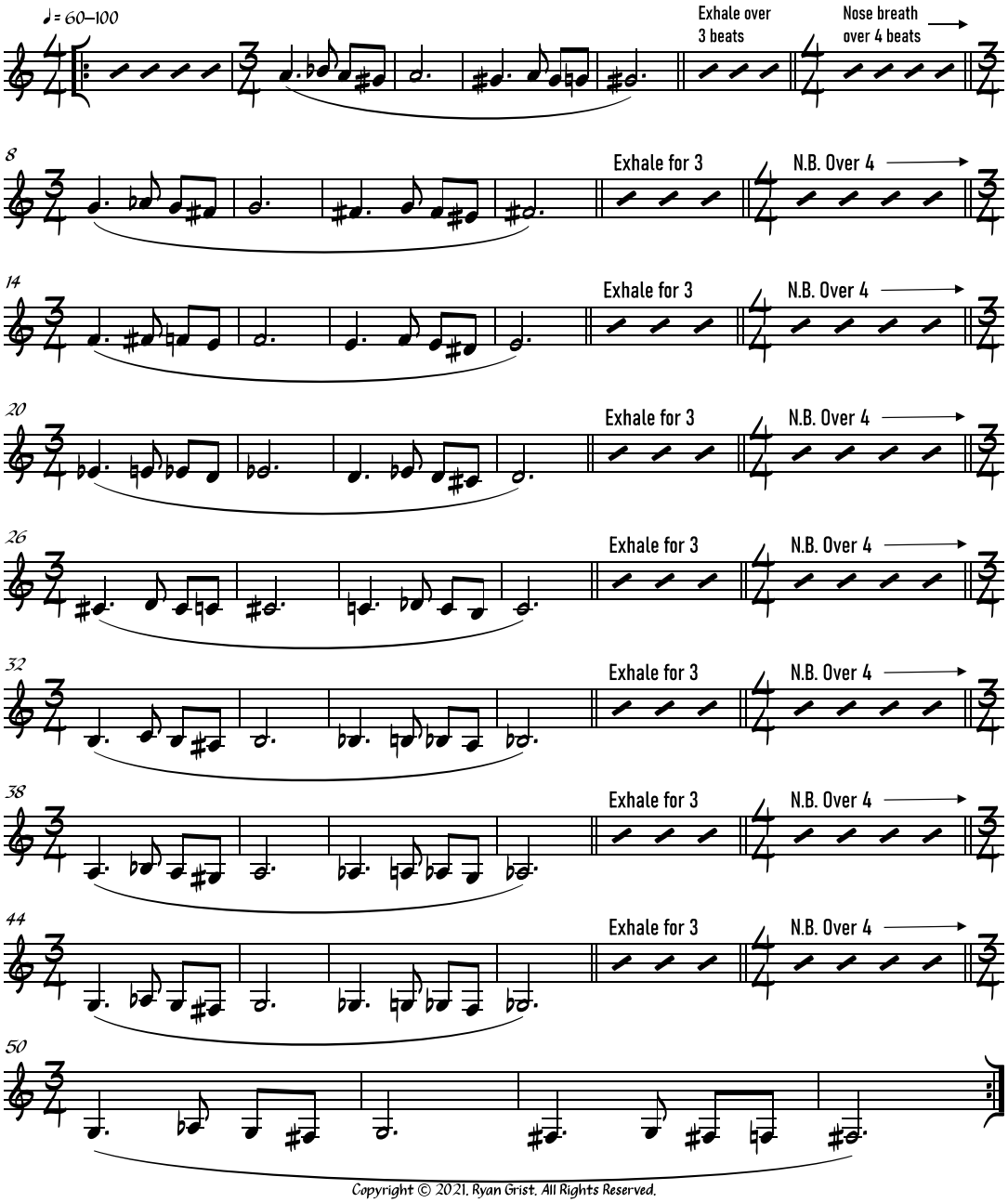
Appendix A



Bb Clarinet

Integrated Breathing Practice

Exercise 1

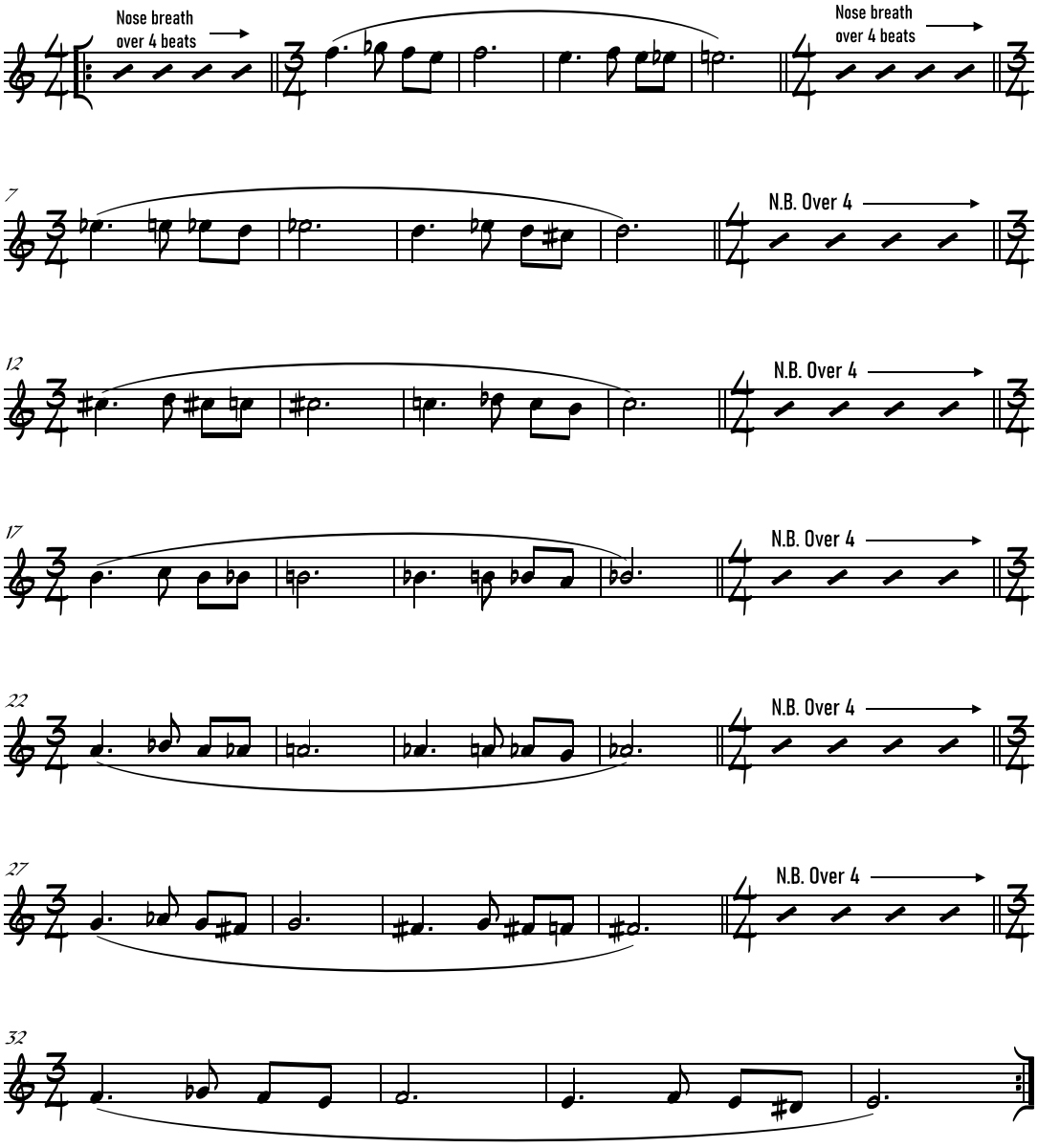


Eb Alto Sax

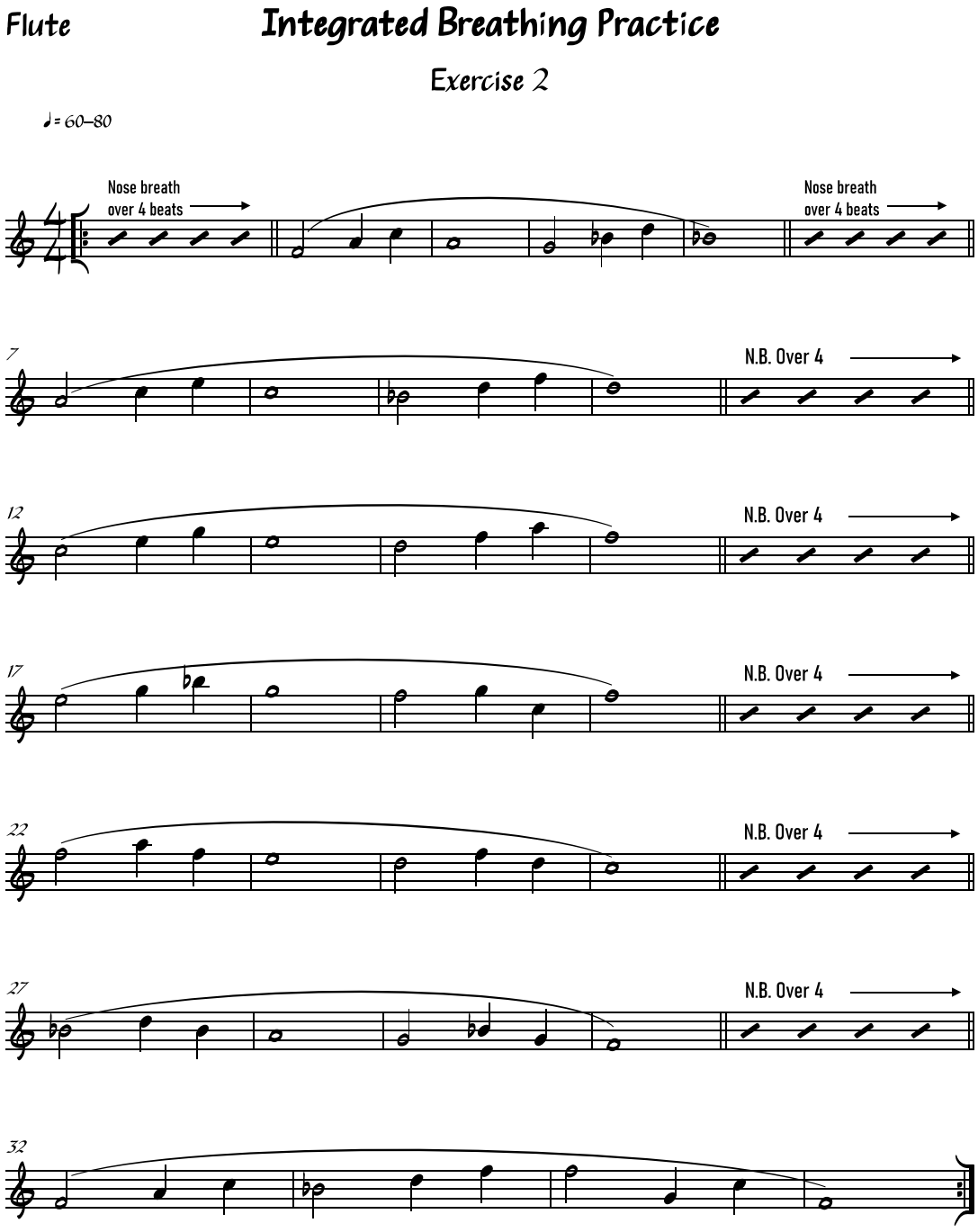
Integrated Breathing Practice

Exercise 1

♩= 60–100



Appendix B

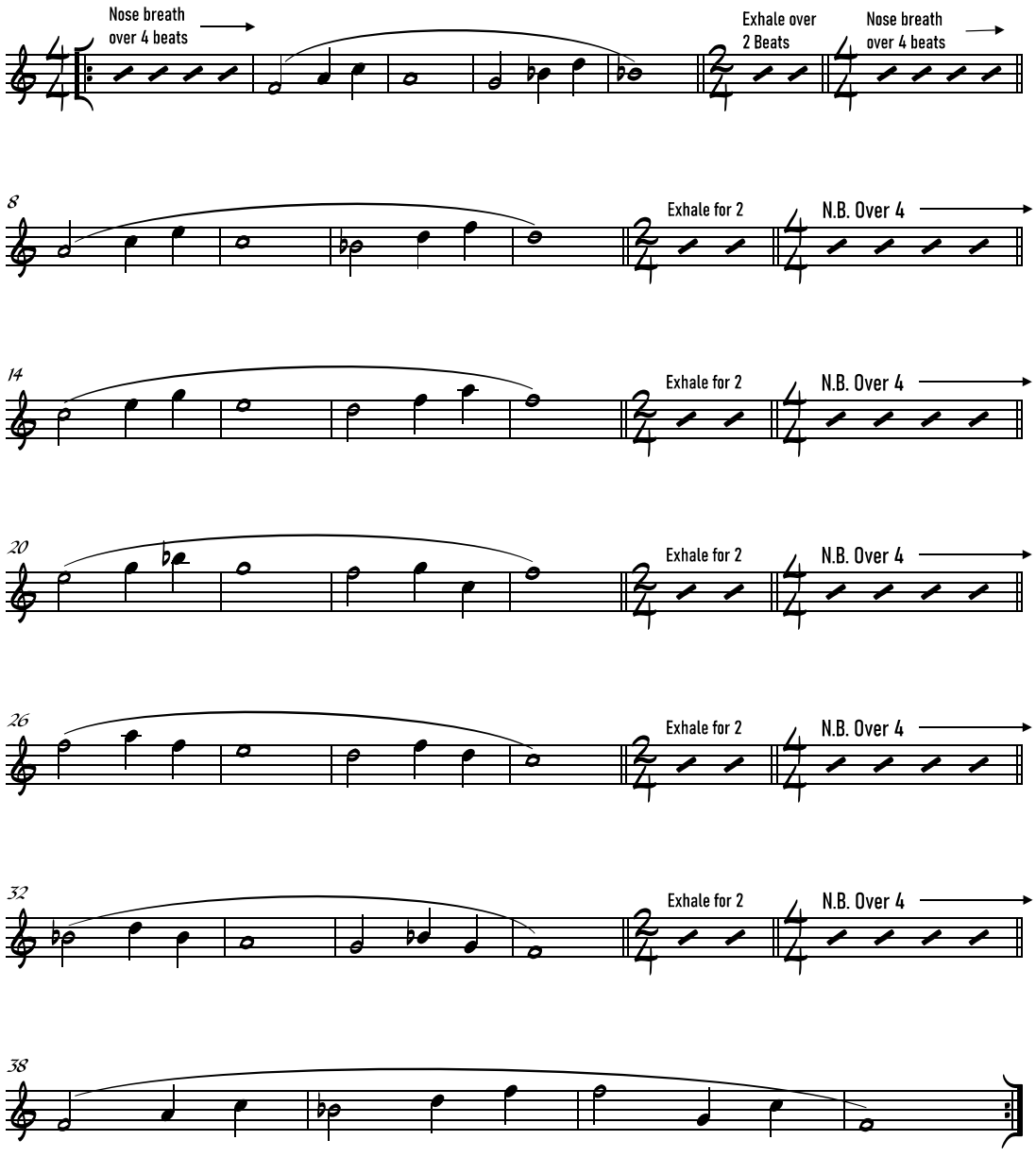


B♭ Clarinet

Integrated Breathing Practice

Exercise 2

♩= 60–80



Eb Alto Sax

Integrated Breathing Practice

Exercise 2

♩= 60–80