The Development of the Boehm System on the Virtuosic Flute and its Impact on Modern Flute Music

A thesis submitted in partial fulfillment of the requirements For the degree of Master of Music in, Music Performance

By
Nathan Davis

May 2014
The thesis of Nathan Davis is approved:

David Shostac

Dr. Liviu Marinescu

Dr. Alexandra Monchick, Chair

California State University, Northridge
# Table of Contents

Signature Page
Abstract
Introduction
Before the Boehm System
  The Ancient Flute
  The Medieval Period
  The Baroque Period
  The Classical Period
Theobald Boehm
  Boehm’s Patents
  1831 Patent
  1832 Patent
  Other Flute Makers Contributions
  Boehm’s Return to Flute Construction
  1847 Patent
  Modern Flute Developments
Impact on Music
Conclusion
Bibliography
ABSTRACT

The Development of the Boehm System on the Virtuosic Flute and its Impact on Modern Flute Music

By
Nathan Davis
Master of Music in Performance

This thesis will examine the modern flute starting in the early Romantic period with the advent of new techniques and flute designs such as the Boehm system and moving through the developments made to the flute, ending with the impact made on today’s music. I will explain how the Boehm system and other developments have impacted flute repertoire and works. The evolution of the modern flute in the nineteenth century along with the romantic musical style of the time gave rise to the romantic virtuosic flute. Moving forward through the development of the flute, I will end with today’s modern flute, which along with a progressive compositional style, gave rise to new flute techniques such as harmonics and alternative flute styles such as singing and playing at the same time. I will show the correlation of instrument design and the impact it has had on the composition of musical works for the flute.
Introduction

Throughout the centuries the flute did not change its overall design. It was not until the nineteenth century that the flute made most of its design changes. Leading up to the romantic period, the flute had various problems including tuning, sound production and equality amongst the entire range of the instrument. During the nineteenth century, many of these problems were solved through the invention of the Boehm system. Compared to earlier flute designs, the new qualities of the newer flute design allowed for flute players to develop and adapt to new music techniques from other musical styles. Also, it allowed for different methods and trends of performance techniques based on the different styles of music. Furthermore, these changes lead to composers being able to write more technical and virtuosic music for the flute.

The earliest flute can be traced to the prehistoric times. These early flutes were crude and generally made from the materials at hand, such as animal bone or plant material. These early flutes were used for ceremonial and religious purposes. The early flute can be put into two separate categories; an instrument that consisted of multiple sound chambers and one consisting of a singular tube. An example of an instrument consisting of multiple tubes tied together would be the pan flute. The other type of flute consisting of one main tubular body can further be separated into two sub-categories. These categories are based on the method of how the instrument was held, either vertically or horizontally. The vertical flute includes modern instruments, such as the recorder. An example of a horizontal flute includes
what people consider the modern flute today, which is also known as a transverse flute. Although the multiple sound chamber flute (pan flute) and vertical flute (recorder) both have had impacts on the flute development, the focus of this paper will be on the transverse flute, which has been developed into the modern flute design that most people think of today.

The modern flute consists of a main tubular body, through which the musician pushes air across a sound hole. This forces the air to circulate through and vibrate down the main body of the flute. The length and width of the main flute body will determine the range and key of the instrument, based on how long the vibrations are throughout the flute body. To produce different notes other than the main key of the tubular body, the flute also consists of holes that are drilled along the main tubular body. This adjusts the vibrating sound lengths down the flute body to alter pitch and sound. By covering different hole combinations, one can alter and change the various notes within the range and key of the instrument.
Before the Boehm System

The Ancient Flute

The first documented evidence of flutes with multiple holes to change the pitch was found in paintings of ancient Greece, around eighth century BC.¹ This type of flute consisted of six holes along the body that allowed it to play all the notes in a specific modal scale to which the flute was constructed for. During the eighth century BC, the most popular instrument was not the flute, but rather the Aulos. The Aulos consisted of a double reed instrument with two separate chambers, one for a base tuning and one for melody. At this time, to be an Aulos player was held with great prestige, which included fame and fortune. For this reason the flute was most often performed by commoners, such as shepherds, who simply played the instrument for pure entertainment value.²

The earliest ancient flutes were most often constructed out of bone. However, every region and culture tended to use whatever materials they had on hand. For instance, in Africa, most flutes were created out of ostrich quills.³ Native American flutes were often made of wood or bone. Asian cultures created their flutes through construction of bamboo. Throughout the world, different cultures used their own methods to create flutes, and they were not restricted to utilizing only one building material. Throughout the continued evolution of the flute, the

² Ibid
³ Ibid
building designs and techniques used for flute construction became more exotic and interesting.

The ancient flute was used for a multitude of different purposes, including cultural events, religious ceremonies, and pure entertainment value. As stated previously, the ancient Greek commoners used the flute for pure entertainment value. On the other hand, the Native American tribes, such as the Apache, utilized the flute as a cultural tool for courtship and a rite of passage amongst male tribal members to attract their mates. These diverse uses were as varied as the cultures and materials from which flute was created.⁴

The Medieval Period

The medieval flute design and construction was in essence a continuation of previous flute designs. These medieval flutes were constructed from a single piece of wood and had six open holes, which were approximately arranged on the body. These military flutes, or fifes, were composed of a “narrow tube with six close finger holes.”⁵ This allowed for the approximate pitches of the different notes within one specific modal scale. These flutes, known as the Zwerchpfeiff by Sebastian Virdung, were used in a military role along with a small drum, which would be used in military march cadences and orders. It was not until the Renaissance period that the

---

⁴ Galway, Flute, 6.
flute design started to expand so that it could be used in other areas, such as music entertainment.

During the Renaissance, the flute construction really started to change and improve, although the flutes were still mostly based off of the previous design of the Zwerchpfeiff. The improvement on flute design may have occurred due to the change in musical style and composition during the renaissance period. During the medieval time period, flute compositions were composed of simple tunes, usually a flute accompanying the vocal melody or a small drum. However, in the 1600s, music compositions started to become dedicated to the flute, which during this time period was known as the Schweitzer Pfeiffen as described by Martin Agriola in his work *Musica instrumentalis deudsch*. These newer flutes had better design and proportions than their earlier predecessors, including the Zwerchpfeiff, which allowed for better finger positions. The newer flutes, known as Querpfeiffen as described by Michael Praetorius’s *Syntangma Musicum* in 1619-20, illustrates a three flute or Querpfeiffen consort. This consort consisted of a discant flute, alto/tenor flute, and a bass flute. A musician would often have all three flutes in order to accommodate the different keys and octaves required. The discant Querpfeiffe produced the highest notes and was composed of a fourteen-inch body and designed for the natural key of A major. The alto/tenor Querpfeiffen was constructed in the key of D major with a length of 22 inches. The Bass Querpfeiffe

---

6 Toff, *Development of the Modern Flute*, 12
7 Ibid, 11-13.
was constructed in the key of G major with a length of 32 inches. Depending on the piece being played, the musician would utilize one of the three flutes.

These Querpfeiffen consort was superior to the previous flute design for several reasons. The holes were more precisely made to fit in the key for which it was constructed for, instead of the approximant hole placements of the earlier military Pfeiffen. Furthermore, an innovation arose with the alto/tenor and bass Querpfeiffen. Instead of one single wooded tube, as the discant Querpfeiffen continued to be made from, the alto/tenor and bass Querpfeiffen were constructed out of two wooden pieces. These two wooden pieces would fit together and allowed for better tuning of the Querpfeiffen by adjusting the length of the flute.

These early Querpfeiffen were most often made of materials that were easy to work with such as plum and cherry wood. These woods were chosen for several reasons, including their aesthetic characteristics, including wood finishing and grain patterns. However, during this time, flutes started to become created out of more exotic materials, such as ebony, glass, and crystal (according to Mersenne in his Harmoninorum of 1648). These exotic flute materials, although attractive looking, were made from materials which were very difficult to work with. Because of the difficulty of construction, these alternative flute materials fell out of favor quickly.

---

8 Toff, Development of the Modern Flute, 14.
9 Ibid, 15.
The Baroque Period

During the baroque period, music came much further than the early madrigals and folk music of the past medieval musical period. The evolving music that composers were producing called for a complexity of dynamics and quality of tone that the vertical flute, or recorder, simply could not match. The transverse flute, on the other hand, was perfect choice to obtain the musical expression needed for the more complex musical works. Furthermore, the transverse flute offered a better clarity of sound and a third octave range. However, the transverse flute at this time was far from ideal for the composers for this time. The transverse flute still needed to evolve further to meet the demands of the baroque music, but it was a good place to start.

During the baroque period, the transverse flute still was not completely controllable when it came to tuning and pitch. At this time, the transverse flute was still constructed for one specific key, in this case, the D mode. However, with proper techniques and cross fingerings such as forked fingerings, a flute player had the ability to play a chromatic scale with some degree of relative pitch. One of the techniques used to play half steps includes partially covering the finger holes. However, this was not ideal as it degraded the sound quality and tuning ability. Pitches amongst many of the notes throughout the chromatic scale were far from clear and were many cents out of tune. To further make tuning a problem, a limitation of the baroque transverse flute was still the human hand’s range of

10 Toff, Development of the Modern Flute, 15.
movement. To accommodate for the reach of the human hand, the A and E hole, which are the first and last finger holes on the flute, would be cut above true center pitch. Thus caused intonation problems with many notes on the flute. To compensate the for the wrong positioning of the A and E holes, those two finger holes would be cut smaller than the rest of the finger holes to account for not being in the true position. Regardless of the shortcomings, the ability to play chromatics opened opportunities for the baroque transverse flute, including consideration for words and compositions of the new musical period, which was a major accomplishment for flute players.

The baroque transverse flute continued to be developed through the baroque period. Around the 1660's, according to Galway’s book entitle Flute, The advent of the D-sharp key was invented and added to the design of the flute. Never before had a key been added to the construction of the flute. This simple, yet effective design of adding a metal key would lead further innovation later. This simple design created a way to play D-sharp on the flute with ease and clarity by the use of one’s pinky finger instead of using a poor sounding cross fingerering, which was previously used to create the note. The D-sharp mechanism consisted of a simple piece of metal, often constructed from silver due to its easy manipulation. This metal piece was attached to a spring and metal support system placed at the very end of the flute on the bottom section of the flute, known as the foot joint. With this D-sharp key, one could play the D-sharp with a much better quality of sound, and this creation lead to
more innovative cross fingerings that could produce better intonation across the entire flute range. 11

Several other innovations were established during the same time period that helped the flute become a better instrument. These innovations were required in order to keep up with the demand from the music of the baroque period. One such innovation contributed to balancing the quality of sound and equality of tone amongst the flute range. A conical bore was invented for a better lower register. The internal bore of the flute, starting at the head joint and continuing all the way to the foot joint decreased in size. The head joint, as stated in Galway’s book, started at zero point seventy-two inches from where the head joined the body joint to zero point forty-five from the end of the foot joint.12 Another design innovation that also contributed to better intonation for the flute was smaller finger holes across the entire flute body. These smaller finger holes were previously cut like recorder finger hole for comfortably fit the human finger. However, with the decrease in finger hole size, the chromatic notes performed by cross fingering were more true to correct intonation. However, the quality of pitch and sound were not perfect; it still fell upon the player to correct for intonation through different techniques to accommodate for pitch.

The materials in which the flute was constructed also had a factor in contributing in the flute’s poor intonation. Most baroque flutes of this time were

11 Toff, Development of the Modern Flute, 16-19
12 Galway, Flute, 21.
constructed from Boxwood for the body and Ivory to support the joints. The Boxwood was selected for two reasons; the first is that it produced a rich mellow sound and second is that the Boxwood grain pattern was very attractive to the eye. However, the Boxwood would adsorb moisture from playing and would swell and warp while playing. This severely affected the intonation of the flute during each piece. Other materials were experimented with including Ivory and other metals. Ivory was found to be unattractive to the touch and feel of the player. Also, Ivory often resulted in problems with lip placement and slipping due to the slickness of Ivory when wet. Metal was found to have a clear bright sound, but still feel victim to environments change of hot to cold thus continuing the problem of intonation.

The problems that plagued the early baroque’s flute were all addressed over the course of the baroque period. The early problem of limited range and intonation and quality throughout the flute range was being improved by the innovation of the addition of the D-sharp key and improved finger hole placement and size. These improved sound and quality innovations lead to new finger techniques on the flute. According to Galway, “Better flutes led to better players, whose performances encouraged composers to write more pieces, and more testing pieces. And in turn prompted further improvements in the instrument.”13 This turn of events foreshadows the impact of further innovations on the flute that in turn affected the music and virtuosity for the flute. However, at this time, the flute still had a long way to evolve in order to reach its full potential.

_____________________

13 Galway, Flute, 25.
The Classical Period

Continuing into the Classical period, the same problems of intonations occurred, and the limitations of the baroque transverse flute were still present. Even though the baroque flute had evolved and addressed many of the main issues of the flute, composers continued to feel that the flute was inadequate as an instrument for many types of pieces. This was largely because the flute still could not keep proper intonation across the entire range of the flute. Several attempts at innovation arose to try to fix this major problem of intonation. One such way was in the flute head joint. The flute head joint at this time was stopped by a cork and cap. The player could adjust this cork and cap in and out of the flute head joint to adjust for intonation and tuning. However, this adjustment would only adjust the tuning in small amounts. For this reason, flautists often attempted to fix this problem by creating new ideas for the flute. Two such flautists were Jacques Hotteterre and Johann Quantz.

Jacques Hotteterre, a famous flautist and composer and flute maker who lived from 1674 to 1763, is contributed to the idea of the flute being set into three major pieces, the head joint, body, and foot joint. However, Hotteterre did not stop there. Instead of containing the flute to three pieces, Hotteterre took the idea further and created a fourth interchangeable section. This was created to try to control the tuning and intonation of the flute. This system was called corps de réchange, or body parts. To create the corps de réchange, Hotteterre adjusted the tuning by taking the
three sections flute body and creating a fourth interchangeable section. This fourth section was created by taking the main body section and cutting it along the division between the left and right hand finger holes. Then, the left hand finger hole section was created in four different lengths, known as an upper, upper middle, middle lower, and lower sections. These section names refer to the intonation of each section, moving from sharper to flatter sections, respectively. These changeable bodies were changed out depending on the specific intonation required for each piece. With the increase or decrease of the flute length, Hotteterre’s *corps de réchange* could change the tuning dramatically. However, this continued to leave the flute player with limited options, as they only had four tuning options and fine adjusting was still a major problem across the range of the flute.\(^\text{14}\) Johann Quantz, another well known flautist, who lived from 1697 to 1773, wrote hundreds of flute works on the flute. Quantz also created three different flute fingerings, a flat fingering, natural fingering, and sharp fingering system. These systems played into his particular innovations. Furthermore, Quantz also tried to fix the intonation problems of the transverse flute during his own lifetime. However, Quantz made a simple innovation for adjusting the pitch and tuning by including a telescoping metal tube to the flute, which was built into the interior of the flute bore of the foot joint. To adjust tuning, he would pull out the telescoping tube to the proper length, which brought his intonation closer to what is was supposed to be. However, this

\(^{14}\) Toff, *Development of the Modern Flute*, 21.
did not truly fix the problem and Quantz himself felt it was still false intonation. In addition to the telescoping tube, Quantz also contributed two additional keys to the flute. These flute keys were placed on the foot joint, creating a D-sharp and E-flat keys. The flute keys created better intonation for cross fingering chromatic notes and helped to avoid some of the awkward cross fingerings that were used at the time. Having two keys for the same chromatic note made sense with Quantz fingering techniques, as the fingerings would change based on whether the piece was sharp, flat, or natural. The added keys did not do much for the difference for the D-sharp and E-flat, but the addition of these extra keys, coupled with the new finger techniques created by Quantz, better adjusted the intonation for my many notes thought out the flute.

The music composers for flute as this time based their pieces off of the natural abilities of the flutes. Many works were composed in D major, the natural key of most transverse flute. As music continued to evolve, composers felt reluctant to compose interesting and difficult flute music because they were not sure the flute could handle the increased demands. For this reason, less flute music was created at this time that was composed in the musical trend of the time period. Luigi Cherubini is quoted as saying “The only thing worse than one flute is two”. As music continued to evolve into the classical period, equal temperament tuning amongst keyboard instruments, including the clavier and piano forte, became the accepted


\[16\] Toff, *The Flute Book*, 44.
form of tuning, rather than older diatonic styles, such as what Quantz’s two key system followed.

During the Classical period, individual flute makers tended to devise their own solutions to the chromatic scale fingerings and equal intonation throughout the flute range by the addition of mechanical keys added to the flute. These flute designs were not shared between flute makers, which resulted in a multitude of different solutions for the same problem. However, the trend of utilizing mechanical keys to help adjust the flute intonation began to expand and become more popular all around. This trend to create one’s own flute design based on mechanical keys continued until the late eighteenth century.

In the late eighteenth century, London flute makers continued to create their own individual flute designs with mechanical key systems. These mechanical key systems were attempts to improve previous intonation problems of the one- and two-keyed flute predecessors. Thus, instead of using a different section of flute, such as Hoteterre’s *corps de réchange*, or the telescoping tuning tube, as designed by Quantz, one would have a four sectioned flute with mechanical keys and improved fingering system for better tuning and intonation. In the 1760’s, London flute makers started to add three more keys to their flute design. The three new keys were G-sharp, B-flat, and F. Looking back, it is evident that these keys are early predecessors to the same key mechanism we see today in modern flute systems. The G-sharp key is played with the left hand pinky as it is today. The B-flat key was

positioned in a similar place as it is with modern flutes. The F key was the most different than today’s modern flutes, being that it was placed in a different location. The F key required a piece of metal to be curved around the flute to reach the awkwardly placed tone hole. The most striking improvement of these additional keys was that it eliminated the need for cross fingering except for one. This meant that the intonation increased dramatically. The only note still requiring a cross fingering for intonation was C natural. However, this sparked a revolution of easier technical fingerings and was a clear step towards better and equal intonation across the flute range. With the easier technical fingerings and better intonation of flute, composers had a new resurgence of flute compositions. Composers created new works for flute, including the G major concerto for flute and orchestra by Mozart. These new pieces challenged the flute player and inspired musicians to create more virtuosic flute music.

Along with the new key system, the London flute makers revisited the idea of creating the C flute. Throughout the baroque period and continuing until the classical period, the flute had been created in the key of D as the natural note. But the London flute makers, Florio, Gedney, and Potter created a longer foot joint to accommodate the lower C. This created the basic flute range that is seen today, what is considered the ‘C flute.’ With the increased length required to create the broader range, more mechanical keys were added to produce the new C-natural and C-sharp keys. These keys were placed on the foot joint and played with the right hand pinky. However, as innovation arises, new problems also arise. The mechanical key system was first cautioned against by most flute players, as the mechanical springs were
faulty and would wear out over time thus allowing the keys to be stuck open or closed. However the drawbacks of this new designs did not stop the new flutes from becoming the predominate flute by the end of the eighteenth century. This flute would later become known as the six to eight keyed flutes.

At the beginning of the nineteenth century, two more flute designs arose, which set the tone for the romantic innovations of Theobald Boehm. Frederick Nolan, a British flute maker, patented a system where mechanical key mechanisms could be linked and paired. Nolan did this by creating a ring that was positioned over a finger hole that did not have a mechanical key. Thus, when the player had their fingers on the finger hole, they would push down on the ring so that both the hole and the tone hole attached to the ring, would close simultaneously. This had not be created before on the flute and set the foundation for later mechanical systems. The second patent, by another London flute maker named George Miller, created the cylindrical metal bore. This metal flute body was originally designed for military flutes, however his patent covered all flute bodies, including orchestra flutes. Even though metal flute bodies had been created in the past, these earlier metal flute bodies had very unstable intonation and tuning due to the poor metals used and the fundamental design followed the baroque design, which was severely affected by the changing environment. With the new six-keyed and eight-keyed flute system, this allowed for far improved intonation and sound resonance due to the metal and design. The metal body flute, which would continued to greatly evolve in the years to come, would prove to be the most popular choice for the modern flutes. However, at the turn of the nineteenth century, wood flutes continued to be the
most popular flute material. But with the creation of the linked mechanic key system of Nolan, and the cylindrical metal flute body, gave a glimpse of the flute of the future and set the stage for creation of the modern flute in the romantic period.

At the turn of the nineteenth century, the flute was still not considered by many composers to be a practicable instrument to have wide use in the orchestra or solo works. Composers in the romantic period were exploring all different keys and modulation combinations. Furthermore, the expression of the music was of great importance with new music. For this reason, the poor intonation and drawbacks of the older flute system could not keep up with the evolution of music. Thus, composers would write less interesting flute parts, where the flute would be by itself in small solo role or as small addition of sound texture to the chord or melody. Even though the older flute systems had come very far, the instrument did not have perfect equal temperament throughout the flute range. For this reason, it required a great flutist to adjust according to the intonation required, of which there were few to come by who could adjust accurately. Because of this drawback, the newer flute designs, including the six-keyed and eight-keyed flutes, became much more popular during this time period. The eight-keyed flute, for instance, became popular because the system was meeting the demand of the music being composed at this time. The eight-keyed flute system would later be coined as the old system or the German system, since the major manufacture for this style of flute was Meyer Flute, based in Hannover, Germany. Regardless of the improvements and modifications of the old German system, it later took a completely new flute design to fix all of the problems that arose from the German flute system – the Boehm system.
Theobald Boehm

Theobald Boehm lived from 1794 to 1881, and worked as a goldsmith, jeweler, virtuosic flute player, composer, and inventor. During this time, he created an entirely new flute design through experimentation and innovation. Boehm was a very virtuosic flute player and felt the problems of the older flute system was a failure and could not be improved on. In his essay on flute construction, Boehm states,

“There is no doubt that many artists have carried perfection to its last limits on the old flute, but there are also unavoidable difficulties, originating in the construction of these flutes, which can neither be conquered by talent nor by the most persevering practice.”

Thus Boehm, like the early London flute makers, decided to create his own flute system. He would later become well established in the music and science community, when he received honors from the Academy of Science in Paris for his work on the new flute system and acoustics of the flute. The Boehm system grew and evolved and set the tone for modern flute construction that is still used today.

When Boehm first attempted to change the flute design, he first turned to other flute makers to construct his flute design to his specifications. However, these earlier flute constructions by other flute makers were not sufficient enough to meet Boehm’s demand. Boehm’s earlier flutes were made with lack of precision and knowledge, and were thus destined for failure. Boehm felt that he was the only one

who could make the flute to his specifications accurately. Luckily, Boehm had a history of metallurgy.

In his younger years, Boehm worked for his father, who was a jeweler and goldsmith. Because of this job experience, he had extensive knowledge of how to work with various metals. Thus by 1810, Boehm taught himself the principals of flute construction. After teaching himself the construction of the flute, Boehm opened his own shop to construct his new flute designs. Boehm felt that the first step to a more perfect flute was quality flute construction and design. Boehm states in his essay on flute construction:

“Spend time and care for the construction and practising of a completely new flute, which with the purest intonation possible, consonance and fullness of tone and together with an expedient mechanism makes possible the performance of every musical figure.”

Throughout his lifetime, Boehm strived for the perfect flute that could play any figure with ease and proper intonation. Boehm wanted to create a flute that didn’t need cross fingering for intonation on any note or a second invention to fix tuning problems such as telescoping tubes. Boehm also wanted a clean and clear sound that included an easier fingering system throughout the range of the flute. Because other flute makers did not create the flute, which could meet his expectations, he started creating his own flutes and designs.

Boehm finished his first flute in October of 1828. This first flute became a success in its sound and quality of tone. This flute design was a re-modification of

the known key system from previous flute designs, however, he included some major modifications, including a tuning slide, hardened gold springs, and mounting of keys on screwed in pillars. All of this was part of his introduction to testing of his theories. Even though this flute was only a test flute, it became his professional flute of choice. Boehm is quoted as stating, “I began to construct... a better sort of key mechanism than was in use previously; and before the year was over, I had finished a flute which met with general approbation for quality of tone and intonation, as well for elegance and solidity.”

Boehm continued to innovate and perform on his own self produced flute system. In 1831, while he was performing, Boehm observed another contemporary virtuoso flute player in London, Charles Nicholson. Boehm was impressed by Nicholson’s quality of tone and sound, but analyzed the reasons behind it, saying,

“I was struck with the powerful tone which Charles Nicholson played... This was owing to the uncommon largeness of the holes of his flute, and the consequent freer development of the notes, but it required Nicholson’s extraordinary talents and excellent embouchure to conceal the defects of his flute in regards to intonation and equality of tone- defects which were owning to the incorrect position of the wholes.”

Boehm realized that the reason that Nicholson’s tone was better, despite the old flute system, was because of the modifications Nicholson made to the flute himself. By enlarging the flute holes, it allowed for greater tone resonance. However, Nicholson still had to compensate for the poor flute design with technique and skill. This showed a deeper underlying problem that the old flute design had; that even a

---

20 Toff, *Development of the Modern Flute*, 46.
22 Ibid, 7.
masterful flute player had to compensate in order to get close to the proper intonation, and even then, they had to make their own modifications.

**Boehm Patents**

The Boehm system evolved approximately three times through his three different patents on the flute construction. The three main patents on his construction of flute were the patent of 1831, the patent of 1832, and the patent of 1847. The first patent was a mere improvement of the older system, as he was still learning and understanding flute acoustics. The second patent fixed the problems within the sound production and tuning through the use of larger tone holes, a silver ring system for tuning, and most importantly, the creation of a rod system for controlling multiple mechanisms at once. The third patent of 1847 was a vast improvement of all of the systems that came before. Before the third patent, Boehm did fast experiments on acoustics of the flute and founded many principals that changed the flute design dramatically. These changes produced many innovations and created the basis of modern flute construction today.

**1831 Patent**

The 1831 patent was composed of two simple fixes to the older flute system. This included altering the A key position and changing the spacing of the left hand tone holes. Essentially, Boehm took the older flute system and altered it a bit to bring better qualities to the flute. Thus, this flute still struggled with the same
problems as before but with less awkward fingerings for the A, F, and F-sharp fingerings.

On the older system, the A tone hole had to compromised due to the constraints of reach for the human hand. Thus, the A tone hole was moved up on the flute body. This however raised intonation problems for the A note and all of the tone holes thereafter. In the older flute systems, to adjust for intonation instability, one would cut the A tone hole smaller to help improve intonation. However, this was met with only marginal success. With the 1831 patent, Boehm moved the A hole back to its true position, while creating a key mechanism to accommodate the reach of the human hand. Thus the intonation was greatly improved with A note, along with better stability for the rest of the flute.

The second improvement included adjusting the spacing of the lower tone holes on the right hand. This brought better balance and control to the flute’s intonation. Boehm created a new double joint right key for the E and F-sharp key. This mechanism allowed the player to close two tone holes simultaneously with his first finger on the right hand. This eliminated both the awkward forked fingering in the right hand for F-natural and allowed for the F-sharp to be played with just the right hand third finger. These improvements were small in compared to later innovations, but according to Gerock and Wolf prospectus, created a flute that had,

“Firmness, Equality, and Richness of tone, which have never been altogether combined in any other description of flute. Simplicity of mechanism in regards the fingering. Facility in filling; producing sweetness and freedom up
to the highest C; and unexampled capabilities for the more delicate graces of expression which belong to a finished style of execution."\textsuperscript{23}

This supports the idea the Boehm was on the right track for his flute construction and that others during this time period supported his innovations and techniques.

\textbf{1832 Patent}

The patent of 1832 broke away from the old German flute design completely with a new adjustment in tone holes, tuning, and mechanism design. The only major similarity that was carried on from the older flute system was the use of wood for the main body. In this flute design, Boehm found the exact natural pitch of each note through personal experimentation of cutting wooded tubes to specific lengths. Through trail and error, he discovered that the tone holes would needed three things; to be more spaced out, for the holes to be moved closer to the embouchure, and for the tone holes to be expanded as much as possible. The expanded tone hole idea came directly from observing Nicholson and seeing his improved flute design, which included larger tone holes. Boehm applied this to his new flute design and created firmness and quality of sound in the first two octaves of the flute with much success. However, he also discovered that the third octave was unstable.

Through experiments, he discovered the harmonics of the vibrating sound in the flute required the fundamental tone hole needed to be open. Furthermore, the fifth note above each note needed to be open in order to allow for venting and

\textsuperscript{23} Toff, \textit{Development of the Modern Flute}, 53.
proper intonation. This created a major flaw in the design of the 1832 patent.

Although the patent stabilized the first two octaves, the use of larger tone holes created a problem of keeping the fifth above hole open. In essence, Boehm created a flute consisting of fourteen tone holes but only had nine fingers to cover the holes. Because of this flaw, Boehm created a new mechanical system for the flute using rods and axles. This flute design is the basis for flutes created today. With this new rod and axles mechanism, multiple mechanisms could be utilized at once, thus allowing for all the fourteen tone holes to open and close properly to fulfill the acoustic requirements of proper intonation. These rods and axles ran the length of flute attaching to many of the different key rings and mechanisms. Boehm then created a new fingering system to best accommodate the new flute, which will lead to today modern fingering system. This created a simpler fingering system and a more in-tune flute.

Another interesting design aspect of the patent flute of 1832 was the use of tuning rings on the newer flute. Boehm felt that the tuning slide of the early flute design left the sound quality lacking due to the friction caused by the gap in the internal tube needed to shorten or lengthen the tuning slide of the head joint to the main body. For true tuning, Boehm felt that the inner tube had to be as smooth as possible. For this reason, the head joint was required to be pushed all the way for a flush fitting. However, it was not guaranteed that the flute would be in tune when pushed all the way in. For this reason, Boehm created silver rings that attached between the head joint and flute body. To adjust for pitch, one would add more rings between the flute head joint and body to lengthen the flute to lower the pitch, and
alternatively remove rings, thus shortening the flute body to raise the pitch. This tuning system was adequate, but was insufficient for fine-tuning. This system of tuning, which is an example of Hotteterre *corps de réchange*, fell out of favor, especially after the next flute patent was created in 1847, due to better construction techniques and materials.

Boehm often demonstrated his new flute designs through his own personal performances, and the flute design of 1832 was no different. He first demonstrated this new flute design during his performances in Munich in November of 1832. He continued to perform, utilizing his new flute design for three more years. In 1835, Boehm traveled to London to demonstrate his new flute design. Throughout the three years, he had only sold one flute. Although flutists of the time were amazed and appreciative of the quality of sound and stability throughout the flute range, they felt it was unpractical to learn a new instrument with an entirely new fingering system from that of the older already established flute system. Furthermore, flute makers found that his design was not profitable enough and was very inconvenient, as it required a very new style of key mechanisms, which until this time was contained to only a few keys. Boehm himself stated,

“Many flute players and instrument makers examined it, but most of them were discouraged by the new system of fingering. Flautists of old standing decided against it because they could not resolve upon studying an entirely new instrument; and possibly, the sometimes saw with displeasure that young artists, by adopting it, acquired an accession of means for producing greater effects in their performance. Most of the instrument makers were
against it, because they found it inconvenient or un-profitable to imitate a sort of key-mechanism quite new to them."

This was incredibly disheartening to Boehm, and he would forever look at his patent of 1832 as a failure. Most likely because of this failure, Boehm left music to study iron and steel production more thoroughly. He would not return to music for some time.

Other Flute Makers’ Contributions

While Boehm studied other subjects, other flute makers took Boehm’s design and set out to improve upon it, seeing the great potential it held. The biggest problem with the 1832 patent flute design was the fingering system associated with it and the rod mechanism that attached to the flute. Boehm designed the rod mechanism to run along both sides of the flute body. However, this seemed crowded and uncomfortable in the flute player’s hands. Furthermore, some of the fingering of Boehm’s new flute system could be characterized as awkward in comparison with older flute fingerings. Thus, three flute makers, Auguste Buffet, Victor Coche, and Vincent Dorus added simple but important modifications to simplify the rod and axle system and help with hand conformability and fingering system. These three flute makers created a rod system composed of rods and sleeves. A rod could run down the body of the flute and could run multiple mechanisms and keys at once. However, for better placement, all of the rods were placed on one side of the flute

---

24 Toff, Development of the Modern Flute, 61.
body. This lead to complications, as one rod would be in the way of another, which hindered the use of multiple key mechanisms. For this reason a sleeve was placed around the rods. By using a sleeve, both the inner and outer rods could work separate mechanisms without blocking each other. This allowed for a more comfortable flute and simplification of fingerings.

**Boehm’s Return to Flute Construction**

In 1846, Boehm returned to the music community and flute construction after he studied acoustics at the University of Munich in Germany. Through many experiments, Boehm discovered the exact mathematics required for the flute proportions. He also understood the science behind sound production, affect by materials used in construction, the difference between conical and cylindrical flute body designs, and the affect of different head joint designs. During this period of testing and experimentation, Boehm refined the design of the flute using a scientific method, which lead him to discover how to create a proper, well-balanced, modern flute.

Boehm first experimented with resonance and vibration patterns, which created different pitches through the flute body. He discovered that the proportions of the flute and precise locations of the tone holes significantly impacted the speed and vibrations of the air resonating through the flute body. He discovered this though experimenting on multiple pieces of wooden tube cut to different lengths. Boehm found that although one octave could be tuned through shifting the holes positions, larger holes were necessary for many reasons, as he already discovered
previously. It was through his scientific method however, that Boehm determined the reasoning behind the larger tone holes. There were several reasons that Boehm discovered. The first was that the larger holes created more power, thus leading to a more stable sound. The second was that smaller holes lead to an unstable sound, which loses clarity. Also, when drilled as close to the correct positions, the power behind each note grows substantially. Also, according to Boehm, with small holes, "the undulations of air often come to near nodes of vibration; and their formation being disturbed or rendered uncertain, the ton sounds with difficulty, or easily breaks into notes answering to the aliquot parts"\(^{25}\) Furthermore, the third octave relies greatly on the correct positioning of the tone holes, as the third octave was unstable in general, so requires greater precision to keep the stability functional. With his theory proportions, Boehm also learned the appropriate length the flute, the ratio of size of the flute bore to the size of the tone holes, and the distance of cork placement in the head joint. These new adjustments to the flute created a perfectly balanced flute that had good tone and quality of sound that contributes to proper intonation through out the flute range.

Furthermore, Boehm experimented with the shape of the main body. He compared a conical tube versus a cylindrical tube. Boehm noticed that most other instruments had one of two different designs, conical or cylindrical. Most instruments, such as the oboe and clarinet were narrower at the mouthpiece of the instrument and expanded toward the end of the instrument. Organ pipes on the

other hand were cylindrical in design. However, no other instrument had a counter-conical design, which was seen in previous flute design. With the flute design, the head joint was the largest area and then the flute body tapering down all the way to the foot of the flute. Boehm found that this design was largely counter productive, which further contributed to the instability of the flute throughout the flute range. This is because the counter-conical shape of the flute fundamentally threw off the intonation and stability of the entire range of the flute. For this reason, Boehm suggested that the flute should only have one slightly conical section, which was the head joint. He suggested that the head joint be slightly smaller than the body, but that this difference should be very slight, and the rest of the body should be cylindrical in shape, rather than tapering down. As Boehm was adapting the mouthpiece to slightly get larger towards the body of the flute, he also included a mouthpiece called a lip plate. This device helped the player focus the air across the embouchure hole at a specific angle of nine degrees, which in turn eliminated the sound hiss of the air as it expanded across the head joint, creating a much more clean pronounced sound.

Another innovation was the use of metal as the main material for the construction of the flute. Boehm examined different woods during his experiments of sound proportion and found he received and clearer results when he used brass tubes instead wood. Boehm continued to experiment with different metals to see their different effects on sound quality. After experimenting with several metals, Boehm came to the conclusion that different metals created different timbres and sonorities. For example, softer metals tended to yield a soft, weak tone. On the other
hand, harder metals, such as German silver, provided a bright, shrill tone. Boehm discovered that silver and brass tended to yield the best results. Furthermore, metal was not subject to the same problems as wood due to the environment and humidity. Metal would not split or break, or be affected by a change of temperature as much as wood was at this time. Silver was a lighter, more durable, better sounding material than wood, and superior in many ways. Boehm stated that, “The superior excellences in regards to tone and intonation of my flute, made entirely of sliver, when compared even with my newly constructed one of 1832, was so striking that it was remarked by everyone immediately.” In continuing with these discoveries, Boehm compiled a list of principles to be utilized in flute construction. These principles included:

“1. That the strength, as well as the full and clear tone of the fundamental notes, is proportional to the volume of air put in motion.

2. That simple vibrations can be most perfectly excited in large tubes having a contraction at the embouchure.

3. That every modification in the diameter or length of the contraction has a great influence on the emission and intonation of the aliquot (harmonics) parts.

4. That this contraction must not be made in straight lines, but in curves.

5. That, moreover, the divisions of the column of air into the aliquot parts, or the formation of vibrational nodes—in short, all phenomena which appear in a vibrating column of air—are exhibited in a cylindrical tube is the best adapted for the construction of a flute.

6. That cylindrical tubes with the cone, as applied by me, at the upper end may be considered as entirely cylindrical; since the influence of the con on

26 Böhm, On the Construction of Flutes, 34.
the pitch is so insignificant, that in a tube with the fundamental note C it scarcely occasions a difference in length of 0.00492 ft."\textsuperscript{27}

With these principles in mind, Boehm would go on to produce a patented flute which would surpass the previous flute design in every aspect.

\textbf{1847 PATENT}

Boehm utilized all of the scientific findings he discovered during his time as a acoustics major at the University of Munich to develop his new flute design. For this improved design, he created a flute with a cylindrical body, which was made entirely of silver. The head joint consisted of properly placed cork to help with ease of sound production throughout the flute range. Furthermore, the head joint featured a lip plate to help the player focus the airstream at the right angle for best sound quality.

Boehm built his new key mechanism off of the improvements made by Buffet, Coche, and Dorus. Boehm took the sleeve and rod system of these flute makers and added it to his own new flute patent. Furthermore, Boehm made slight improvements and modifications to better fit the proportions of his new flute design to fit with his improved tone hole placement. Boehm also made the flute more responsive by giving each key mechanism its own individual needle spring, which was a much stronger, more reliable spring system that kept the key off of the tone hole until pushed manually. Also, Boehm invented new pads that consisted of felt

that were wrapped in a fine membrane (skin) for proper closure of the enlarged tone holes. This membrane gave a consistent seal and mimicked the human hand.

The flute of 1847 was very well received by the entire flute community, and quickly became the flute of choice for both professionals and amateurs alike. This new flute came with an entirely new fingering system that required flutists to learn in order to operate the new flute. Even so, individuals clamored to buy the new flute, as the vastly better quality in music production far surpassed the requirement of learning new finger techniques. Boehm had finally created the perfect flute that he was looking for; a flute with brilliant sound and pitch that had evenly balanced intonation throughout the flute range. Boehm stated that by utilizing the new patented flute construction, “The acoustical proportions for a flute being now exactly ascertained, and given in numbers, it is not difficult to make perfectly tuned flutes, be it flute d’amour, concert flute, or octave flute of any given pitch.”28 This new flute of 1847 opened new horizons for flute composition in its ability to play any music available.

Modern Flute Developments

After the Boehm system and the arrival of the modern flute, there have been many attempts at improving the Boehm system. In the 1800s, many modifications arose by different flute manufactures, such as Armstrong, Murray, and the Borne-

28 Böhm, On the Construction of Flutes, 35.
Julliot. Some of these modifications continue to be used today, however many of the modifications created fell into oblivion due to the over-complication of manufacturing and fingering techniques. For example, the auxiliary G sharp lever was used to trill between F and A, but was unnecessary due to developing fingering techniques. By the mid-twentieth century, the modern flute design returned to a simplified Boehm system that resembled Boehm’s original design, but with some key changes.

During the 1800s, a few of the modifications that were created did improve upon the Boehm system, and continue to be seen in the creation of modern flutes. The Briccialdi B-flat key is an addition to the modern flute that has improved upon the Boehm system and remained with modern flute design. The Briccialdi B-flat key was invented by Giulio Briccialdi (1818-1881). Briccialdi was Italian virtuosic flute player who wanted to have an alternative way of playing B-flat other than the only way presented in the Boehm system by use the left hand first finger and thumb and right hand first finger. Briccialdi added the alternative B-flat key over the thumb B key and linked it to the B-flat lever in the right hand allow for B-flat to be played by just the left hand first finger and Thumb B-flat key. Boehm later designed a B-flat thumb key after Briccialdi that was placed below the regular B thumb key on the flute body. Boehm felt that his key was superior and more logical in placement than Briccialdi’s B-flat key. However, history has shown with modern flutes today that the Briccialdi thumb B-flat key prevailed.29 Another notable addition to the Boehm

29 Toff, Development of the Modern Flute, 73.
system is the contribution by Djalma Julliot and François Borne (1840-1920). Julliot was a French flute manufacturer and Borne was virtuoso flautist and professor at the Toulouse Conservatory in France. Julliot and Borne contributed to the split-E and split-G keys. (The flute book, 58) These key modifications fixed the sharp tonality of the production of the third octave E by rearranging the movement of particular key mechanisms when linked with other key mechanisms. This created a better quality of sound for the third octave E without drastically changing the fingering required.  

Another modern development is the C-sharp trill key. This key was patented in 1902 by J Thibouville-Lamy & Cie; the C-sharp trill key give the main benefit of allowing an easier trill from C to C-sharp, B to C, B-flat to B and third octave G to A. The fingering with the trill key allows for greater ease of trilling between these notes by using one finger to operate the trilling action. Previously, this trill required a long fingering between the two notes, which incorporated the manipulation of many fingers simultaneously. Furthermore, the C-sharp key, when used in conjunction with other fingering, results in a better tone and stable note in the higher register notes.

A more recent modification to the modern flute is the creation of the O-ring within the headjoint. The modern headjoint has seen many new developments in design and structure. However, the most notable headjoint modification is the incorporation of the O-ring within the flute's headjoint. Originally, the top of the

30 Ibid, 134.
headjoint was plugged using a cork. Cork is prone to swelling and shrinking over
time due to moisture. Thus, as the cork shrinks, it does not create an air tight fit to
the headjoint tube and allows for an airy sound and unpredictable intonation. For
this reason, the cork within the headjoint has to be replaced from time to time.
However, the new O-ring does not have these problems. Instead, it is created using a
synthetic rubber that creates a perfect seal in the headjoint tube. Also, this rubber
does not expand or contract with moisture, thus not needing to be replaced over
time. The O-ring is a modern solution to a traditional design flaw of using cork
inside the headjoint.31

As modern flute manufactures developed new flute designs, the material in
which the flute was produced was also experimented with. The flautists found that
the headjoint material dramatically altered the flute’s sound overall. Just as Boehm
discovered in his original test that the different types of metal created different
sounds due to the hardness of the metals, modern flautists discovered that exotic
materials could produce different timbres. Modern flutes are constructed of many
different materials, including silver, nickel, gold, platinum, or a blend of these
metals. Gold tends to produce a mellow, rich sound due to its density. However,
platinum, because it is far more dense and hard than gold, produces a brilliant clear
sound. Most flutes today are constructed of silver, but there is no limit to the
material in which a flute can be made of. In recent years, flutes have also been
constructed out of acrylic or plastic tubes, and can even include led lights. These

31 Toff, Development of the Modern Flute, 128-179.
flutes produce a different timbre all together, and demonstrate the vast range of materials that a flute can be made from.\textsuperscript{32}

\textsuperscript{32} Toff, \textit{Development of the Modern Flute}, 184.
Impact on Music

The new flute that Boehm created in 1847 dramatically affected how composers wrote works for the flute. The older German flute system, along with the inherent inadequacies associated with that system, left composers very restricted in what was possible for flute performance. As stated before, music in the romantic period progressed rapidly to fit the trends of the musical development. As music become more virtuosic and expressive, the older flute system hindered even the best flute players, leaving them to only play simpler pieces from the classical period.

According to Galway, In the classical period, the flute was seen as merely a tone color for orchestral writings. Composers such as Mozart and Hayden did not trust the flute’s ability to maintain pitch, and so the only times they gave the flute a major section of music was when they played with another instrument, such as the oboe, so that they would have an instrument to tune to. Furthermore, Mozart did not always write the flute into his orchestral pieces. When he did, it was often a conservative piece, played with another instrument, or written for a double flute part, due to the older system’s inability to reach full volume in an orchestral setting. All of these considerations were probably due to the inherent problems that went along with flute techniques and instability. But even with all of these problems, the flute continued to grow in popularity and ability throughout the Classical and Romantic periods.

33 Galway, Flute, 38.
Moving forward into the romantic period, the Boehm flute, along with its ability to manage intonation and pitch with more control, allowed some composers to explore the color tone presented by the silver Boehm flute. This includes composers of the later romantic period, who were more willing to write specifically for the flute. For example, the new flute abilities allowed Debussy to write *Prélude de L’Après-midi d’un faune* and *Syrinx*, which featured the flute in the opening motif of the work. The descending chromatic scale utilized by the flute in the opening would not have been possible while utilizing the old German system. Without Boehm system’s effect on modern flute tuning and control, many of the works during this time period would have been impossible without the correct intonation and stability of the modern flute.

The music of the early romantic period was growing in expression and virtuosity. One can observe this in Paganini’s *24 Caprices* for violin; a collection of etudes that stretched the limits of what was considered possible to play on the violin. But early romantic solo flute music was still in its infancy and not really explored. Boehm really helped establish the beginning of virtuosic flute performance with repertoire. As Boehm was inventing his new flute system, he composed new music to highlight the abilities and stability of the new flute system. Boehm’s works, such as *The Grand Polonaise* were a direct effect of the improved flute design and exploration of flute virtuosity. The piece explores the entire range of the flute. Without the ability to control intonation, ease of technical fingering, and stability throughout the entire flute range, this work would only be possible for the most masterful players on the older German system or possibly, impossible.
The Grand Polonaise pushed the flute’s techniques and music control to the
edge with the rapid melodic figures, lightning fast scales, and technical patterned
phrases. For example, Boehm writes in a small cadenza in bar 218 that is an
ascending chromatic triplet sixteenth figure. With Boehm’s improved fingering
system, this passage is technically easier and the player has more control over
intonation than what would have been possible with the older German system. With
the older system and the use of cross and forked fingers to adjust for pitch amongst
the chromatic range, the passage would be in tune and would be noticeable, even to
the untrained ear.

The improved finger system, control of notes, and improved intonation, gave
all flautists equal opportunity to explore any melodic figure they could imagine. This
includes the exploration of flute arrangements, which were taken from other music
genres. Since the improvement of the flute, flautists explored various genres to
expand the capabilities of the new flute. One such flautist was François Born (1840-
1920). Born was another famous flautist who sought to explore his own abilities.
Born decided to sample from Bizet’s opera, “Carmen”. With this, he took the many of
the themes from Carmen, including the habanera theme that the character Carmen
sings to the soldier, and arranged an entire fantasy for flute and piano. This work
not only explores and demonstrates the abilities of the new flute system, but also
shows that the flute can take on the characteristic of other genres and can even
imitate vocal style.

34 Theobald Boehm, Grand Polonaise, in D Major, Opus 16 (New York: International
Music, 1977), 12.
Flute virtuosic exploration also includes other arrangements from other instruments. This is seen in the arrangements for solo flute in Paganini’s 24 Caprices. These works were originally written for violin, and expanded the boundaries of what was considered possible for the violin. The same effect was created when the piece was transcribed for the flute. Each arrangement interprets Paganini’s original violin version differently; the violin can perform certain musical effects that the flute cannot, such as chords and possessing a very wide range. Thus, some of the individual variations lend themselves to be performed by violin. However, the flute interpretation created a very difficult interpretation by stretching the flute’s range to meet the violin’s. Furthermore, in most interpretations of the 24 Caprices, the violin is often playing chords. Since the flute cannot play all the notes in the chord simultaneously, the flute interprets the chords as arpeggiated figures. The faster one can play the notes within the arpeggiated figure, the more the resonance of the chord comes out.\textsuperscript{35} Thus, arrangements really expanded the technical abilities of the flute. The difficulty of such music is extremely hard, even when played on the modern flute system, but would have been impossible for the older German flute system.

Another romantic work that demonstrates the newly developed flute is Fantasie by Georges Hüe (1858-1948). Hüe bridges the gap from the romantic to twentieth century musical period. Also, Hüe was born after the development and establishment of Boehm flute system. Thus, Hüe would have not known the other

\textsuperscript{35} Niccoló Paganini, 24 Caprices Opus 1 for Solo Flute (New York: International Music, 1975), 3.
system except through education about the flute. Because the flute had a clear tone and beautiful sonority, Hüe choose to write his *Fantasie* for flute instead of any other instruments. Hüe’s *Fantasy* explores the full breath of the flute abilities including intonation, volume, and difficult melodic and chromatic figures. As stated before, Mozart often would not write for a singular flute in his orchestras due to lack of volume and power. Furthermore, the flute was often written with the notion that chromatics would always play a part in poor intonation and was not often written for flute. These pitfalls of the flute were obvious, as seen in flute music in the early nineteenth century. However, later in the nineteenth century, the flute repertoire increased dramatically with music such as the Hüe *Fantasy* that regularly explored the areas previously untouched by composers due to the shortcoming of the older flute system.

The impact of the Boehm system continues to resonate today. The expansion of what is possible still penetrates flute compositions in the twentieth century. Even modern influences have added to flute repertoire to do the flute’s ability to perform almost any melodic figure. Jazz has impacted the flute repertoire and inspired composers to write new interesting flute music that further expands the repertoire of the of the modern flute system. A composition that demonstrates the modern interpretation of the flute is Robert Muczynski’s (1929-2010) *Sonata for Flute and Piano*. Muczynski was a famous pianist and wrote for many different instruments. Muczynski’s flute sonata includes the influences of jazz upon the flute repertoire. The Sonata consists of four movements, each with their own individual technical problems and ideas. Over the course of the four movements, the player must
overcome intonation and tuning from leaping from the bottom of the flute range to the top of the flute range into the third and fourth octaves. Furthermore, Muczynski explores the flutes abilities in very technical passages that would have been impossible with the older German system due to the complex cross fingerings and intonation difficulties. The Boehm system and its development allowed the modern flautist to explore the abilities of the Boehm system, branch out into new genres, and to incorporate other style, such as jazz, into the flute repertoire.

The Boehm system created a much easier technical fingering system throughout the range of the flute. Thus, many awkward cross fingerings and forked fingerings were eliminated. Furthermore, the more precise placement of the tone hole allowed for flautists to devise fake fingerings and harmonic fingerings due to the stability of the harmonic design for the Boehm system. Fake fingerings allowed for easier flute passagework in higher ranges through the use of fingerings of notes that are one octave and a fifth below the desired note. This is produced by overblowing the lower note, to which one would produce the same note as the higher, desired note. Furthermore, harmonic fingerings allowed the flute to produce hollow sounds or multiple pitches at once, thus a fundamental pitch to be sounded with the other relative pitches to resonate above the fundamental pitch. An example of a composer to take advantage of harmonic is Ian Clarke. Clarke is a living composer who was inspire by trains to write the musical work *The Great Train Race*. This musical work uses flute harmonics to imitate train sounds and whistle

---

with great effect. Without and well-balanced flute system such as the Boehm system, this music would be impossible to play. Although Boehm mostly did not foresee these two techniques when he was creating the Boehm system, it was only through the development of this system that the new fingerings are possible. These abilities have had an impact on today’s composers, allowing for new interpretive music to be created for the flute, as the flute can create sounds that most instruments cannot.
Conclusion

The evolution of the flute expands the breadth of human history, from primitive early flutes to today’s modern metal flute. However, compared to many other instruments, the flute has a central point in time where evolution affected the course of flute composition and development forever. Before the Boehm system, any improvements on the flute were merely small fixes to a larger fundamental problem. Thus, the music repertoire for early flutes represented the limited abilities of the early baroque flute and composers cautiously composed for the flute, if at all. After the advent of Boehm system, a renaissance in flute composition and exploration can be seen. This renaissance has continued all the way up to the twenty-first century. Today’s composers and flute players continue to push the limits of the Boehm system and modern flute, and are constantly improving upon the design and techniques. Without the dramatic improvements made to the flute, the world would surely be lacking in the vast virtuosic music and flute performers throughout history. Some of the most recognized music of our time hinges on modern flute solos, such as the works of Debussy, which in turn inspired the composers, which came after them, such as Hüe and Clark. The development and establishment of the Boehm system not only affected the flute repertoire, but all music composition.
Bibliography


