NOTATION AND PERFORMANCE OF AVANT-GARDE LITERATURE FOR THE SOLO FLUTE

BY

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To my parents, who were convinced that all things are possible if time and effort are applied diligently, and who bestowed this philosophy upon their children.

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By

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The purpose of this dissertation is to present the rudiments of acoustical theory and show the relationship between these theories and the new avant-garde techniques as they apply to the performance of solo flute literature. The opening two chapters are concerned with a basic explanation of the concepts of acoustical theory and a specific examination of the flute's construction and tone production based on these factors.

The next two chapters are concerned with the contemporary practices idiomatic to the flute. These devices are explained with an acoustical basis in mind. In addition, emphasis is given to multiphonics, which are explained acoustically, with examples of its usages and problems.

The remaining chapters include a general survey of contemporary notational practices. The exploration into acoustical phenomena resulted in new devices in composition and performance with the consequent problem of how to notate these new techniques. The various notational solutions reached by avant-garde composers and the problems these systems have created are discussed. A brief summary with recommendations is given in the concluding chapter.

Two appendices are included. Appendix A lists books and articles that supply fingerings for multiphonic sonorities for flute. Appendix B lists books and articles that supply suggested and/or accepted symbols used in contemporary music literature. Appendix C lists representative compositions of avant-garde literature for the solo flute. A bibliography is included.

CHAPTER I
INTRODUCTION

Need for the Study

The increasing popularity of contemporary instrumental music is becoming more evident in every phase of musical society. The emergence of various avant-garde or contemporary performing groups such as Scratch Orchestra,[1] the Italian ensemble Musica Elettronica Viva, and various university-based contemporary ensembles provide performance media that are more accessible to the composer and the audience than any that had previously existed.

Avant-garde music tends to view art "as a process of exploration rather than as a collection of objects."[2] This requires greater flexibility and adaptability on the part of the performer to act a dual role with the composer in the realization of the

1 Cornelius Cardew formed the Scratch Orchestra in 1936, as a group of musicians (not necessarily with extraordinary skills) willing to improvise and perform pieces that are unusual in being the results of group process of participation rather than the creation of individual composers or performers.

2 C. Small, "Contemporary Music and Contemporary Culture; Part III," Music in Education, Vol. 35, no. 348 (1971), p. 437.

composition. This new concept of the performer tends to point out a trend that is becoming more evident in twentieth century music. Two major attitudes toward composition have emerged; the traditional or conservative and the avant-garde.

The history of music has often been seen as primarily a history of technological change, "in tools, both physical and intellectual."[3] The two emerging attitudes exemplify this advance in technological change in their approach to the usage and expansion of the available 'tools' (SHMRG: sound, harmony, melody, rhythm, and growth),[4] and can be distinguished by which of these elements receives the greater emphasis and development. Robert Ehle aptly points out that "both the appearance of the music on the page and the performer's actions in performance provide clear evidence as to which of the two categories is involved."[5]

The avant-garde can be described as "those composers or works which display the newest technique (often anti-technique, i.e. silence."[6] This creates a great diversity in style because each composer is striving to create his or her own idiomatic medium while

3 R. C. Ehle, "The Dilemma of Contemporary Music," The American Music Teacher, Vol. 26, no. 1 (1976), p. 21.
4 J. LaRue, Guidelines for Style Analysis, (New York: W. W. Norton and Co., Inc., 1970), Ch. 1.
5 R. C. Ehle, "The Two Major Stylistic Episodes of Twentieth Century Music," The American Music Teacher, Vol. 24, no. 6 (1975), p. 26.
6 D. Cope, "A Post Avant-Garde," Composer (US), Vol 3, no. 2 (1972), p. 61.

simultaneously rejecting all other composer's ideas, in a constant search for "new" and "better" sounds.

The enormous diversity and expansion of the medium has resulted in many frustrations for the composer and performer alike. Basically, the issue is a communication problem; the composer's wishes versus the performer's reality.

Composers of contemporary or avant-garde music have gone beyond the bounds of traditional music in terms of limitations on the structure and components of musical compositions. Modern music "too often . . . is not understood by those performing it and is consequently not well played."[7] This often seems to be the cry of the performer and composer regarding avant-garde works.

With composers creating new devices and expanding old ones, the traditional methods of notating these devices become antiquated and insufficient. It is the performer who is "largely responsible for the eventual success or failure of a work, through programming it or not and giving a good or bad performance,"[8] and if performers are not able to understand the composer's intent, then the outcome of the performance is doomed.

7 James Galway, "An Interview with James Galway," Instrumentalist, Vol. 30 (January 1976), p. 45.

8 D. Bollard, "Some Observations on Musical Style, Interpretation, and Performance," Australian Journal of Music Education, no. 18 (April 1976), p. 25.

Do performers today understand contemporary composer's intentions? A government study on the analysis of student attitudes toward contemporary American music stated that "a lack of understanding of what the contemporary American composer is doing is an issue of paramount importance." Comprehension of the technical methods and concepts used by the composer "will aid in the ultimate approval and acceptance of the efforts of the composer by his audience."[9] By approving of or rejecting avant-garde compositions, the performer is making aesthetic decisions concerning the composer's statement of the human condition based on his or her own perceptions of the validity of this expression. In order to address this process fairly, the performer must master the various techniques and devices that are common to this genre of music.

An investigation of contemporary music educational material finds it lacking in thorough explanations to music students about the devices avant-garde composers are using, why they are using them, and how they want the final product to sound. This dissertation is meant to fill this particular gap in the written literature regarding contemporary practices and an explanation as to their bases and usages. To confine the study within

9 R. Hornyak, An Analysis of Student Attitudes Toward Contemporary American Music. August 1965 - March 1966, U.S.Department of A.E.W., Office of Education, Project #5-450(5-8288), p. 26.

attainable limits, the contemporary techniques examined will be those idiomatic to avant-garde literature for the solo flute. As musical expression expands, it becomes necessary for performers of twentieth century literature to increase their background in and familiarity with avant-garde techniques and the theories upon which they are based.

Purpose of the Study

The intent of this study is to present the rudiments of acoustical theory and show the relationship between these theories and the new avant-garde techniques as they apply to flute performance in twentieth century literature.

Content of the Study

Chapter II is concerned with a basic explanation of the concepts of acoustical theory. It includes an examination of the acoustical characteristics of various instruments. Following this chapter, a more specific look at the flute is presented. Its construction and tone production based on acoustical factors are explained.

The fourth chapter concerns itself with the contemporary practices idiomatic to the flute. "Sound per se is now of primary importance in the instrumentor's

arsenal of techniques."[10] Many of these so-called new devices are merely extensions or refinements of older established procedures and can be viewed with an acoustical basis in mind.

Chapter five deals with one specific type of practice that is in use in avant-garde music, the technique of multiphonics. An acoustical explanation and examination of multiphonics is included along with examples of its uses and problems.

New exploration and expansion into acoustical phenomena resulted in new devices in composition and performance and created a need for new techniques of notation. Chapter six deals with the problems of notation, including pitch; duration; articulation, timbre, and dynamics; aleatoric music and frame notation; and graphics.

The final chapter presents a brief summary of the study. It also offers conclusions and various recommendations for future study and planning. A bibliography is included.

10 G. Read, Contemporary Instrumental Techniques (New York: Schirmer Books, 1976), p. ix.

CHAPTER II
ACOUSTICS

Any investigation into twentieth century contemporary flute literature presupposes a practical awareness of acoustical theory. What is acoustics? How does it work? Why is this information important to a performer?

Primarily, acoustics is "that branch of physics which treats of the phenomena and laws of sound, soundwaves, and other vibrations of elastic bodies."[1] Further clarification of this definition more readily reduces it to a workable tool for the performer. Basically, sound is vibrations of air particles which stimulate the response of auditory nerves. These vibrations are caused by the displacement of a body, such as the prongs of a tuning fork. Internal forces develop within the body which return it to its normal position. Its momentum then carries it through its so-called normal or rest position to an opposite position, thus creating a contrary displacement. These bodies are referred to as elastic. An analogy that might help to clarify this action is to imagine a young tree growing in an open field. A momentary gust of wind forces the tree to bend southward.

1 Article "Acoustics," in Funk and Wagnalls New Practical Standard Dictionary (New York: Funk and Wagnalls Co., 1947), p. 27.

When the gust recedes, the tree straightens itself, but it does not stop at its normalupright position. Its momentum forces it northward and back again. This entire process continues until friction gradually slows down and eventually stops the motion. Graphically, it would appear as follows (see figure 1):

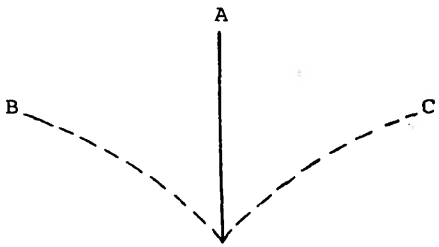


Figure 1
Graphic depiction of vibration

From A to C and back to A is referred to as a single vibration. Of course, this term also includes the motion A - B - A or C - A - B. The distance from A to C is known as the amplitude. The greater the amplitude (A to C) of the vibration, the louder the resultant sound will be. As amplitude diminishes, the sound fades away.

The motion A - C - A - B - A (or C - A - B - A - C) is termed a double vibration or a cycle. The number of vibrations or cycles that occur in one second is called the frequency. The frequency of the vibrations determine the pitch of a sound; for example, the frequency of a_1 at

concert pitch is 440 cycles per second. Smaller elastic bodies result in more rapid vibrations (higher frequency) so that the pitches of the corresponding sounds are higher. Pitch does not depend upon the amplitude.

Once a body is set in vibratory motion, sound waves result. Essentially, sound waves are alternating pulses of compression and rarefaction or, in different terms, the air moving alternately in states of contraction and expansion. This motion is subject to many varied influences that can affect its direction. One of the most common influences is reflection. Reflection results when the pathway of the sound wave meets an obstruction that is large compared to the wave. The wave is then reflected or bounced in a different direction, especially if the surface of the obstacle is hard. Upon encountering a softer surfaced obstruction, part of the energy of the wave is absorbed as it is transmitted. This changing of the pathway of sound is called refraction. Another change which the soundwave is subject to is referred to as diffraction. Diffraction is a bending of the pathway of sound around an obstacle.

A sound is rarely a pure sine wave, but is more often made up of a sine wave of the fundamental frequency and other sine waves of which the frequencies are integral multiples of the fundamental frequency. For purposes of

graphic representation, the fundamental sine wave is commonly used[2] (see figure 2).

Figure 2
Sine wave

This shows the rising and falling motion of the wave. Figure 3 illustrates the graphics of air particles moving within a tube: it represents one sine wave in each half of its cycle (from L to L), not two sine waves. The points of intersection are called nodes (labeled by the letter N - see figure 3).

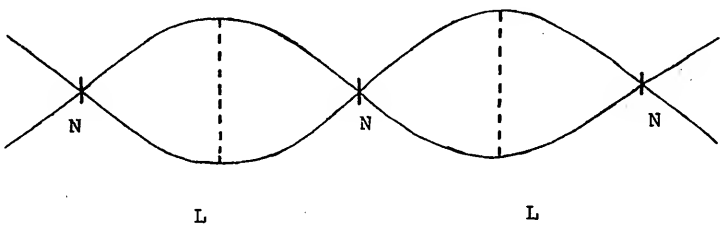


Figure 3
Graphic of air particles
within tube

2 Fourier Analysis of sound waves as discussed in J. H. Appleton and R. C. Perera, The Development and Practice of Electronic Music (New Jersey: Prentice Hall, Inc., 1975), p. 36.

Nodes are points of minimum amplitude or "in a vibrating air column, nodes are the points of highest density, where the air particles do not move."[3] The L in figure 3 refers to loops or antinodes which are points of maximum movement. The overall length of a wave is determined from a point in one wave to the same point in the next cycle (see figure 4):

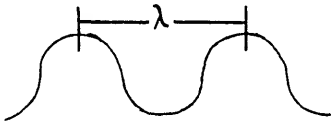


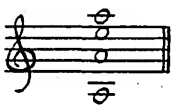
Figure 4
Length of a wave

Frequency and temperature are important factors in determining the wave length. Velocity of sound varies with the media which it must traverse. Its celerity also depends on wind direction, strength, and temperature. Leaving the first two factors to architectural acoustics, the importance of temperature becomes clear to a performer. The speed of sound increases approximately one foot/second for each degree (F.) rise in temperature. This variation of velocity with temperature is the principal reason why many wind instruments play flat when cold.[4]

3 Willi Apel, "Node," in Harvard Dictionary of Music (Cambridge: Harvard University Press, 1972), p. 575.
4 Robert Sabine, "Acoustics," in The International Cyclopedia of Music and Musicians (New York: Dodd, Mead, and Co., 1964), p. 10.

One last phenomenon of sound should be examined. It is the phenomenon of reinforcement through impressed force, or more simply put, sympathetic vibrations. Resonance is the term used to describe this effect. In a wind instrument, the air in the tube itself accomplishes resonance.

With the basics of acoustics covered, one can advance to the examination of the acoustical characteristics of various instruments. "All musical instruments produce composite tones consisting of many pure tones, called harmonics, produced simultaneously."[5] The musical tone itself consists of a fundamental (the harmonic of lowest frequency which due to its loudness determines the pitch of the composite tone) vibrating in conjunction with upper partials. Partials or overtones are the harmonics above the fundamental. Their frequencies are integral multiples of the fundamental's frequency ($\sum f_n = n, 2n, 3n, \ldots$). See figure 5.



880 = 4n
660 = 3n
440 = 2n
220 = n

Figure 5
Corresponding frequencies of
partials above their fundamental

5 Willi Apel, "Acoustics," in Harvard Dictionary of Music (Cambridge: Harvard University Press, 1972), p. 10.

The only difference between partials and overtones is a semantic specification. The second harmonic is also the second partial, but is known as the first overtone.[6] The aggregate of fundamentals and overtones is called the harmonic series. It consists of a fundamental and an infinite number of overtones. Figure 6 illustrates the harmonic series with a fundamental of c.

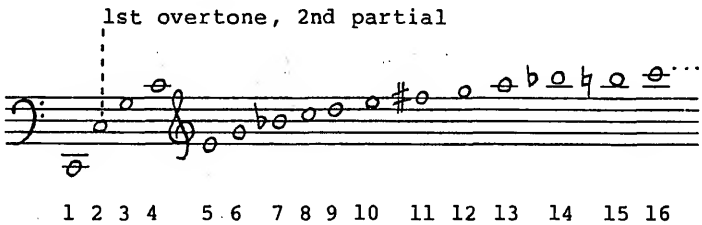


Figure 6
Harmonic series with c fundamental

A vibrating body vibrates not only as a whole, but also in segments of 1/2, 1/3, 1/4, etc. of its entire length (see figure 7).

6 Willi Apel, "Acoustics," in Harvard Dictionary of Music (Cambridge: Harvard University Press, 1972), p. 10.

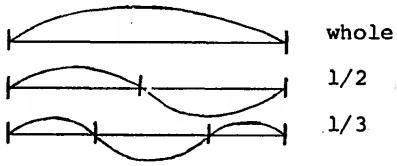


Figure 7

Pictoral representation
of vibrating segments

These secondary vibrations have a smaller amplitude than the fundamental and are therefore not as loud. Combined with the fundamental, these tones fuse and blend with each other so that the ear hears the tone as a whole. It is the varied number and comparative strength of these harmonics that create the character of a tone, its tone color or timbre. The attack transients of a tone (the manner in which it is begun on different instruments) have a substantial effect on the perception of timbre and, in conjunction with the harmonics that contribute to the tone, allow the ear to differentiate between the various musical instruments.

Tone production in a wind instrument results from the vibrations of the particles of air within the pipe much in the same manner that vibrations occur from a plucked string stretched between two points. The major difference is that in a string instrument the pitch of the string is affected by length, density of material, and tension. In

a wind instrument the pitch of the vibrating air column depends primarily upon its length. Doubling the length of the air column results in lowering the pitch one octave. (For example, see figure 8).

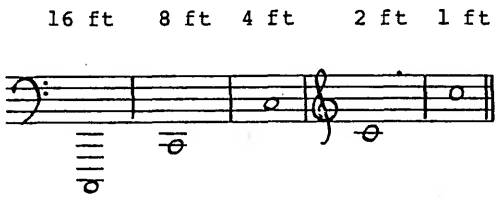


Figure 8
Length and corresponding
pitch of air columns

Pipes come in two distinct varieties. First are the open pipes, so called because they are open at both ends. Figure 9 illustrates this case.

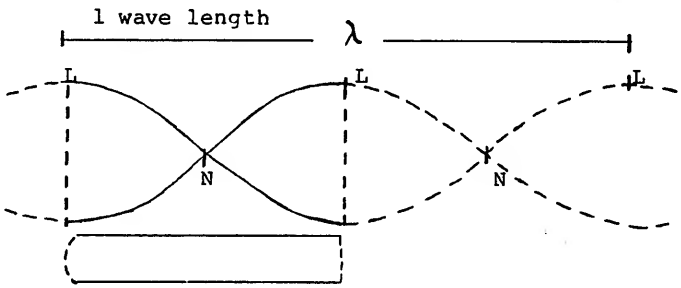


Figure 9
Open pipe illustration

As can be seen in the illustration, an important characteristic of an open pipe is that antinodes are located at both ends. These points (L) represent areas where changes in the density are greatest. Located between these antinodes is an area of high density where there is little change. It is a node (N). Recalling that a wavelength is measured from a point in the wave to a similar point in the next wave (⊢—— λ ——⊣), it can be seen (in figure 9) that the wavelength of the fundamental tone of an open pipe is twice the length of the pipe.

The second type of pipe is a closed or stopped pipe (see figure 10).

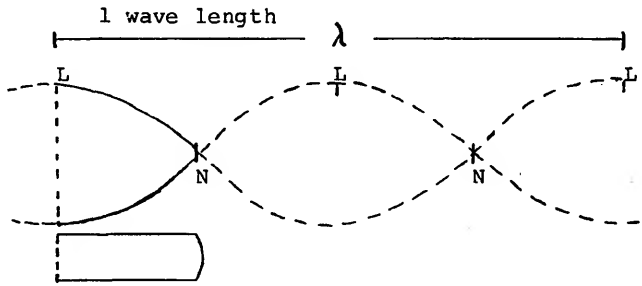


Figure 10
Closed pipe illustration

In a stopped pipe, a node (N) is always at the end and an antinode (L) is always located at the mouthpiece or beginning. Because wavelength is inversely proportional to frequency, the fundamental of an open pipe of a specified length is an octave above that of a closed pipe of the same length.

Another important difference between an open and closed pipe is the functioning harmonics that result from their different construction. Open pipes are capable of producing all the harmonics in the series, while closed pipes produce only the odd-numbered harmonics (see figure 6). Even-numbered harmonics can occur only when an antinode is located at both ends as in an open pipe (see figure 9).

The term "harmonic" has two different yet related meanings. Thus far, "harmonic" has been restricted to the general acoustical field. It also is involved in a more specific area, generally associated with string instruments and flutes. If a vibrating string is touched lightly at one of its dividing nodes (figure 11) it will be prevented from sounding its fundamental.

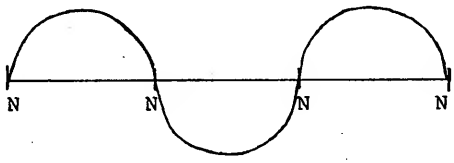


Figure 11
Dividing nodes

Because a string vibrates in sections, the node chosen will continue to vibrate and will sound its corresponding note. These notes have a veiled quality since the fundamental is not heard, and are called 'harmonics'. For string instruments there are two types of harmonics: natural harmonics, which use open strings as fundamentals and are indicated notationally by placing a small circle above the desired tone (see figure 12), and artificial harmonics, in which the performer makes his own fundamental and the notation gives not only the correct fingering position, but also the desired node (see figure 13).

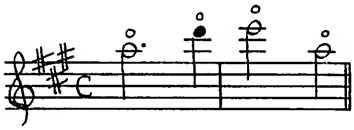


Figure 12
Natural harmonic notation indicators

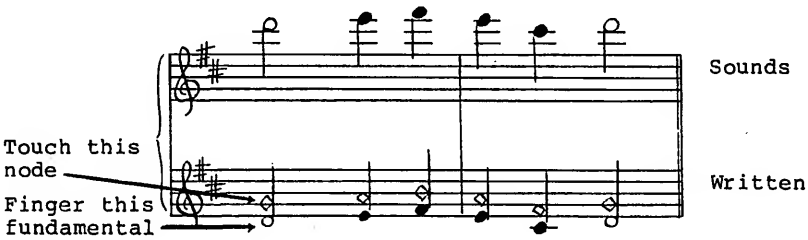


Figure 13
Artificial harmonic notation

On the flute, harmonics are produced by either overblowing or venting. Overblowing is a process of changing the shape and direction of the air stream from the lips. Venting is a procedure of opening a hole located at or near a node. As with string instruments, it is possible to use several different fingerings by overblowing at the octave, fifth, etc., or venting to obtain various partials to create the same harmonic pitch. The sounds are again very light and veiled in quality. Designations for harmonics in flutes (and some other woodwind instruments) are similar to those used by string

players for natural harmonics. Figure 14 shows the desired pitch with the harmonic notation indicated (∘). The notes in pararenthesis are the fingered fundamentals used to obtain the harmonic.

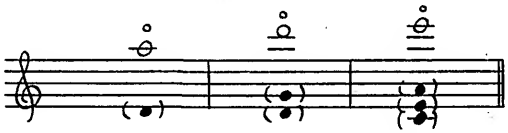


Figure 14
Possible harmonic fundamentals

Usually the player transposes down an octave and a fifth (or an octave) to obtain the desired result, but other options are available and sometimes requested by the composer.

The demands being placed upon the performer of contemporary or avant-garde literature are increasing with each new composition. Many of these "new" or so-called "unusual" devices are based upon established acoustical principles. It becomes imperative that the performer be well versed in or at least have a practical working knowledge of acoustical theory to approach successfully performance of twentieth century literature.

CHAPTER III
THE FLUTE

Construction

With a background of acoustical theories as a basis of reference, an investigation into the actual construction of the modern flute can proceed. The flute is approximately 67 centimeters (26.4 inches) in length. Its bore or air column is 1.9 centimeters (0.75 inches) in diameter and is cylindrical for 3/4 the length of the body. A narrowing of the bore occurs at the embouchure end of the flute or head joint as it is called. This narrowing is in the form of a parabolic curve and reduces the diameter of the bore to 1.7 centimeters at the end of the head joint.[1] The plug or cork stopper that is located at the end of the head joint is set at a distance equal to the diameter of the tube from the center of the embouchure hole (see figure 15). This distance is 17 millimeters (about 11/16 inches).[2]

1 J. Bachus, The Acoustical Foundations of Music (New York: W. W. Norton and Co., Inc., 1969), p. 224.
2 Theobald Boehm, The Flute and Flute Playing (New York: Dover Publications, Inc., 1964), p. 108.

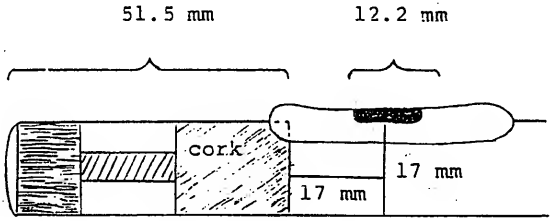


Figure 15
Flute head joint measurements

The shape of the embouchure hole is either elliptical ( ) or rectangular ( ) and about 1/2 inch in its long dimension. The measurements of the embouchure hole most often used are those given by Theobald Boehm: 10.4 millimeters by 12.2 millimeters (0.409 in. by 0.480 in.).[3]

The flute disassembles into three separate pieces. The head joint already mentioned and the body of the instrument, which divides into the middle section and the foot joint. The body of the flute contains thirteen tone holes plus other holes to facilitate trills, shakes, and alternate fingerings (see figure 16). Some flutes employ an additional key on the foot joint enabling them to obtain one extra note, low b ( ).

3 Theobald Boehm, The Flute and Flute Playing (New York: Dover Publications, 1964), p. 24.

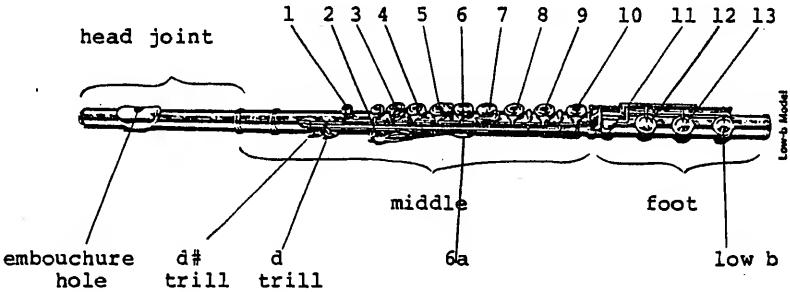


Figure 16
The flute

The parts of the flute are joined together by means of tenons. A tenon is an extension of one segment of the pipe which is made to fit by sliding into the adjoining socket of the next pipe forming a tight joint. The tenon between the head joint and the middle section is approximately two inches in length and is sometimes referred to as a tuning slide.

There are basically two types of modern flutes in use today, the plateau or closed-hole flute and the French model or open-hole flute which has perforations in five of the keys. Preference for a particular model (both are available with low b foot joints) is personal. Since international pitch became standard around 1920, the bore, construction, scale, and pitch of the flute also became standardized. National patterns for a particular model of

flute have emerged. In the United States, both plateau and French model flutes are built and played, but the French model is the type more often preferred by professional teachers and advanced students. In France, the obvious choice is the French model and the plateau flute is rather scarce. England is as heterogeneous as the United States but without the preference for the open-hole model. Germany, Italy, and most of Eastern Europe are faithful to the plateau model with the French model being less in demand.

Theobald Boehm's Influence

One cannot discuss the modern flute without acknowledging the efforts of one Theobald Boehm (1794 - 1881) in connection with construction principles. The flute as we know it in the twentieth century owes much of its existence to this man. In fact, it is often called the Boehm system flute.

Originally, the flute of the early eighteen hundreds had anywhere from five to ten keys with a conical based bore structure. The new construction concepts which Boehm employed in 1847 completely revolutionized his flute and can be grouped into three main principles.

The first area of reconstruction has to do with the bore of the flute. Boehm introduced the cylindrical bore with the parabolic head joint. He found that because of this contraction of the bore as it reaches the embouchure ("amounting to about 1/10 of the diameter at the cork[4]), the second and third octaves of the flute tend to be out of tune with the first octave. Through experiments Boehm found that by constructing a small chamber beyond the embouchure hole, he could adjust the tuning of the upper octaves. This is accomplished by the use of a plug or stopper, which screws into the end of the head joint. Moving the adjustable cork enables the performer to alter the position of the antinode at the embouchure and thus bring the three octaves into closer intonation agreement. Figure 15 illustrates the proper position of the cork to create the chamber beyond the mouth-hole. From one end of the flute to the other end is 670 millimeters (mm) which is the theoretical length of the air column. The actual length of the air column is 618.5 mm (for low c) from the c tone hole (end of the flute for instruments without a b foot joint) to the face of the cork. This distance (51.5 mm) must be incorporated into any calculations regarding the flute. It exists to correct the flattening influence of the mouth-hole, cork, tone holes, and the diminishing of the bore so that the

4 E. G. Richardson, The Acoustics of Orchestral Instruments and Organ (London: E. Arnold and Co., 1929), p. 47.

column corresponds to the length of a vibrating string of the same proportions.[5] Improper placement of this stopper can result in serious intonation problems.

The second area of work involves the tone holes and their placement. Boehm required that holes be bored for all of the chromatic notes in their acoustically correct position. Each of these holes was then made as large as possible and required to remain standing open to aid intonation and tone quality. On the present flute, g# and d# are the only notes which remain closed. They are easily opened when needed (see figure 16). The two trill keys (d and d# - see figure 16) and the a# key which duplicates the thumb plate are also closed notes but are accessory keys to aid the technical facility of the player.

The above improvements necessitated the third area of construction by Boehm. He devised a key mechanism to enable the fingers to control all of the holes. This new mechanism greatly enhanced the facility of the performer and allowed for newer and more agile feats of technique.

The materials of which flutes are made is again a matter of taste. Earlier flutes were made from many various substances including wood and ivory. Modern flutes are most commonly made of silver, wood, gold, or platinum. Wooden flutes are reported to have "sweet"

5 Theobald Boehm, The Flute and Flute Playing (New York: Dover Publications, Inc., 1964), p. 34.

sounds but very little projection power. The heavier metals, gold and platinum, are known for their mellow tones but are considered not as versatile as silver. In fact, silver flutes were first introduced by Boehm in 1847, and were preferred for large room performances mainly because of their "great ability for tone modulation, and for the unsurpassed brilliancy and sonorousness of their tone."[6]

Acoustical Properties

As a result of its construction, the flute functions as an open pipe capable of producing all of the partials in the harmonic series (see figure 6). Because of its adjustments in construction (the movable cork) certain of the partials are flat or sharp to the tones of the true harmonic series and are therefore referred to as inharmonic. These overtones are not substantially elicited when the entire system is set in vibration. It is due to this fact that the note of a Boehm flute is considered pure in a sense that the aggregate of upper partials is at a modicum. Oscillographic records of the flute played at soft volumes show "by the pure and unbroken sinusoidal wave-form, that the 'note' is almost

6 Theobald Boehm, The Flute and Flute Playing (New York: Dover Publications, Inc., 1964), p. 54.

entirely composed of an isolated fundamental."[7] (see figure 17).

Figure 17
Sinusoidal wave-form

These waves are created and maintained within the air column of the flute. Since the pitch of the flute is "determined by the length of a vibrating air column within the tube",[8] the opening and closing of various holes in the walls of the instrument define the length of the wave that is allowed to generate the sound.[9] The power to maintain the vibrations acoustically results from an oscillating air stream.

The air column is set in motion by the player blowing across the embouchure hole. The breath strikes the edge of the mouth-hole cutting the air into various eddies. The vibrations of the flute air column are generated by this edge tone mechanism. The player controls the air stream which determines the frequency and quality of the sound and allows for greater flexibility and control.

7 E. G. Richardson, The Acoustics of Orchestral Instruments and Organ (London: E. Arnold and Co., 1929), p. 48.

8 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 1.

9 J. Bachus, The Acoustical Foundations of Music (New York: W. W. Norton & Co., Inc., 1969), p. 183.

Tone Production

Essentially, there are three main principles involved in tone production on the flute. The first principle concerns the speed of the air column. The player's external muscles,(abdominal and stomach) push and flex against the diaphragm muscles which in turn function to control the speed at which the air is expelled from the mouth into the flute. The harder the air is expelled, the faster the speed of the air column: the slower it is expelled, the slower the speed. It is this speed of the air within the column that controls the dynamic level or loudness of the pitch. Faster air speed results in louder levels. This concept of air column speed should not be confused with intensity or support. "Loudness is the subjective reaction to intensity and it may be modified through quality, pitch, and other factors even if the intensity remains constant."[10] In other words, it is possible to play at any dynamic level with a high degree of intensity. Support is an isometric action obtained by the diaphragmatic muscles working against the abdominal muscles. A similar muscular tension occurs when the air is forced through a small opening in the lips, but this time it is the embouchure muscle which gives resistance

10 E. Stringham, "Acoustics," in The International Cyclopedia of Music and Musicians, Vol. 1 (New York: Dodd, Mead, and Co., 1964), p. 11.

against the air column rather than muscle versus muscle as in the abdominal area. These tensions must be present at all times (in varying degrees) in order to produce the control necessary to play with what is considered a "good" tone, appropriate to musical demands.

The second principle involved in tone production is that of the size of the air column. By changing the size and shape of the aperture between the lips through which the air leaves the mouth, the performer can alter the timbre of the sound. A smaller aperture increases the edge or core of the sound produced and can cause the pitch to rise or become sharp. A larger aperture causes the resultant sound to be diffuse in nature with the pitch becoming somewhat lower. Players use this principle combined with the first (air column speed) to achieve a wide range of dynamics and tone colors without the pitches becoming marred by intonation difficulties (for example: blowing harder causes a sharper pitch, but enlarging the embouchure hole lowers the pitch). As with all physical skills, it is easier to achieve than to verbalize.

The last principle of tone production concerns the air column direction. Without the use of register keys, the different registers or octaves are obtained through the direction at which the air stream cuts the edge of the embouchure hole. When the stream of air is aimed low (with the lower jaw pulled back), the column focal point

is directed more into the embouchure hole and the lower register notes will be produced. By allowing the lower jaw to move forward, the player will direct the air stream across the embouchure hole and the ease with which the higher register notes speak will increase. The same effects can be achieved by rolling the flute in or out through wrist movements. This is not a good technique to encourage because the movements do interfere with the embouchure control and lip placement. These external movements (the wrist) are not necessary when the same results can be obtained through lip control (with slight jaw or head movement) without sacrificing flexibility or facility.

The discussion of these three principles leads to the conclusion that though the flute is easily played out-of-tune it is also easily played in-tune. This is true, but "it is not possible to play a flute with good tone quality . . . focused, controllable sound, at any pitch other than that for which the instrument was built in the first place, give or take a leeway of roughly five to ten cents."[11] The performer will use those three principles to adjust the quality of the sound and to

11 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 7.

A cent is a logarithmic measurement equal to 1/100 of the semitone of the well-tempered scale; therefore, a chromatic semitone equals 100 cents. Willi Apel, "Intervals, Calculation of, IV" in Harvard Dictionary of Music (Cambridge: Harvard University Press, 1977), p. 420.

achieve the proper pitch. For example, if the tuning slide tenon is drawn out the pitch will correspondingly be lower. The player will then adjust the pitch throughmeans of focusing the tone more by uncovering a larger portion of the embouchure hole than usually covered with the lip, or compensate by using a tighter embouchure. This results in a very broad, loud sound that has little or no flexibility in soft passages. Conversely, if the tuning slide is pushed in (giving sharper pitches), the player will cover more of the embouchure hole to achieve a focused tone resulting in a very thin sound. In essence, this is saying that the flute when played with a correctly focused sound will only play at the pitch for which it was constructed and that the tuning slide is used less as a device for tuning and more as a means of regulating tonal quality.[12]

Vibrato

Vibrato is a fluctuation of the frequency and its amplitude[13] "produced by a controlled irregularity in the wind supply."[14] This process can be accomplished

12 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 7.

13 Brought to the attention of this writer in a conversation with Edward C. Troupin, April, 1980.

14 Robert Donington, "Vibrato," in Grove's Dictionary of Music and Musicians, Vol. 8 (New York: St. Martin's Press, Inc., 1954), p. 765.

by two different methods. One means of obtaining vibrato is through the rapid relaxation and constriction of the throat muscles. Teachers do not often recommend this method because it is more difficult to control. When the constrictions become too fast, a "nanny-goat" vibrato results and sounds rather like an overworked electric organ. The pulses to the vibrato can also become too pronounced and begin to sound like accented strokes rather than the expected smooth texture. Many times the tension caused from using throat vibrato can result in either subvocalizations that can be heard or in a smaller overall sound. Its usefulness comes when the performer is required to play with a much faster vibrato or with one calling for pulsations.

The most commonly used vibrato is an intensity vibrato. This method of vibrato is generated by the isometric action of the diaphragm working with the abdominal muscles (as described under principle one in tone production). The resultant tension from this procedure creates an undulation or shaking motion of the air column, and produces a smooth and controlled vibrato.[15] The vibrato speed is dependent on the amount of tension created. Greater tension produces faster vibrato and less tension produces slower vibrato.

15 William Montgomery, "Flute Tone Production, Part II," The Instrumentalist, Vol. 33, no. 3 (October 1978), p. 45.

In the intensity method of vibrato production, the undulating movements of the air column result in slight pitch fluctuations. These distortions are quite small ("five cents maximum on either side of the pitch center and usually less."[16]) and arise out of the manipulation of intensity. The timbre of the tone changes during this effect due to the different harmonics or partials employed during the rising and falling motion of the pitch. It is an instantaneous process and produces a shimmering effect characteristic of good flute sound. An out-of-focus (out-of-tune) blown pitch does not shimmer because of a lack of reinforcement within the tube. Full reinforcement of partials from the tube does not occur from a single pitch (one without vibrato), but is brought into utilization when vibrato is used.

Primarily, vibrato is used for expressive purposes in a restrained or deliberate manner. Flutists often use vibrato to add warmth or change the color of the tone.

16 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 10.

Overblowing

A discussion of overblowing and harmonics is closely related to or dependent upon the explanation of tone production. The three principles involved in tone production in conjunction with the acoustical characteristics of the flute are the bases for the concepts of overblowing and of obtaining harmonics.

As discussed before, a vibrating air column has the same attributes as does a vibrating string - the characteristic aggregate of fundamentals and overtones. By a forcing of the air pressure beyond the normal level needed to produce a fundamental, the higher partials of the harmonic series are produced and accentuated.[17] This process is referred to as overblowing.

Because the flute is an open pipe enabling it to produce all of the partials in the harmonic series, it is said to overblow at the octave. The octave is the first interval in the harmonic series (see figure 6). This first octave or fundamental octave consists of the notes b to b_1 (see figure 18) and is obtained by normal embouchure pressure.

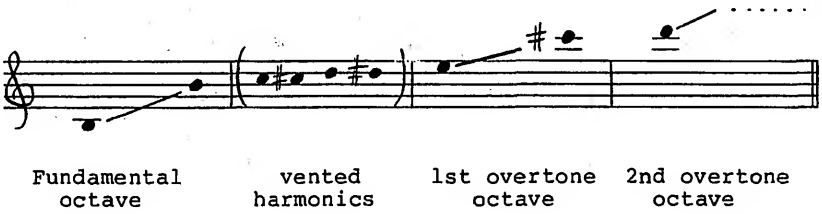


Figure 18
Octave breakdown

The first overtone octave, consisting of the notes e_2 through $c\#_3$ (figure 18) is obtained by splitting in half the width of the air stream necessary to produce the fundamental octave. The size or width of the air stream is controlled by the size of the opening in the player's lips. This reduction by half of the air column results in a subsequent doubling of the rate of vibration causing the octave displacement. (For example, in figure 5 it can be seen that a_1 has a frequency of 440. Doubling that frequency results in 880 which is the frequency of a_2, an octave higher.)

The second overtone octave (d_3 and upwards, figure 18) follows the same pattern as the preceding one. The air stream must be half the width of the one used to obtain the first overtone octave, plus opening certain finger holes to act as vents which will be discussed later.

The process of overblowing serves two important functions in flute playing: that of enabling the player to obtain the upper register notes and secondly, to produce the various harmonics available.

Upper Register Notes

When flutists speak of the upper register, they are referring to the notes d_3 and above (see figure 18). The notes below this register are either fundamentals or the octave notes obtained by overblowing those fundamentals. Therefore, upper register notes are third or higher partials. This makes them more difficult to achieve especially for beginning students as they require a more advanced lip control than is often exemplified by "younger" players. Flutes are not equiped with register keys such as the ones found on oboes and clarinets, but depend on lip control to overblow the higher notes. These upper partial notes are lower in pitch than the notes of the true harmonic series due to the flattening effects of the flute's construction. Boehm was aware of this difficulty and described it as being caused by the "wave meet[ing] with a resistance from the air contained in the lower part of the tube, which is so considerable that all the tones are much too flat when they come from holes placed at the points determined by actually cutting

the tube . . . And, moreover, the height of the sides of the holes adds to the flattening effect."[18] To correct this inherent flattening effect of the upper partials, flute players open specific finger holes when playing notes in the upper register. This process of opening keys is referred to as venting.

Venting is founded on the acoustical principle of altering the length and width of the tube which in turn affects the distance the air column must travel. As discussed in the acoustics chapter, the vented hole is located at or near a node (N). The venting procedure aids in the production of an antinode (L) which in turn raises the pitch of the note. In explanation of this rather confusing statement, it is a known fact that "a widening of the bore of a pipe near an antinode (L) of the note which it is sounding raises the pitch of that note..."[19] Since venting alters the length and width of the tube at that point, it accomplishes the same feat: that of raising the pitch of an already flattened note, thus bringing it into a corrected pitch.

An unusual aspect of this single venting process is that in the notes $d\#_3$ (or $e\flat_3$) to g_3 (see figure 19), the vented fingering corresponds to the note fingered an octave and a fifth below the desired pitch.

18 Theobald Boehm, The Flute and Flute Playing (New York: Dover Publications, Inc., 1964), p. 26.
19 E. G. Richardson, The Acoustics of Orchestral Instruments and Organ (London: E. Arnold and Co., 1929), p. 47.

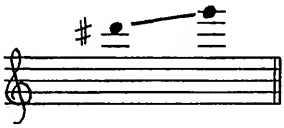


Figure 19
Single vented notes

Figure 20 illustrates this phenomena as such: the fundamental pitch is notated as (●); the upper register desired pitch is represented by (○); and the fingering that corresponds to the vented pitch is shown by (◇).

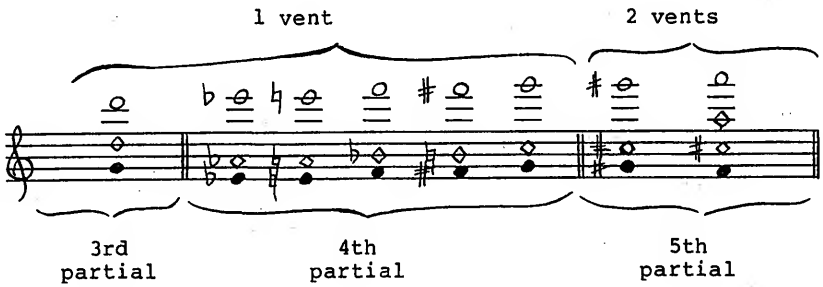


Figure 20
Corresponding vented fingerings
of upper register pitches

Looking back at figure 13, one can immediately see that this is a similar process to the one string players utilize to obtain artificial harmonics: fingering a fundamental, touching lightly a node, and sounding the desired harmonic. The difference is that by venting and thus creating an antinode and a shorter tube length, the veiled quality associated with harmonics is eliminated.

The first pitch interval (d_3) in figure 20 seems to contradict or at least be out of place with the other parts of the example. Its vented fingering is an octave below the desired pitch rather than an ocatve and a fifth. This is unusual but can be acoustically explained. The pitches $d\#_3$ to $g\#_3$ are all fourth partials (as shown in figure 20), but d_3 is a third partial of the fundamental g_1. The vented hole is 1/3 the distance from the embouchure hole to the end of the tube (using the

fundamental g_1 tube length). When opened, the fingering would produce the third partial of a harmonic series constructed on the fundamental g_1 - which is d_3 (see figure 21).

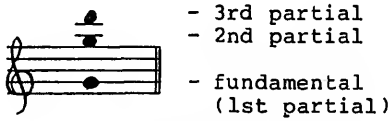


Figure 21
Fundamental g_1 with partials

As can be seen in figure 20, the notes $g\#_3$ and above require two vents rather than one. The acoustical principles involved are the same but exceedingly more confusing the higher the notes go.

Another characteristic of this venting process is that with each rise in pitch from $d\#_3$ on, the antinode (L) opening achieved by venting moves one degree closer to the upper end (embouchure) of the flute[20] (see figure 22).

20 C. B. Hilton, "Acoustics and Upper Register Fingerings," Instrumentalist, Vol. 21 (February 1976), pp. 60-63.

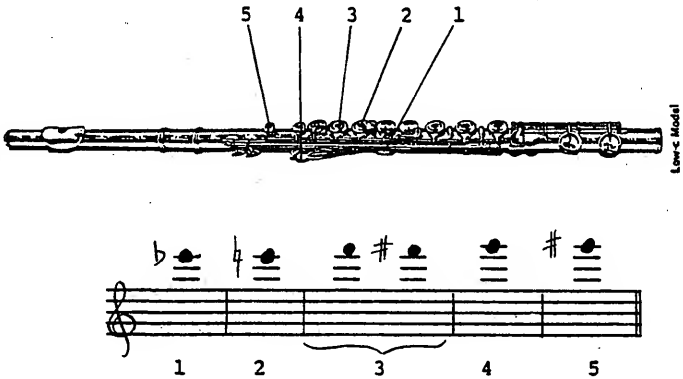


Figure 22
Illustration of inward movement
venting process

The f_3 and $f\#_3$ represented in figure 22 by the number 3 finger hole involve a shift in the left hand thumb key and the use of the f# key in the right hand. This movement opens a key that lies between the first and second finger of the left hand. So, even though the two notes appear to use the same vent in terms of fingering, the actual opening conforms to the inward movement principle.

Harmonics

Harmonics, defined as overblown pitches different from the normal fingerings that follow the harmonic or overtone series (figure 6), are one of the earliest and easiest ways with which to alter ther timbre of the flute. These

veiled partials are dependent upon the principle of overblowing. Splitting the air stream of the fundamental in 1/2 results in a 12th above the fundamental or the second overtone (3rd partial); etc.

When discussing harmonics, there is often a slight confusion as to the uses of <u>overblowing</u> and <u>venting</u>. Overblowing is necessary in the production of harmonics and the upper register notes of the flute. While venting is normally associated with upper register note acquisition, it is also used to a degree in harmonics. Between the fundamental octave and the first overtone octave in figure 18 are the notes c_2 through $d\#_2$. As indicated, they are vented harmonics of the fundamental octave. The use of the vent changes the veiled quality of these tones and they no longer respond as harmonics. To play the notes c_2 through $d\#_2$ as harmonics, the performer simply uses the fundamental fingering rather than the normal vented fingering and overblows to the octave. Because of the construction of the flute, there are no harmonics possible for the notes e_2 and f_2 (also $f\#_2$ for those flutes with a low c foot joint). These notes use the same fingering (not vented) as the corresponding note in the fundamental octave and the range of the flute does not extend downwards enough to accomodate an octave and a fifth below to allow for these harmonics. The notes of the first overtone octave (figure 18) are in fact

harmonics produced by overblowing, but are rarely thought of as such because of the fact that they do not act or sound like harmonics in terms of intonation and timbre.[21]

As discussed in the chapter on acoustics, the designation for harmonics on flute is a small circle (∘) placed above the desired pitch (see figure 23).

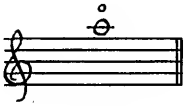
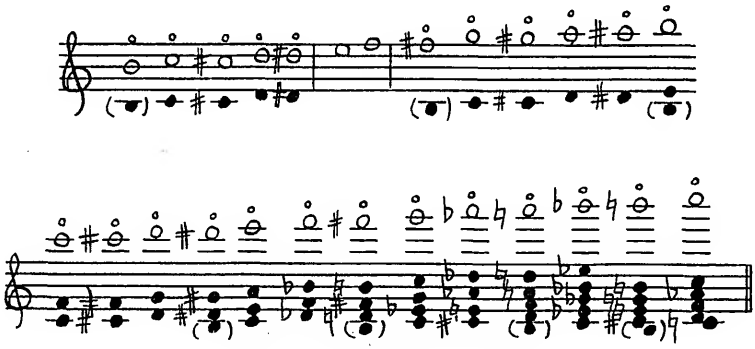


Figure 23
Designation of harmonic

Usually these notes are obtained as unvented third or higher partials of the 15 chromatic tones from low b up to open $c\#_2$ (assuming a low b foot joint is in use - 14 tones if not). Because the flute is an open pipe capable of producing a full range of overtones in the harmonic series, many different fundamentals are available to the player from which he can select the desired harmonic. Figure 24 illustrates the harmonic possibilities in terms of fingerings.

21 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 14.



(o) = desired harmonic
(●) = possible fundamantal

Figure 24
Illustration of harmonic possibilities

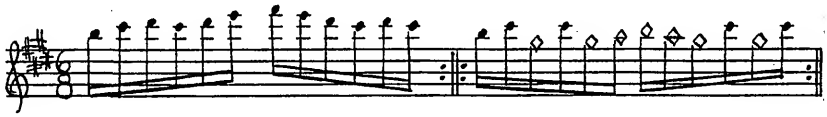
The fact that there are varied possibilities for obtaining harmonics is fortunate for the flutists due to the problem encountered with the pitches above d_3. They are flat to the fundamental pitch and embouchure adjustment is hardly adequate to correct this inherent difficulty. Basically, the problem arises out of the playing resistance found in the instrument in the higher register. Regardless of which fundamental is used, it is difficult to obtain harmonics beyond a_3 or b_3. Another problem is that acoustically, only the lowest note on the flute (low c_1 or b) is perfectly vented. The notes that are generated higher (on shorter tubing) are incomplete in their venting, which results in a flattening of the upper partials in relation to the fundamental. Therefore, the

upper partials of fundamentals that are located near c_1 (or b) are closer to "true" pitch than the partials of fundamentals using short tubing. The many possibilities that are available help eliminate or correct some of these problems.[22]

Though composers are most interested in harmonics for their timbral quality, flute players have found an entirely different use for them. Harmonic fingerings are often employed as an extra resource to aid in increasing technical facility. Difficult passages, fingerwise, can be simplified through the use of harmonics. For example, figure 25-A presents a difficult technical problem if

22 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 14-15.

repeated at fast speeds. By using harmonic fingerings (figure 25-B) the difficulty is eliminated and the overall sonority is not noticeably affected.



A B

Figure 25[23]
Facility exercize

23 Technical facility exercize (memorized) as taught by Robert Cavally. Based on the flute orchestral excerpt from The Moldau (from Má Vlast) by Bedřich Smetana.

CHAPTER IV
CONTEMPORARY PRACTICES

There are enormous expansion and diversity in the technical requirements involved in instrumental performance of twentieth century literature. Those idiomatic to the flute are here subject to examination under three major subheadings: monophonic sonorities; special effects; and multiple sonorities.

Monophonic Sonorities

Monophonic sonorities, as the name implies, are those special devices which involve production of a single sound and a dependence on traditional or established principles of flute playing. There are six major areas or categories under monophonic devices. The first category is that of harmonics.

Harmonics

Artificial harmonics

The discussion of harmonics in the preceding two chapters dealt with the "natural" harmonics, which are derived from a fundamental according to the acoustical

principles of the flute's construction. It is also possible for the performer to obtain harmonics from apparent fundamentals. These are referred to as "artificial" harmonics. Through the use of nonstandard fingerings, a pitch which approximates another pitch can be used as a fundamental (an apparent fundamental with which to obtain harmonics - see figure 26). These "artificial" harmonics are different in timbre from "natural" ones due to the enhancement of their unusually derived upper partials.

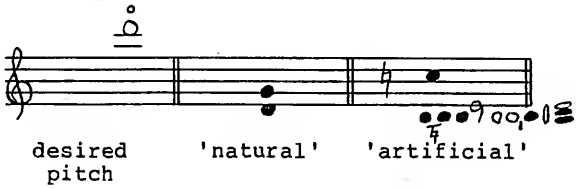


Figure 26
Harmonic derivation

Also, these harmonics do not follow the relationship found in the harmonic series (see figure 6) and therefore seem at times to have no logical relationship with the fundamental[1]. Notationally, in addition to the standard small circle above the note (∘), fingerings for the "artificial" harmonics are usually provided by the composer when a timbral change is desired.

1 B. Bartolozzi, New Sounds for Woodwind (London: Oxford University Press, 1967), p. 13.

Octave harmonics

In addition to "natural" and "artificial" harmonics, this category contains other devices that are closely related to or dependent upon the harmonic series. The next device encountered is referred to as fundamental octave harmonics.

As discussed in chapter three, there are no harmonics "natural" or "artificial" for the notes below f_2. Because of the flute's construction, the octave and a fifth necessary to obtain these fundamentals is not available. It is possible however, through the use of non-conventional or unusual fingerings to produce pitches in this range (b to f_2) which give the veiled effect of low register harmonics. By definition, they are not harmonics, but rather altered fingerings that result in soft, fuzzy, 'spread' sounds that closely resemble the higher harmonics obtained by overblowing a fundamental. The usual notation for a harmonic (°) can be employed, but the altered fingerings to obtain these sounds should be provided.

Whistle tones

Whistle tones, also known as whisper or flagelot tones, are in this category under monophonic sonorities. William Kincaid is credited with the first official use of this device as a teaching technique. He used whistle tones as a warm-up exercise designed for lip control and relaxation[2]. Whistle tones are the soft, high, and clear individual upper partials of the fingered note. Usually, they involve the fifth through tenth partials with some lower notes capable of producing up to the sixteenth partial, or four octaves above the fundamental (see figure 27).

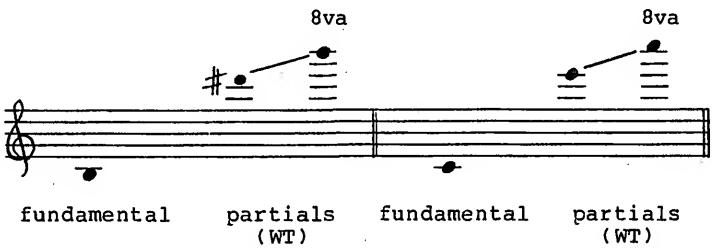


Figure 27
Whistle tones

This allows for between five to fourteen available sounds. Whistle tones are possible on every fingering but the lower fingerings are more quick to produce the desired effect.

2 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 26.

These soft tones are produced by gently directing the air column across the embouchure hole using little or no lip pressure. The whistling sound (the higher partials) is the air spilling over the edge of the lip plate without causing the air in the tube itself to vibrate. The resultant pitches are sharper than those normally obtained with that fingering. The actual register of the whistle tone is controlled by raising or lowering the tongue, just as if you were whistling, hence one possible source of its name. There are no standard means of notation for whistle tones. Commonly, WT is printed over the note with an * and an explanatory footnote. Also seen is the use of a diamond shaped note (◇) with a footnote. Some composers employ the method of notating the fundamental and the desired whistle tones (see figure 28).

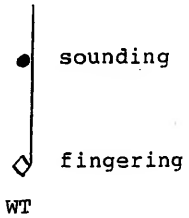


Figure 28
Whistle tone notation

This points out one of the problems encountered with whistle tones. Notating the sounding pitches is very nice on paper, but whistle tones are very unreliable. They are

not easily isolated as they tend to oscillate between pitches very readily. Also, their dynamic range is limited. The tones themself are barely audible beyond twenty feet. Many performers have discovered that sustainiing whistle tones is difficult and articulation nearly impossible.

Pitch Changes

The second category under monophonic sonorities involves changes or distortions of single pitches. Basically, this category divides into three areas of pitch alteration: pitch bending; muting; and altered fingerings.

Bending pitches

Bending involves raising or lowering a pitch without changing the fingering. By moving the head or jaw up and down or by rolling the flute out and in, one can achieve this effect. It is also possible to bend pitches through the use of lip control. All three processes involve the same principle of controlling the direction of the air stream as it cuts across the embouchure plate. This causes the pitch to rise if the air is positioned upward (about a 1/4 tone sharp) and fall if blown downward (up to

a 1/2 step flat). It is much easier to lip a pitch down than to force it up. Notation for pitch bending is unclear and plentiful. Unclear in that it can indicate the direction in which the tone is bent, but not the exact degree of its distortion. Some of the various methods for indicating bends are seen in figure 29.

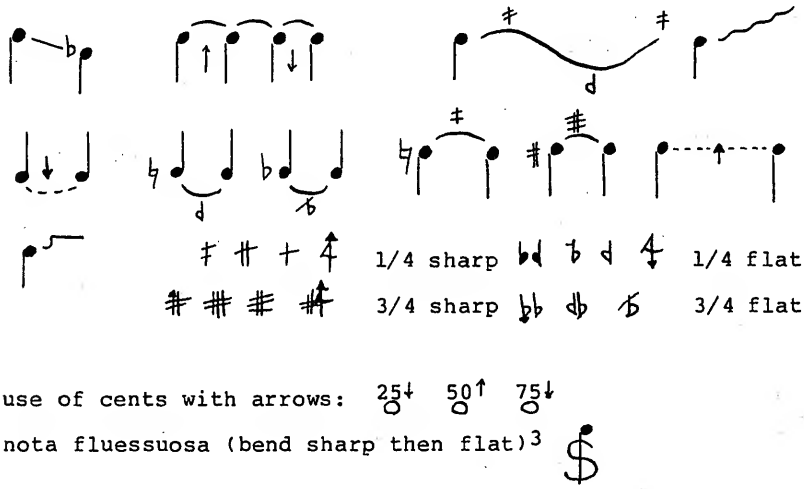


Figure 29
Pitch bending - varies by composer

Muting tones

The second area of pitch modification is muting. Because of its method of tone production, the flute does not lend itself to muting as easily as does the violin or trumpet. One method of muting requires changes in

3 A. Lesueuer, "Special Effects in Contemporary Music," Instrumentalist, Vol. 22 (December 1967), p. 67.

fingerings. By closing holes below the last open tone hole, the timbre of the pitch can be softened. The results are fuzzy, soft pitches which are sometimes called spread tones. Two other methods of muting are available but involve adjustments to the flute itself and must have time with which to be prepared. The first of these is to remove the foot joint and place a tissue or cloth (preferably soft) into the remaining tube. This is an effective muting process but does result in the loss of several notes (c_1, $c\#_1$, $d\#_1$, and $d\#_2$). The second method does not cause any notes to be lost but is longer in preparation. It requires that the embouchure hole be partially covered resulting in a reduced air flow without reducing the intensity. This produces a softer or muted effect. Tape is the easiest material to use and does not damage the lip plate. Placing strips of tape on either side of the embouchure hole effectively reduces the size of the air stream and accomplishes the muting process (see figure 30).

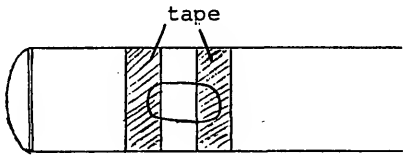


Figure 30
Flute embouchure hole muting

Altered fingerings

The third area of pitch modification involves altered fingerings. These unusual or non-standard fingerings distort the fixed fundamental/overtone arrangement of the flute by allowing tone holes to be vented that would not normally be opened. This brings about the formation of multiple tube-lengths within the flute. It is the entrance of these multiple tube-lengths that allows closely aligned harmonics to sound in juxtaposition with the original harmonic series, thus changing the timbre of the pitch. Although some of these fingerings and ideas are new, others have been employed by flutists for some time. Because playing extremely loud notes can force the pitches sharp, performers have often substituted "strong" fingerings when projection is necessary. Even though many flutists are aware of these notes, composers of contemporary music often supply fingerings when they wish

them to be used. In the same context, the opposite effect is also employed by using sharper pitches to play softer passages. Usually these pitches are reinforced harmonics. The reinforcement is achieved by using a fingering that would support a common partial of two different fundamentals. This will result in a note of bright timbre and less intensity (a narrow focus). It is possible to play these sharper pitches in tune very softly without going flat or losing the tone altogether. The notation for these fingerings is usually provided and many times is possible only on a French model flute.

Another obvious result of altered fingerings is timbral variation. The most common usage is for darkening or spreading the sound. Brightening the timbre by adding high partials and thereby weakening the fundamental can be achieved, but as discussed in the previous paragraph is commonly associated with playing soft passages in tune. The opposite effect, tones that lack upper partials, have a very non-resonant, diffuse quality. Often they are referred to as "hollow" tones because of their empty, lack-of-focus sounds. Very similar to these tones are "weak" tones or "funky" fingerings, as they are sometimes called. As the name implies, these tones are weak and distorted due to their unusual fingerings and resultant transparent tonal structures.

Thus far, the area of altered fingerings has primarily been concerned with timbral change or enhancement. Another consequence of altering or substituting fingerings is that of actually changing the pitch itself. Fingerings that can raise or lower a pitch without employing extra harmonic reinforcements are known as "inflected pitches". These pitches tend to be "stuffy" and not as resonant as normal fingerings. Interestingly, vibrato does not yield as good a response with inflected pitches as it does in normal usage. Vibrato seems to enhance the mistuned partials and the tone becomes progressively more stuffy.

One of the newer and more extensively used areas of altered fingerings is that of microtones. Basically, microtones are pitches that are located between half steps, whether they are quarter tones or some such larger or smaller fraction of the interval. These notes are produced either by bending (usually lip control) or changing the fingering in some manner that allows closely aligned harmonics to sound. The French model flute is well adapted to this technique because of its perforated keys. By depressing the rim of the key and not closing the tone hole (rim vent, or by partially venting the tone hole), microtones can easily be produced. A complete microtonal scale on any flute is difficult for several reasons. First of all, on the plateau flute many options for fingerings are removed because of its closed tone

holes. A complete quarter tone scale on the plateau flute is not possible without extreme dexeterity of lip bending which is not always practical. On the French model flute a quarter tone scale can be closely approximated. The primary reason for problems is due to the fingering mechanism of the flute. Referring back to figure 16, the g key (#5) is mechanically linked to the g# hole covering (#6, thus the reason for the necessary duplicate tone hole #6a) and the f key (#8) closes both the f# tone hole (#7, not the f# key #10) and the g hole cover (#7). The f# key (#10) also closes the g tone hole (#7). This linked mechanism makes it difficult to achieve microtones between these pitches solely by rim venting. Drastically altered fingerings, usually employing the closing of keys below the last open tone hole, must be used to achieve the desired microtones. Also the notes between a# and d (in both octaves) encounter similar problems simply because they are restrained by the closed-key structure of the flute on these pitches (present on both the plateau and French model instruments). Some flutists maintain that regardless of the instrument played "no complete set of quarter tones can be worked out on the plateau system flute"[4] and that even the French model flute is capable only of an approximation and not a complete quarter tone scale.

4 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 18.

Some of the problems associated with microtonal pitches are caused by the fingerings. First of all, the new fingerings are often complex and unusual, making sight reading and learning a slower process than normal. Also, these unusual fingerings do not lend themselves to facile technical passages easily and sliding on and off key rims can result in unfortunate mishaps. In addition, these distorted fingerings interfere with the normal use of dynamics as they result most often in softer or less focused pitches that are impossible to play loudly. This aspect of microtonal production requires that embouchure adjustments be made by the performer. Many times rolling the flute will be employed to amend pitches. This can interfere not only with tone production, but also with dynamics and the microtones themself.

Another problematic area of microtones involve notation. As seen in lip bending (figure 29), there are various means also for notating microtones whether they are higher or lower than normal pitches. This aspect of microtones will be investigated in the chapter on notation.

Vibrato

Vibrato as such has often been used by flutists to change the timbral quality of a pitch whether it be in the area of intensity or emotional content. In contemporary

literature, the extent of vibrato usage has expanded. Quite often, composers instruct performers to play passages or single notes without vibrato. Depending upon the register and dynamics involved, this device can greatly alter the timbre of the given pitches. At the other extreme, exaggerated or pronounced vibrato is often used. This can either be in the area of the speed of the pulsations (be they fast or slow) and the actual size or range of these undulations (wide or narrow). Notation usually involves a descriptive note and the following indications (see figure 31).

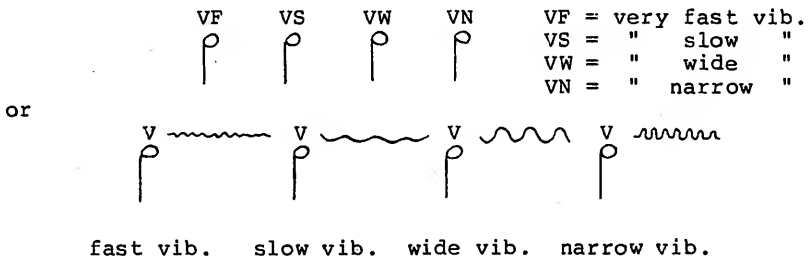


Figure 31
Vibrato notations

These notational indications are by their very nature ambiguous in that they can only give generalizations regarding a very individualized activity.

In addition to no vibrato and pronounced vibrato, composers sometimes request uneven vibrato. As with the other usages, notation would necessitate some form of descriptive instructions to accompany the figure. Uneven vibrato is sometimes displayed as seen in figure 32.

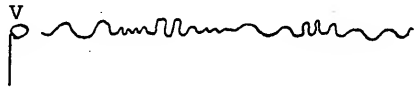


Figure 32
Uneven vibrato notation

The use of many of the devices of contemporary literature often overpowers or rules out the use of vibrato. Composers and performers should be aware of the phenomenon as it influences performance guidelines. For example, singing while playing (which will be discussed later) causes vibrato to become rather ineffective as does its usage with most multiphonic devices.

Trill and Tremolo

The fourth category of monophonic sonorities involves trills and tremolos. These devices are not new to twentieth century usage, but have been employed by composers for many years. Trills, which are the rapid alternations between two notes either a whole or a half step apart, first originated in the sixteenth century.

They were used by performers as ornamented resolutions at cadences most often occurring on suspended dissonances. These trills employ standard fingerings with some uses for special trill keys (see figure 16) to aid in facility. Tremolos, which involve alternations between intervals larger than a whole step also use regular fingerings.

In contemporary literature, this category has been expanded to include trills or tremolos on single pitches and for microtonal pitches. Color trill, bariolage, enharmonic trill, key vibrato, and unison tremolo all refer to the same technique, the single pitch trill. Most often this device is attained by alternating between standard fingerings and harmonic fingerings. They are essentially timbral trills and are often notated by using a combination of the trill indicator (tr) plus the symbol for harmonics (o) (see figure 33).

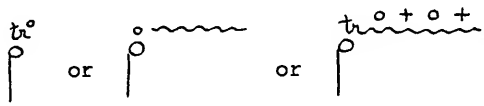


Figure 33
Harmonic trill notation

Trills or tremolos involving microtonal pitches are very similar in concept to single pitch trills in that they both incorporate non-standard fingerings. Microtonal trills are comprised of standard and altered fingerings

being rapidly exchanged. These altered fingerings as discussed earlier (see pitch changes) can be as much as a quarter tone different in pitch from the standard fingering. Obviously, more possibilities occur in the upper register of the flute where more numerous and adjacent partials are available. Notation for these microtonal trills would be as follows (see figure 34).

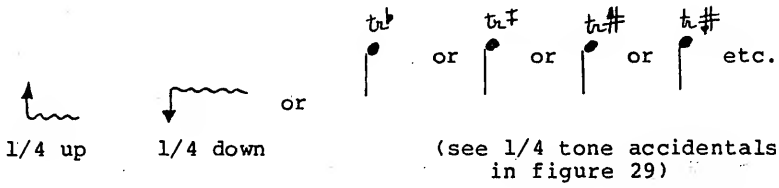


Figure 34
Microtonal trill notation

As with altered fingerings and multiple fingerings there are many available charts for trills and tremolos in their various forms. Composers usually use these sources to supply the necessary fingerings in the notation when they wish unusual or new trills or tremolos.

Extended Range

Contemporary uses of the solo flute demand a vast extention of the range of notes that are available. Previous composers thought of the range of the flute as

incorporating the notes from c_1 to d_4 with the added low b in some cases (see figure 35).

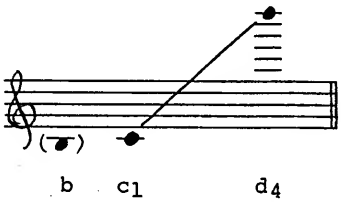
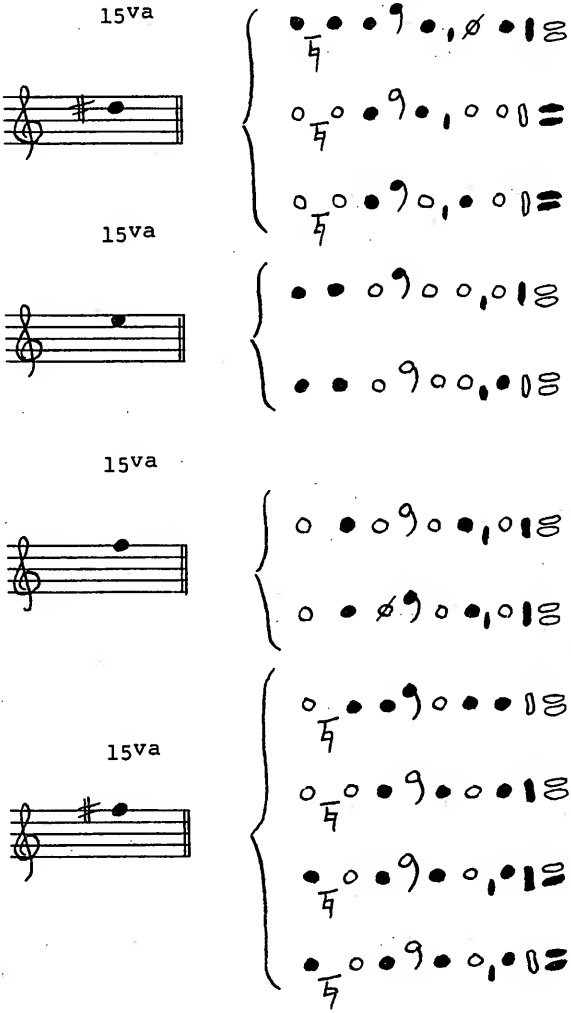


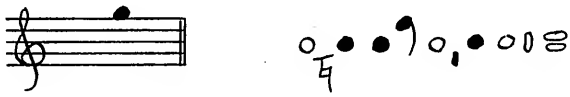
Figure 35
Extended flute ranges

Literature in the twentieth century now has extended the range upwards to include the pitches through g_4. These notes are shrill, loud, and sometimes unattainable for all flutists as they are difficult to achieve. They are problematic not only because of the embouchure and air pressure control needed but also because of the unweildy fingering positions. Figure 36 supplies the fingerings used to obtain $d\#_4$ through g_4.

15va



15va



o open key

● closed key

ø half holed (rim only)

T b♭ thumb key

T b♮ thumb key

Figure 36
Extended upper register fingerings

The addition of the low b key helped to extend the lower limits of the flute's range. It was used as early as 1821/22 in the chamber music of Friedrich Kuhlau. In his Duos fur Zwei Flöten opus 39, the first duo in e minor contains a low b in the first movement in the second flute part. In orchestral music, the low b appeared as early as 1843, in the "Intermezzo" of Mendelssohn's Midsummer Night's Dream. Composers began employing this lower register addition with increasing frequency and going even further by writing low b♭ as seen in Mahler's Fourth Symphony (second movement) and Ravel's orchestration of Mussorgsky's Pictures at an Exhibition. Actually, this low b♭ can be achieved several ways. Some manufacturers produce a low b♭ foot joint to be used in these specific

cases, though it has not become a popular or necessary accessory. The easiest method by far is to borrow the concept of scordatura tuning from the strings. By pulling the head joint of the flute out one inch, all of the notes sound a half step lower. Thus by fingering low b, low b♭ will sound. Of course, all of the other notes will also have to be transposed by the performer until the head joint can be returned to its proper tuning position.

There are available three other methods of extending the range of the flute downwards. The first method actually involves only one note. By stopping the end of the flute with a cork (or even by using one's knee) and playing the lowest note, one can achieve a stopped-pipe subtone sounding an octave lower. According to acoustical theory, the fundamental (or in this case the lowest note) of a closed pipe is an octave below that of an open pipe of the same length. In essence, the air column inside the flute stopped is double that of the open ended flute. Because it is a subtone, it is exceedingly soft dynamically.

The remaining two methods extend the range downwards an octave but involve tone production that is not traditional in nature and by rights does not belong in this subheading. They are buzzing and key slaps and will be discussed in greater detail under the subheading of Special Effects.

Glissando/Portamento

The sixth category of monophonic sonorities involves the concept of sliding between pitches. This act is often erroneously referred to as glissando. Strictly speaking, glissandos are rapidly executed scale passages such as performed by drawing the thumb quickly across the keys of the piano. Sliding between pitches with all the intermediate tones being allowed to sound is known as portamento, not glissando, even though it is commonly referred to as such. This sliding effect, easily done by the violin or trombone, can be utilized by the flute in several ways.

On closed hole or plateau system flutes, sliding between pitches can be effected only by bending pitches or lip slides, the most easily achieved by going flat in pitch. The only other available slide is the actual glissando or "key rip" for closed hole flutes. The open tone holes of the French model flute afford a greater variety in method of obtaining slides. By allowing the fingers to glide off the tone holes and then slowly releasing the key rims, unbroken "slides" in pitch can be obtained for the notes d_1 to $b^{\flat}{}_1$ and d_2 to $b^{\flat}{}_2$ (see figure 37).

Figure 37
Key slides

Since there are no open holes present for the notes $b^{\flat}_1$ through $c\#_2$, slides incorporating these pitches are unattainable. By using second and third partials, it is possible to slide from b_2 to f_3 thus extending the range of possible pitch slides.

The most effective slide to be found on the flute involves using the head joint only. By removing the bottom two sections of the instrument (the key mechanism segments) the resultant pitch afforded by the head joint alone approximately is a_2; approximately, because the pitch can be bent a quarter step sharp or a half step flat. Also, various head joints are slightly different in length affording different basic pitches.

There are three basic methods of obtaining slides on the head joint alone. The easiest method is by inserting a finger or similar shaped object into the head joint. The inserted object alters the air column length within the tube and effectively changes the pitch. When the object is first inserted into the head joint, the pitch descends from a_2 to approximately $d\#_2$ (see figure 38-A),

some head joints and performers being capable of lower pitches due to various head joint lengths and pitch bending.[5]

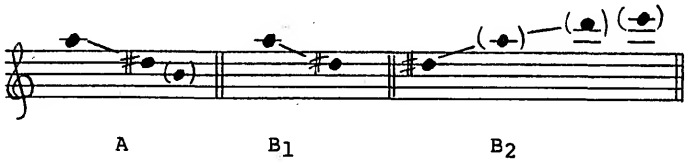


Figure 38
Head joint portamentos

As the shape of the inserted object can vary greatly, the performer needs to experiment and decide what produces the most effective slides and the relative amount of insertion necessary to produce the needed pitches. An interesting phenonmenon occurs if the blocking object is large enough to close but not seal the tube as it is inserted (such as a wooden stand devised to hold a flute). The pitch of the slide will first begin to descend until it reaches about $d\#_2$ (at 5.1 cm insertion - see figure 38-B_1). Upon further insertion, the pitch will reverse its direction and begin to ascend. At approximately 9.7 cm of insertion the original pitch (a_2) will sound. Continuation of this process will result in a pitch that

5 The author consistently achieved a tritone - not trying to adjust the embouchure at all by bending or any other means, but by maintaining the same embouchure and air pressure.

is either d_3 or e_3 at 12.7 cm (see figure 38-B_2) varying in accordance with the exact length of the head joint (they vary from about 17.0 cm to 16.6 cm). Variations or differences of these pitches can be obtained through practiced lip bends or by forcing the next set of partials to sound. The second set of partials would produce the following pitches (see figure 39).

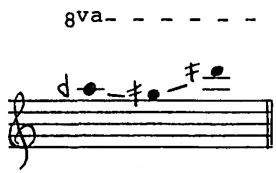


Figure 39
Second partial portamentos with the head joint

Acoustically, the tube appears to be operating in both modes simultaneously. The sounding pitch of the open pipe head joint is a_2 and the sounding pitch of the closed pipe head joint is a_1, an octave apart. The pitch that is half way between the two notes is $d\#_2$. Intuitively, if both modes were operating at the same time, the optimum point, at which the open mode relinquishes control, would be at a point half way beween the two, which pitch-wise is the note $d\#_2$.

Mathematically, the way to obtain a tritone is by consulting the harmonic series (figure 6) and finding the ratio of the numbers of the first occurring tritone. These are #5 (e_1) and #7 ($b\flat_1$). The result of dividing 7

by 5 is 1.4. Returning to the head joint which is 17.0 cm in length and subtracting 5.1 cm (the point at which $d\#_2$ occurred) the result is 1.428, which is the ratio of a tritone. Mathematically the results match the intuitive view of the two-mode (open - and closed-) explanation of the phenomenon that occurs when the head joint slide produced by insertion is used.

The two remaining methods of executing slides on the head joint are similar in that they both employ the use of the hand to achieve the desired effect. By slowly closing the end of the head joint with the flat palm of the hand, a slide can be achieved. This slide involves the notes a_2 downward to $d\#_2$ (see figure 40-A). At this point approximately the pitch will jump down to a_1, acting as a closed pipe. The tone tends to fade as the head joint approaches closure with the hand, until the final jump downward. By overblowing to the next set of partials, another slide incorporating the notes $a^d{}_3$ to (approximately) e_3 (see figure 40-B) can be attained. When fully closed, this set of overtones will produce $d\#_3$, with this ending jump from open to closed being only about a half step in pitch. A final slide involving the notes e_4 to $c\#_4$ (see figure 40-C) is possible theoretically. Practically, it is easy to play the closed $c\#_4$ but difficult to maintain a sound when the palm of the hand is removed (opened). The tone tends to diminish rapidly making this slide impractical for many flutists.

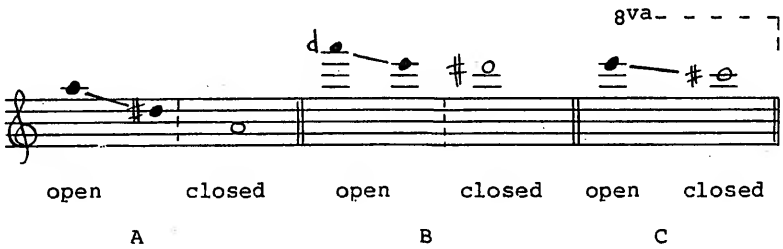


Figure 40
Optional pitches for portamentos
with head joint and hand

The third slide using the head joint alone is achieved by enclosing the open end of the pipe with the fist. By placing the end of the head joint in the crook of the hand formed between the thumb and the first finger, the player can control the slide by closing and opening his hand. The notes afforded by this slide are a_2 to a_1 (lower if lipped down - see figure 41-A). The second set of partials achieve the notes $a^d{}_3$ to approximately $d\#_3$ (see figure 41-B).

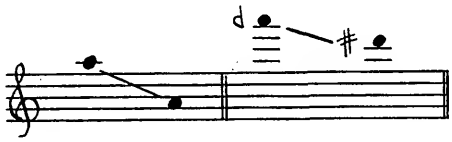


Figure 41
Portamentos with head joint and fist

Both of the slides involving the head joint alone and the hand use the same acoustical principle to achieve the protamento effect. The use of the hand at the open end of the pipe causes the air column within the tube to lengthen as the pipe is closed. This causes the pitch to lower until complete closure is achieved. It should be emphasized that all of the pitches attained by slides are subject to individual distortions, lip bending, and the peculiarities of the individual instruments used.

Special Effects

The second subheading under contemporary practices is that of special effects. This area includes the categories that use unusual or special directions in addition to or substitution of traditional monophonic sounds. There are three categories in this area.

Articulation

Tonguing practices

The use of the tongue to articulate pitches in wind playing is nothing new. In fact, single, double, and triple tonguing are as old as the instrument itself and are the expected methods for executing the beginnings of tones even today. In contemporary literature, these older methods are still used in addition to many other devices. Composers are now calling for a more varied approach to initiating sounds on the flute. By changing the attack concept to harsh, windy, or weak, the initial timbre of the note can be altered. Some of the articulations that are being used as substitutes for the more normal t or k are ht, puh, tuh, hiss (ssss), or the tongueless beginning. There are no specific notational devices for these varied articulations, but some type of explanation would be in order.

Fluttertonguing

One of the most common twentieth century articulation devices is that of fluttertonguing. It was first introduced by Richard Strauss in the "Windmill" variation

of Don Quixote (1897). Fluttertonguing (flatterzunge) is best described as "a rolling movement of the tongue, as if producing d-r-r-r."[6] It is similar to a string tremolo and is considered to be the wind equivalent. Fluttertonguing does not intensify the tone, it merely changes its sound.

There are two ways to fluttertongue. The first uses the Spanish r. It is best described as a rolling motion of the tip of the tongue against the hard pallate directly behind the front teeth (upper incisors). Some refer to it as the dental r. This fluttertongue is best in loud circumstances or with middle to upper register notes. There are two parameters to this method of fluttertonguing. By changing the breath pressure one can alter the speed of the flutter. Secondly, by positioning the tongue in different locations in the mouth, the intensity of the flutter can be changed independent of the breath pressure. It is the more commonly used of the methods of fluttertonguing. The second method of fluttertonguing is the French r which uses the vibration of the uvula against the back of the throat, similar to gargling. There is not as much flexibility in this method and there arises at times a problem in initiating the flutter. Also, some players are unable to achieve this throat action. It is suggested that a tongue tremlolo be substituted if the

6 Willi Apel, "Tonguing," in Harvard Dictionary of Music (Cambridge, Massachusetts: Harvard University Press, 1977), p. 857.

player is unable to achieve a French r flutter in the low register. Because it is a softer flutter, it is most easily used in the lower register and with softer dynamics. To achieve a raspy sound, it is possible to combine both styles of fluttertonguing at once. Fluttertonguing can also be used in conjunction with monophonic and multiple sonorities (with some difficulties), singing and playing or other such vocal sounds, harmonics, and in alternation with double and triple tonguing.

The notation of fluttertonguing varies somewhat, but most commonly is illustrated as follows (see figure 42).

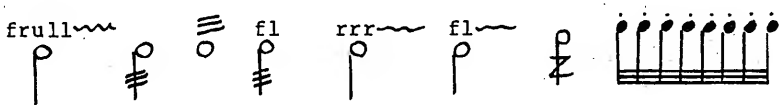


Figure 42
Fluttertonguing notation

New articulation indicators

In contemporary literature, composers are now requesting a more varied means of beginning tones. In addition to the accepted agogic and tonic accents, a wide variety of dynamic accents are appearing. By combining the accent indicator (>) with different instructional symbols, a variety of accents have become an integral part of twentieth century literature. These newer accents are

combinations of contemporary devices and the common accent. There are six new combinations. The harmonic accent ($\overset{\circ}{>}$) which sounds the fundamental and several harmonics at the same time, the flutter accent ($\overset{fl}{>}$) which uses a short burst of fluttertonguing to initiate the sound, and the breath accent ($\overset{br}{>}$) which uses the breath alone to initiate the tone. These three accents involve techniques that have been previously discussed. The remaining three accents incorporate techniques which will be discussed later in this chapter. They are the key accent ($\overset{+}{>}$), achieved by using key clicks in conjunction with the tongue, the blowing accent ($\overset{bl}{>}$), which is a toneless whistle (similar to what many flutists use to warm the instrument before playing), and the singing accent ($\overset{sing}{>}$), which uses the vocal chords to help initiate the accented note. These newer accents display a tendency that is prevalent in contemporary music, that of combining the traditional with totally new devices.

Key clicks

Another type of articulation involves the phenomenon caused by the clicking of the keys on the flute. For many years flutists have employed the snapping shut of the left hand g key to aid in production of lower register notes. This method of helping the notes to speak faster is

effective because the snap creates "an acoustical impluse that aid[es] in setting the large air column . . . in vibration."[7] Contemporary use of this technique has expanded to include other facets of acoustical theory.

Key snaps or clicks (as they are sometimes called) produced on the flute yield pitches that are the same as the fingering used. Actually, two pitches are achieved. These pitches are the lowest pitch that would be sounded and the first overtone, which would be an octave higher because of the open pipe theory upon which a flute is based. The lower of the two pitches is the dominant pitch and will be heard. The lower register affords a much better response to this technique than does the upper octaves as they tend to be extremely soft dynamically.

There are two kinds of key slaps when the flute is an open pipe. The first is referred to as a blown key slap or a slap with air. It involves clicking the key when the note is initiated - be it held or staccato. It results in a popping sound on the pitch fingered. The notation most often encountered involves placing a cross (+) above the note or a diagonal slash through the note head (see figure 43-A). The second open pipe slap involves only the snapping of keys with no air being blown. The pitches will sound as the note fingered. This works best and almost exclusively in the lower register (there are a few

7 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 21.

exceptions). The notation, though not standardized usually involves replacing the note head of the desired pitch with an x or a + (see figure43-B). The range of open pipe snaps without air is from b to c_2 (see figure 43-C).

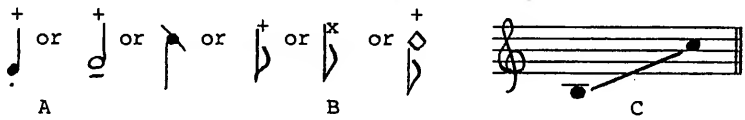


Figure 43
Key slaps

By closing the embouchure hole with the tongue or chin, the flute becomes a stopped pipe. The pitches then afforded by slapping keys are quite different from those attained on an open pipe. Rather than sounding the same pitches when slapped, tones a major seventh (M7) down from the fingered note are produced. The exception is the lowest note attainable on the flute (either b or c_1, depending on the individual instrument). With the embouchure hole closed, the slap achieved on the flute's lowest fingered note sounds an octave below the fingered pitch, rather than a major seventh down (see figure 44).

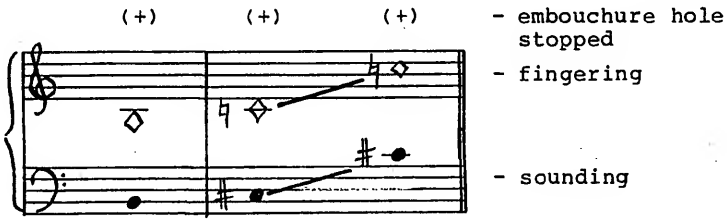


Figure 44
Closed embouchure hole key slaps
resulting sounds

There is no standardized way to notate a closed embouchure hole key click, but several methods are being employed in the literature. The most common sign is the cross, +, of the open pipe notation placed in parenthesis (+). Many times the composer will go one step further and indicate the fingered pitch and the sounding pitch for greater clarity (see figure 45).

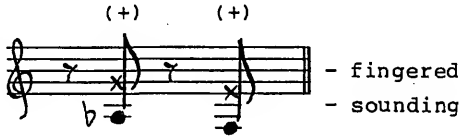


Figure 45
Closed embouchure hole key slap notation

Obviously, since the embouchure hole is sealed, these slaps are first of all produced without the breath and secondly, very short. Strangely enough, these key slaps project relatively well, but only in the low register. In general, the dynamics in both types of key slaps (stopped or open) depend on the force of the slap itself. Due to their nature, series of rapidly executed key slaps are usually unplayable because of the awkwardness of the fingerings. Also, the notes b_1, c_2, and $c\#_2$ do not yield good key clicks, blown or slapped, most likely due to the fact that their fingerings involve very little of the tube of the flute with no keys to snap.

Percussive tongue articulation

The last device under articulation concerns the percussive effects of the tongue itself. In addition to the previously mentioned accents, the sounds that can be created with the tongue can also be used in initiating pitches. Most of these have already been discussed, such as fluttertonguing, tremolo tonguing (used in place of fluttertonguing in the low register for those unable to roll the uvula - sometimes referred to as "doodle" tonguing), and hissing sounds done in conjunction with the pitch. One of the last to be explored is that of tongue clicks. These are the sounds created by sharply snapping the tongue from the top of the mouth down into the soft under part of the lower jaw, producing a "tok" percussive sound. These clicks can be done in two ways, either with the embouchure hole open or by closing off the embouchure hole between the lips. The first method produces very soft pitches, almost inaudible if not being used on an electronically amplified flute. The second method yields far better tongue clicks, in that they are more resonant. By enclosing the embouchure hole with the lips, the tube of the flute helps to magnify the sound being produced. The range of the clicks varies drastically due mostly to the different shapes of performer's mouth cavities when they produce the click. Specifically, each fingered note

yields an approximate range from a major third (M3) to an octave below the fingering, again depending mostly upon the performer. Notation for tongue clicks is not standardized. Often, tongue clicks are used in combination with key slaps to aid in resonance and projection. Tongue clicks seem to be a rather unused device so a common notation has yet to survive various mutations. Figure 46 shows one method of notating tongue clicks.

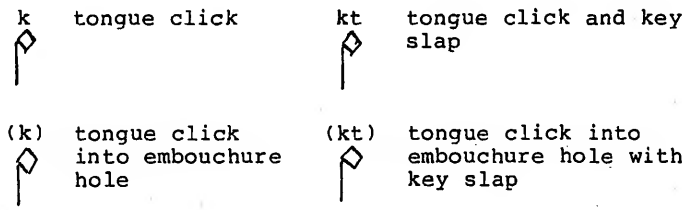


Figure 46
Tongue click notation

Another unusual type of articulation using the tongue is called a tongue stop or tongue ram. This technique is accomplished by enclosing the embouchure plate with the lips and stopping the embouchure hole quickly with the tongue. This device yields the same resonance sound as does the key slaps with the embouchure hole stopped. The differences between the two are that the key mechanism noise is eliminated in tongue rams and the latter are noticeably louder than slaps. Dynamics are controlled by

the amount of breath that is forcefully exhaled. Notation for tongue rams usually will include an explanatory note but are commonly seen as follows (see figure 47).

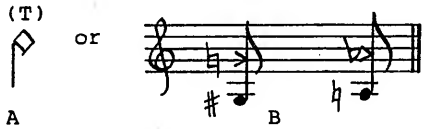


Figure 47
Tongue ram notation

As seen in figure 47-B, the pitches that occur sound a major seventh (M7) below the fingered note.

Noise Elements

The second category under special effects is noise elements. As the name suggests, traditional performance techniques are replaced by various devices that elicit unusual sounds from the instrument. One such large area of noise elements involves those devices that can best be described as colored noise. These techniques use air being blown across or through the instrument without necessarily involving normal tone production.

Open embouchure noise elements

The term colored noise engulfs a diverse array of sounds that can be divided into two areas of concentration. The first area involves those sounds which are produced on the flute when the embouchure hole is open (normal playing position). By using the traditional playing position without producing a tone, the fingered notes will create discernable pitches even though they are by nature rather soft. If blown intensely, overtones will result. A low, rasping sound can be obtained by strongly blowing with the aperture of the lips placed very close to the embouchure hole. Other than changing the fingering, the only remaining method of altering the timbre of these notes is through the use of fricative and sibilant consonants (vowels have little if any effect). Another use involving the open embouchure hole position is to incorporate trills, tremolos, and even fluttertonguing to alter the character of these toneless (by traditional standards) sounds. In addition, it is possible to whistle through the teeth across the open embouchure hole producing some interesting sounds.

Closed embouchure noise elements

The second area of colored noise involves the use of the flute when the embouchure hole is closed. Well known in this area is the jet whistle effect which is produced by covering the embouchure hole with the lips so that no air escapes. By blowing into the flute in this manner, a "swoosh" sound is created. This sound was used by Hector Villa-Lobos in The Jet Whistle in 1953, and has since become a popular device. Flute players have used this technique for many years as a quick way to 'warm-up' the instrument. The jet whistle sound can use any of the articulation methods, from fluttertonguing to tongue stops, and its dynamics are very versatile. The timbre, pitch, and volume of the jet whistle are governed by four parameters. The first parameter influences the pitch and timbre of the jet whistle. It is involved with the angle at which the air is directed into the embouchure hole. Higher partials are the predominant sound if the air stream is blown into the embouchure hole (as when producing low tones) the sound of the jet whistle will be accordingly lower (approximately one octave lower), because the lower partials are stronger (see figure 48).

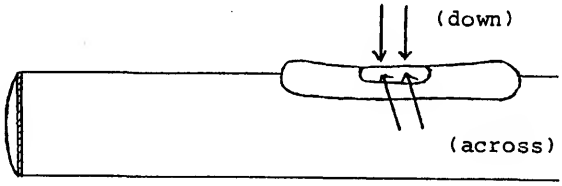


Figure 48
Air stream direction into
embouchure hole

The second parameter of control for jet whistles influences timbre and pitch. Unlike the open embouchure hole noise elements, the vowel sounds are audible in jet whistles because of its closed embouchure sound production mechanism. Through the use of vowel sounds, the shape of the mouth cavity can be altered. This alteration affects the tonal quality of the sound, causing it to fluctuate approximately as much as an octave. By changing from the vowel [i] to [u], the mouth cavity will increase in size causing the pitch to drop accordingly. This difference in pitch is controlled by the performer and will vary from player to player.

The third parameter is concerned with volume control and to a degree also pitch and timbre. In the jet whistle, volume is controlled by the breath pressure and can range from loud shrieks to soft sounds that are very similar to residual tones (see Multiple Sonorities). High pressure (forceful blowing) will result in high volume

levels. Similarly, forceful breath pressure will strengthen the upper partials of the sound causing the pitch to rise and the timbre to change. Unfortunately, loud jet whistles can only be sustained for a second or two before the player is out of air.

The first three parameters are very interdependent upon one another, each influencing the effect of the other two. The fourth parameter primarily is the range determinator of the other paramenters. It involves which notes are fingered when the jet whistle is blown. Essentially, it follows the chromatic fingerings in that higher notes result in higher sounding jet whistles. In this respect, it also affects timbre in that by using third and fourth octave fingerings, the higher partials are emphasized resulting in more intense sounds.

Although not standardized in its notation, the jet whistle's various determinants should be taken into consideration by composers when they require its use. In his book The Other Flute: A Performance Manual of Contemporary Techniques, Robert Dick proposes a notational system for the jet whistle which, although it is imposing upon first glance, does incorporate all of the various paramenters of the sound produced (see figure 49).

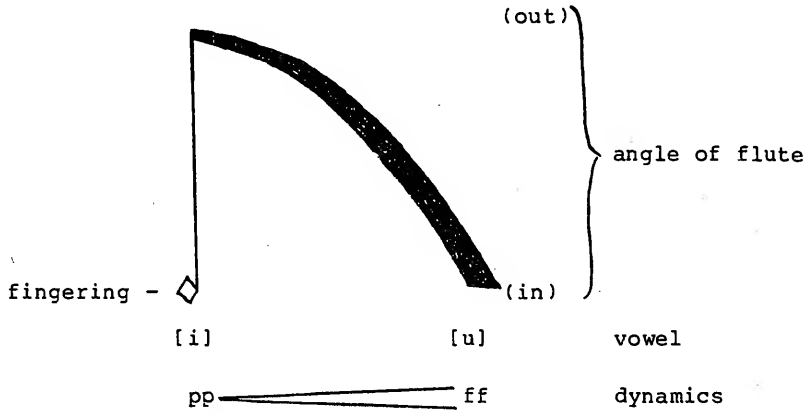


Figure 49
Jet whistle notation[8]

There are two remaining techniques in the closed embouchure hole colored noise area. The first is similar to the jet whistle except that the player must inhale rather than exhale. The sound is quite diminished in volume and is often times used to extend a phrase that would otherwise by necessity be broken. Vowels are very effective on the inhaled jet whistle, but as suspected, consonants are unusable.

The second area involves whistling into the closed embouchure hole. This can be done by either whistling through the lips while covering the hole or by whistling through the teeth into the closed hole. Some

8 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 135.

experimentation by the performer as to which method is the most successful for his style of playing is necessary.

Another area of the category noise elements can best be described as brass usage of the flute. It is sometimes referred to as buzzing and involves treating the embouchure hole of the flute as a lip-reed instrument mouthpiece. The sound is produced by buzzing the lips into the embouchure hole in the same manner as a brass player buzzes into his mouthpiece. A variation of this technique is to remove the mouthpiece segment and buzz the lips on the remaining two sections of the flute. The results are not as satisfactory sound-wise, and the necessity of removing part of the instrument imposes a delay in performance manipulation. The pitches produced by buzzing into the embouchure hole sound approximately an octave lower than notated and are easily subject to lip bending. When overblown, the twelfth sounds rather than the octave. This is due to the fact that by using a lip-reed tone production process, the flute becomes a closed pipe capable of only the odd numbered partials (see figure 6). Pedal pitches (two octaves below the pitch fingered) on the closed fingerings (low c_1 or low b depending upon the flute itself) are possible if blown very softly. Standardized notation for buzzing on the flute has not yet been adopted. It is therefore necessary for the composer to indicate the desired results verbally.

A suggested notation would include not only the correct fingering, but also the resulting pitch. There are two basic problems encountered with buzzing on the flute. The first becomes evident when the performer begins to practice these techniques. The buzzing process is often very irratative to the player's lips causing swelling and loss of control in normal playing. It also creates large quantities of saliva which must pass through the instrument causing pads to gum and rot and the mechanisms of the keys to rust. The second problem area occurs because of the flute's construction. It is designed as an open pipe and closing it creates an inharmonic series. This results in a "lack of harmonic reinforcements [which] lead to uncertainty of pitch placement . . . (semitone either way) . . . as well as a kind of timbre that can only be described as extremely vulgar, not at all unlike a Bronx cheer."[9]

Vocalized and non-vocalized noise elements

The third area under the category noise elements involves vocalized and non-vocalized sounds that are to be produced through the instrument or mouthpiece. The vocalizations that are commonly employed are speaking, whispering, laughing, and shouting and enunciating vowels

9 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 29.

and consonants. Non-vocalized sounds include grunts, groans, growls, mutterings, barkings, hisses, yells and screams, yelps, coughs, whistles, and assorted squawks. All of these elements can be sounded and articulated in conjunction with fingered pitches: with pitches produced through the instrument without specific fingerings indicated, or used with the mouthpiece alone. Notation for these various sounds is by no means standardized. Composers have borrowed from vocal notation in some instances and have created new graphics to display the desired sounds in others.

Stage Directions

The third and final category of Special Effects is best labeled as stage directions. This category encompasses a large assortment of miscellaneous directions to the performer varying from general to specific instructions. Covered in general directions one would usually find the instructions for stage spacing, the actual set-up of the performance area (on the revers, around the concert platform, in the auditorium) and any off stage usage that might be required, be it audio or visual. This includes pieces that require the performer to begin playing while still backstage and enter during the performance (Masks by Oliver Knussen is an example of this type of staging).

The visual aspects include everything from lighting of stage and auditorium to costumes for the performer, giving instructions for body movements, facial expressions, and theatrical gestures. Body movement includes instructions for standing or sitting during different sections or for the entire piece, and even directions such as playing into an open piano with the sustaining pedal down. All of these techniques require verbal descriptions to aid the performer in understanding the intention of the composer as each will develop his or her own individual method of notating these directions. As mentioned before, Masks by Oliver Knussen is a good example of stage directions for the performer, as it requires facial and body instructions for performance.

One other stage direction that must be included is that of amplification and the use of recording devices in performance. Because these techniques involve external machines, the problems encountered with their usage will not be thoroughly discussed in this paper, but it is important to include them in this category of stage directions.

Amplification of the flute can be achieved in two basic manners, by contact microphone or through the use of individual air microphones. Primarily these are used either to increase the volume of the flute sound which can be useful with some of the softer contemporary techniques

such as whistle tones, or to alter greatly the timbre of the flute. Both of these types of amplification are used in Voice for solo flute by Toru Takemitsu. The utilization of recording equipment has become a popular device in contemporary literature, but will not be discussed here as it can no longer be classified as solo flute literature. The possible exception to this area might be the use of tape loops that are recorded and played during the performance. Such is the case with Interpolation by R. Haubenstock-Ramati. This piece requires the flutist to perform a duo or trio (as desired) with himself. This can be done live through the use of a tape loop - recording the first version of the mobile and them immediately replaying it while version two is performed, thus creating a duet. It can also be performed with the duo version being prerecorded for the sake of ease in manipulation of the machines. Any of these newer devices and techniques will require explanations to the performer in order that the piece can be properly recreated or created as the case may be.

Multiple Sonorities

Historically,the development of the flute and other woodwind instruments has been towards the "emission of single sounds of maximum timbric homogeneity throughout

the range of [the] instruments."[10] Contemporary practice has expanded these characteristic idioms to include multiple sonorities. This third subheading includes all of the contemporary techniques that produce two or more simultaneous pitches. There are five categories in this subheading. The first is that of residual tones.

Residual Tones

Residual tones are the "noise-like resonances of the tube of the flute.[11] Acoustically, a residual tone consists of a weak fundamental with a few of its higher partials sounding. To achieve this sound, the flutist must use a wide aperture opening and project a relatively unfocused stream of air into the flute. Residual tones can be produced on all of the possible fingerings of the flute, but sound most readily on the two lowest pitches (partials) of any given fingering. A full range of dynamics is possible with residual tones, but when played strongly, the possibility of achieving clear resonances of the higher partials of the fingered note occurs. At softer dynamic levels, residual tones may be used in conjunction with whistle tones. A suggested method for

10 B. Bartolozzi, New Sounds for Woodwind (London: Oxford University Press, 1967), p. 3.
11 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 133.

notating residual tones is as follows[12] (see figure 50).

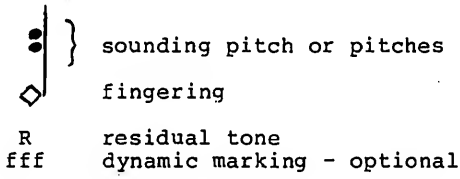


Figure 50
Residual tone notation

Random Pitch Effect

The second category of multiple sonorities is unusual in that the multiple sonority achieved is an illusion. It is referred to under various names such as "pedal key" or "random pitch" effect in an effort to describe the resultant sound. It is actually a very fast tremolo that results in a shimmering effect giving the aural illusion of consisting of several notes at once. This technique is done by using the fingerings of the left hand, g_1 to $c\#_2$ and its overtone projections: g_2 to $c\#_3$; d_3 to $g\#_3$; etc. By rapidly trilling the two trill keys on the right hand (d# and d trill keys - see figure 16) while randomly or in some set pattern moving the fingers of the left hand, this shimmering effect can be produced. The name pedal effect

12 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 133.

implies some type of pedal point or a "long-held note, . . . sounding with changing harmonies in the other parts."[13] The pedal in this technique actually changes pitch slightly from $d\sharp_2$ to $d\sharp\sharp_2$ (with the same transitions for the various overtones). It is caused by the opening of the two trill keys, d# and d. Their placement at the upper end of the flute (toward the embouchure hole) allows for all of the notes of the left hand to be used. The change in the pedal pitch, from $d\sharp_2$ to $d\sharp\sharp_2$, is caused by the shortening of the remaining length of the tube of the flute moving upward from the notes g_1 to $c\#_2$. No standardized notation is indicated in the literature, and explanatory notes detailing the requested effect are necessary and must be added to the already established tremolo or trill configurations.

Sing, Hum, and Play

The third category of multiple sonorities involves singing or humming while simultaneously producing pitches on the flute. The result is an unusual timbraic combination of flute and voice that varies from performer to performer due to differences in vocal timbre. This practice was introduced into the musical scene by various jazz and pop musicians such as R. Kirk, I. Anderson, and

13 Willi Apel, "Pedal Point," in The Harvard Dictionary of Music (Cambridge, Massachusetts: Harvard University Press, 1977), p. 651.

H. Mann. It has since become a very popular device in twentieth century avant-garde literature.

Since the vocal portion of this technique involves opening and closing the throat to initiate the sounds, it is necessary for the flutist to maintain a constant flow of air in order to compensate for the fluctuation caused by singing. The voice over the flute does not visually effect the embouchure, at least in the middle and upper registers. In the lower octave (b to c_2), "vocal vibrations disturb the embouchure, causing higher partials to appear instead of the desired pitch."[14] This explains why many flutists find it difficult to sing (or hum) and play in the lower register as they discover that the pitch tends to 'jump up' an octave too easily.

The most simple use of this device is for the flutist to sing in unison or at the octave of the played pitch. This combination affords a very strong acoustical reinforcement of the played pitch and is much easier for the performer to sing. Even when singing (or humming) the same pitch, the voice can be distinctly heard or separated from the flute's sound. Playing and singing different intervals, such as seconds, thirds, fourths, fifths, etc., are more difficult because the performer not only must cope with the flute's tone production, but must also aurally find pitches vocally while continuing to play.

14 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 30.

This more complicated use of singing and playing different intervals can be accomplished in several various manners. The most simple is to sing a single pitch while the flute plays a melody. The reverse, the flute holding a pitch while the voice sings a melody, is more complicated than the first. Obviously, the most complex is when the voice and the flute are treated as two separate melodic lines, which incurs problems not only in notation, but also in performance ability.

Another facet of singing and playing is the production of combination tones. When two tones are sounded together, a third resultant tone can be distinguished from the other two. Its frequency is either "the difference (differential tones) or the sum (summation tones) of the frequencies of the other two primary tones or of their multiples."[15] Summation tones are not as easily distinguishable as are differential tones from the two primary pitches. Most of the written literature concerning combination tones in conjunction with flute and voice refer to the produced third tone as a differential tone because it is heard below the other two pitches as in accordance with its mathematical formula ($f_2 - f_1 = f_d$). This resultant or combination tone is difficult to hold because any variation in the sung pitch will cause the tone to fluctuate as much as, or more than, a half step,

15 Willi Apel, "Combination Tone," in Harvard Dictionary of Music (Cambridge, Massacusetts: Harvard University Press, 1977), p. 185.

while the sung note moves only a small amount in pitch. Because of this phenomenon, it leads one to believe that rather than being a differential tone, the resultant is instead a residue tone. As defined in Grove's Dictionary of Music and Musicians, a residue tone is "the lower-pitched tone that may be heard when a group of harmonically related tones is sounded quietly together. It can be distinguished from the difference tones because if all of the components are raised in frequency by the same amount, the residue tone also rises, though not by the same amount. If a difference tone were predent it would remain constant in frequency."[16] Another clue here is the fact that residue tones occur when the pitches are quietly sounded. On the other hand, differential tones are the resultant tones when the pitches sounded are both loud in volume. The dynamic level of sung and played pitches on the flute is not loud and is more easily achieved when blown and sung at softer volume levels. The exact origin of residue tones is somewhat obscure and they are not as yet fully understood. These residue tones are less pronounced if the vocal part is above the flute line. This is due mainly to the more open structure of the flute's harmonic (overtone) series.

16 "Residue Tone," in The New Grove's Dictionary of Music and Musicians, Vol. 15, Sixth Edition, edited by Stanley Sadie (London: Macmillan Publishers Limited, 1980), p. 755.

Various types of notation are present in the literature and are usually accompanied by verbal descriptions. This is necessitated by the fact that the sung note is not always given a specific pitch by the composer, but is left up to the performer. Figure 51-A illustrates one type of notation that specifies both the sung and played pitches with the "s" indicating the vocal note. Figure 51-B is an example of the notational practices of allowing the performer to sing any pitch he or she is able to sing with the specified flute pitch. Figure 51-C illustrates the notation of unison sung and played pitches with vowel changes occuring which alter the timbre.

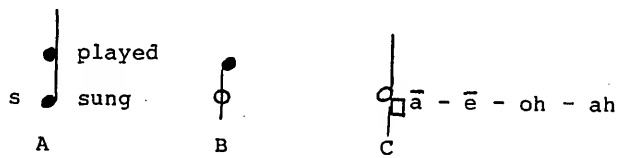


Figure 51
Sing and play notation

Often times composers will incorporate the use of two lines of staff to indicate the sung and played pitches (see figure 52).

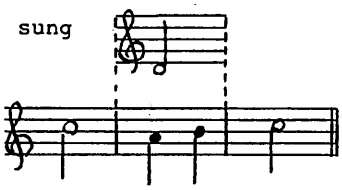


Figure 52
Two staffed sing and play notation

This variation in notational practice is in part due to some of the problems that arise with sung and played notes on the flute. First of all, the vocal range is limited by the individual performer, whether male or female, and by specific vocal tessituras. Indicating the sung pitches at times eliminates certain voices unless the octave substitution is suitable to the composer. In many cases, this forces the male performer to sing falsetto in order to achieve the desired closeness of the sung and played notes. This probably is one reason why some composers do not specify the sung pitch, such as Toru Takemitsu in his Voice for the solo flute.

Another problem with sung and played notes is that of its effect on vibrato. The throat in effect is doing double duty by singing while playing. This causes vibrato to be almost ineffective. The fluctuation of the air stream that is associated with vibrato causes the sung and played pitches to dissipate and become very difficult to sustain.

One other aspect of a problem encountered with sung and played pitches is that when they are performed in conjunction with multiphonics, the results are very difficult to achieve and often rather unsatisfactory. The reason for this unhappy union is that multiphonics (which will be discussed in CHAPTER V) are rather tenuous in their tone production and the singing tends to disrupt the process. This is not saying that singing with multiphonics is impossible, as it is not, but it requires an advanced performance ability involving adroitness and flexibility of the flute embouchure and could be quite frustrating to the less advanced player.

Double and Triple Stops

The fourth category of multiple sonorities is that of double and triple stops for the flute. These are short duration sonorities consisting of two and three pitches. Acoustically, these sonorities "result from overtone relationships and/or fingerings which provide two or more possible tube-lengths for use in the production of tone."[17] Physically, the flutist "aims" between two pitches letting the embouchure allow both to sound by increasing the size of the aperture. Double stops are the

17 J. C. Heiss, "For the Flute: A List of Double-Stops; Triple-Stops; Quadruple-Stops; and Shakes," Perspectives on Notation and Performance, Edited by B. Boretz and E. T. Cone (New York: W. W. Norton and Co., Inc., 1976), p. 114.

beginnings of multiphonics on the flute, but only the lower partials are allowed to sound limiting the sonority to two or three pitches.

Basically, there are three categories or ways to produce this type of multiple sonority. The first area involves those sonorities that are attained by using standard fingerings. These are based on harmonics and can be achieved either by overblowing upwards to reach the two notes or by relaxing the embouchure and allowing the pitches to bend down to the sonority. This process requires much more air because it is necessary to widen the aperture of the lips so that both sounds will be produced. Essentially, the player allows both the fundamental and its first and second overtone (depending on whether it is a double or triple stop) to sound. The simplest double stop in this category is that of the octave (see figure 53-A).

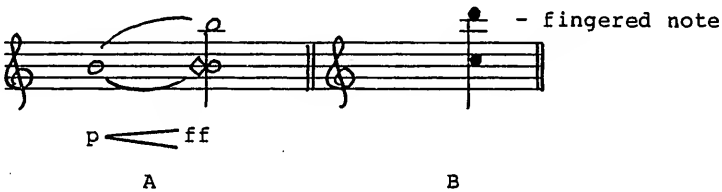


Figure 53
Double stop notation

Most performers find it easier to achieve this sonority if they allow the dynamics to help in their production. Figure 53-B is an example of allowing the double stop to occur by fingering a second overtone octave note (see figure 18) and allowing the lower partials of its tone to sound.

The second area concerns those sonorities that use altered fingerings. As discussed under Monophonic Sonorities, altered fingerings allow closely aligned harmonics to sound in juxtaposition with the original harmonic series due to their multiple tube-lengths. By allowing these harmonics to sound together (through the use of a wider air stream - less focused - into the flute), many various double stops are possible (see figure 54).

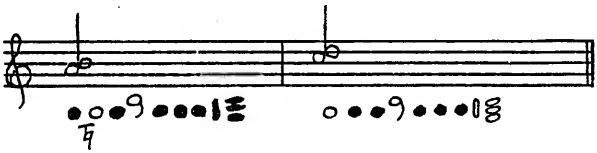


Figure 54
Double stops

The third area of double stops are those sonorities which are achieved through the use of standard fingerings with the addition of the trill keys (d and d#). This is a much smaller category as the two trill keys restrict its range to the few notes it can achieve. Of all of the

multiple sonorities, these are the easiest to produce. Figure 55 shows the most common use of this category.

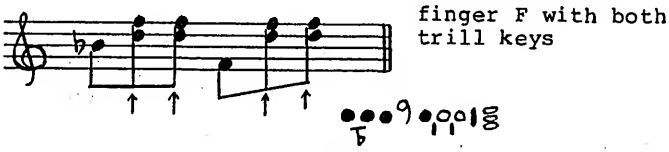


Figure 55
Double stops

Since much of this area is still in various stages of exploration, notation is somewhat experimental. The primary element for clarification must be that fingerings for the multiple sonority be provided along with explanations as to what effect is desired.

The last category of multiple sonorities is that of multiphonics. Because of its importance in avant-garde literature, multiphonics will be dealt with as a separate chapter.

CHAPTER V
MULTIPHONICS

A multiphonic is a sonority that is generated by means of a fingering that allows for the simultaneous sounding of from two to six audible pitches. The interval relationships of these pitches within the sonority varies from intervals of microtonal nature up to those intervals which are larger than an octave, such as major tenths (M10's), M11's, and M12's. Because of the abundance of mathematical possibilities that arise from this varialble arrangement of pitches, there are over 1,000 possible combinations of multiphonics theoretically available.

Though the components of a multiphonic consist of a fundamental and select harmonics of "theoretically equal amplitude,"[1] each of the individual pitches displays a unique timbre and intensity. Depending upon the sonority, the pitches range from bright, clear sounds to the more muted and fuzzy blends of tones with all of the possible combinations in between. Most commonly, multiphonics on the flute are soft dynamically and not cleanly defined in terms of pitch and timbre. This is due to the fact that the aperture is not sharply focused to produce clear, single pitches, but rather it is widely aimed in order to

1 G. Read, Contemporary Instrumental Techniques (New York: Schirmer Books, 1976), p. 150.

obtain the diverse array of multiphonic pitches available. Another aspect of flute multiphonics that should be considered by composers and performers alike is that the sounds "rarely attack at the same instant or at the same rate of speed."[2] Many times the pitches actually seem to oscillate between tones or one frequency will dominate and then relinquish control to another. Controlling the sonority becomes a fractiuous affair and the flutist soon realizes that multiphonics are to be considered short duration effects until much greater flexibility and control are attained.

When attempting to learn multiphonic techniques, it becomes evident to the flutist that production of these sonorities is basically a trial and error process. Players and instruments differ, and a synergetic effort at combining the various aspects of tone production in seemingly atypical applications must be made in order to achieve these effects. The techniques employed to initiate multiphonic sonorites are similar in concept to those used in overblowing fingerings of the fundamental octave to produce the upper partials (see CHAPTER III, page 35). The major difference with multiphonics is that the air stream used is "broadened vertically to reach the target area of each pitch and the air speed is mediated between the velocities needed to play the notes

2 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 33.

individually."[3] This broader dispersion of the air velocity and direction allows more pitches to sound simultaneously. It increases the angle at which the air stream strikes the embouchure hole (referring back to the third principle of tone production: air column direction) by creating a larger aperture between the lips. This widening adjusts the air stream angle so that pitches from all three of the octaves (figure 18) can possibly be employed. One of the adverse effects of this embouchure change is that the larger aperture causes more air to be lost than would normally be used for a single sonority of the same duration. Also, when trying to sustain a multiphonic, the aiming between notes to achieve the sonority tends to increase the effect of one tone becoming predominate. As mentioned earlier, multiphonics are at times slow to respond and tricky to execute. This often leads to unintentional starts and stops on the part of the newer performers of this effect.

The physical means producing these sonorities has been described in various and somewhat diverse manners. But since all flutists are different, this is to be expected. Basically, there are two methods available to help initiate multiphonics. They involve beginning either with the lowest or highest frequency of the sonority. Sounding the lowest frequency available of a given fingering, the

3 Robert Dick, The Other Flute: Tone Development Through Extended Techniques, Vol. I (New York: Edu-tainment Publishing Co., 1978), p. 32.

player must increase the lip tension which alters the air stream direction and forces the air pressure beyond the normal level. This process is very similar to the one used to obtain harmonics from the fundamental octave, but the lips must be spread slightly creating a larger aperture so that the lower pitch is not lost when the upper tones are activated.

The reverse method of beginning a multiphonic is to first produce the highest frequency available. By decreasing the lip tension and widening the aperture to include the lower (as well as higher) pitches, the multiple sonority can be produced. Either method can achieve the desired texture and it becomes a matter of individual technique for ease and accessibility of the particular multiphonic. Some multiphonics are more easily achieved with one method than the other and only by trial and error can the performer discover which process is better suited to his or her needs. Furthermore, the flutist need not be overly worried about harmful effects to the embouchure incurred through playing multiphonics. The flexibility, strength, and exactness of lip placement and control will greatly aid the performer in normal tone production.

Acoustically, a multiphonic results from "overtone relationships and/or fingerings which provide two or more possible tube-lengths for use in the production of a

tone."[4] This type of statement or some similar such wording, is the most commonly encountered explanation for the phenomenon of multiphonics. Its shortcoming is the fact that the theoretical aspects of its physical origins have, until now, been left unexplored and unexplained.

To examine the occurance of multiphonic sounds some basic theoretical principles involving the flute and sound energy dispersion should be understood. The energy output of the flute is distributed along the harmonic series with the higher frequencies representing more energy. With a given energy input, the output harmonic series will be determined by the effective acoustical length of the flute. The player supplies the initial energy and the flute concentrates this energy into the harmonic series, the fundamental wave length of which is determined by the fingering in use. The flute focuses its input into a harmonic series but is not capable of amplifying this series. The distribution of this energy input is determined by the player through the velocity of the air stream that is injected into the embouchure hole. Higher energy input gained through high velocity air pressure will result in the production of higher frequencies. This is because the kinetic energy (E) per unit volume is proportional to half the product of the density of air

4 J. C. Heiss, "For the FLute: A List of Double-Stops; Triple-Stops; Quadruple-Stops; and Shakes," Perspectives on Notation and Performance. Edited by B. Boretz and E. T. Cone (New York: W. W. Norton and Co., Inc., 1976) p. 114.

(ρ) times the square of its velocity (v) (see figure 56).

$$E \propto \frac{\rho v^2}{2}$$

Figure 56
Formula for energy in relation
to density and velocity

With this velocity of air pressure, the sounding of lower frequencies will be less likely to happen, not because the energy is being removed or taken away from the lower levels, but simply because the higher energy level will bring the higher frequencies into play. When producing a multiphonic, the player adjusts embouchure and air velocity so that the energy input into the flute will excite as many partials of the harmonic series of that particular fingering as possible. This is functionally what occurs when multiphonics based on the overtone relationships of the harmonic series are produced.

The second part of the multiphonic definition involves fingerings which result in the creation of several tube-lengths within the flute. These fingerings involve venting, whether complete or partial (as in a rim vent). Physically, a vent that corresponds to the diameter of the flute gives an effective acoustical length as measured.[52*05] For example, the lowest note (c_1 or b, depending upon the flute) is measured from the face of the

cork stopper to the open end of the flute - giving its effective acoustical length. This is the only note that is vented to the diameter of the flute as the finger holes are not as large. As mentioned earlier, venting in conjunction with the second overtone octave (see figure 18) involves opening keys at high density points to release or let escape some of the energy thus creating an antinode (a point of lower density) which in turn helps to raise the pitch. Venting as connected with multiphonic fingerings does not occur at the points of maximum or minimum density in the wave length series, but rather the venting process creates changes in the density at points in the air column that are neither a node nor an antinode. This theoretically creates several different air column or tube-lengths within the flute. Allowing these various lengths to resonate produces the multiple sonority effect with seemingly unrelated pitches sounding.

Half-holing or partial venting (available on French model flutes) allows for a lower pitch than if completely vented. Not as much energy can escape and therefore the effective acoustical length of the tube will be longer. This technique affords muted or fuzzy-sounding pitches because the venting is not complete and only part of the energy is released.

With every fingering yielding at least one multiphonic and the total possibilities numbering over 1,000, it becomes clear that some type of classification system must be instituted to enable the composer and performer to locate and utilize these various multiphonics. Several systems have been used by compilers of flute multiphonics, each adhering to their own categorization principles. Lawrence Singer defines three kinds of flute multiphonics as those sonorities with dominating high, medium, or low frequencies.[6] In his book The Avant-Garde Flute: A Handbook for Composers and Flutists, Thomas Howell lists his collection of multiphonics by pitch (in an ascending 31 tone sequence) from the lowest to the highest with that pitch as the original (fundamental) and not a derived frequency.[7] This index by pitch then is used to locate the numerically listed multiphonics. The Other Flute : A Performance Manual of Contemporary Techniques by Robert Dick categorizes multiphonics into three sections.[8] The first are those sonorities based on natural harmonics. They are divided into sets which consist of the intervals of octaves, P5, P4, M3, m3, and M2. Intonation varies within the sets but can be

6 L. Singer, "Woodwind Development: A Monophonic and Multiphonic Point of View," Woodwind World: Brass and Percussion, Vol. 14, no. 3 (June 1975), p. 14-16.

7 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 63-180.

8 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 81-127.

controlled through bending the pitches. Also, it is pointed out that all factors controlling notes within a specific set (such as dynamics) are similar in their response. The second section is based on the fingerings of the pitches of the chromatic scale. Many of these incorporate alternative fingerings which produce varied multiphonics, with both diatonic and microtonal intervals. The final section incorporates those multiphonics created from fingerings based on microtonal segments. These so-called segments are short scalar passages, usually three to four notes in length, produced by venting one hole and continuing to close the remainder of the holes as if fingering a descending chromatic scale. The results yield sonorities of unique timbre that can be performed with greater facility between multiphonics than most fingerings will allow.

Organizing a multiphonic classification system based on the acoustical construction of the flute is a logical categorization of the various sonorities possible. The first category consists of those sonorities based on the overtones of the harmonic series. These multiphonics involve standard fingerings and their respective upper partials. For example, see figure 57.

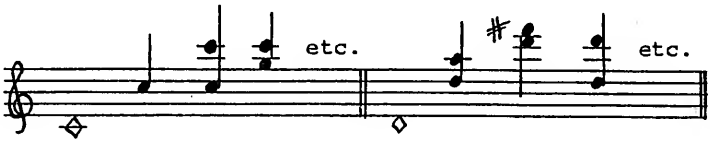


Figure 57
Overtone based multiphonics

The second category would involve those sonorities that incorporate the concept of venting. This process of opening holes (complete venting as with a closed hole flute) can be divided into two subcategories. One group consists of the venting process in conjunction with fingerings that produce long tube-lengths on the flute (see figure 58).

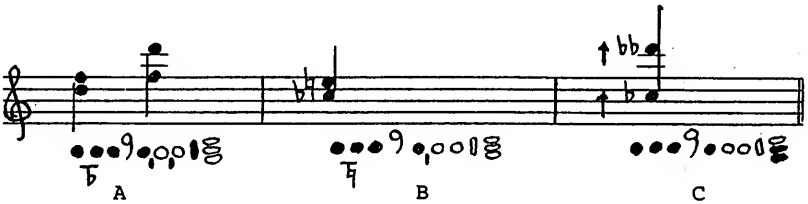


Figure 58
Long tube-length multiphonics

The second subcategory involves those fingerings that yield short tube-lengths to be used with the venting process (see figure 59).

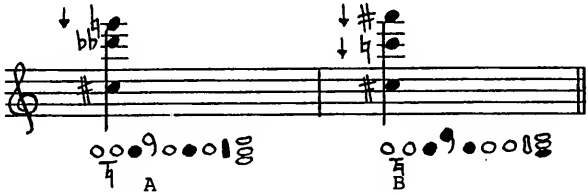


Figure 59
Short tube-length multiphonics

The final category is made up of those sonorities that use complete venting, partial venting, and the use of the harmonic series in combination to achieve multiphonics. There are three subcategories in this grouping. The first involves those sonorities that incorporate the fingerings of the second overtone octave (see figure 18). These fingerings are completely vented third and fourth partials based on the harmonic series of that particular fingered fundamental. By using these higher fingerings and playing the resultant "under" partials, pitches that do not seem to fit the correct harmonic series are elicited (see figure 60).

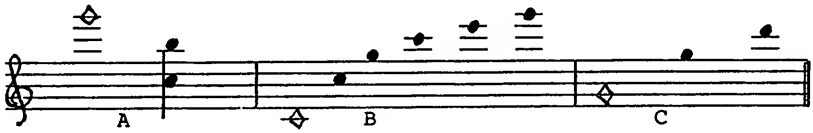


Figure 60
An underblown multiphonic

Figure 60-A shows the resultant pitches afforded by the underblown g_3 (b_2 and c_2). The b_2 is incongruous to the harmonic series built on c_1 (see figure 60-B), just as the c_2 is foreign to a series built on g_1 (figure 60-C). These different pitches are the result of the complete venting procedure explained earlier that allows the flute to resonate in more than one harmonic series simultaneously.

The second subcategory incorporates those sonorities that are produced through fingerings that use partial venting. Partial venting, or rim venting, is possible only on French model flutes. Its perforated keys allow the rim of the key to be depressed while not closing off the tone hole. This introduction of microtonal intervals into the harmonic series produces many varied multiphonic sonorities (see figure 61).

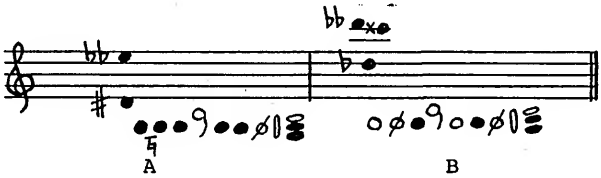


Figure 61
Multiphonics with microtonal intervals

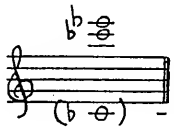
The major drawback to this subcategory of multiphonics has to do with the problem encountered in notating microtonal pitches. Figure 61-A uses the 31 tone scale of Thomas

9 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 61.

Howell[9]. As normally read, e$^{\flat\flat}$$_2$ would be played as d_2 in a 12 or 24 tone system. However, one 31 tone scale, the double flat ($\flat\flat$) is not equivalent to two half steps. The frequency of e$^{\flat\flat}$$_2$ in a 31 tone arrangement is 601.7, whereas in a 24 tone set-up, the note above d_2 would be e$^{\flat d}$$_2$ (three 1/4 tones flat) and its frequency is 604.5. A small "but important" difference. The major problem arises in the notational systems employed and will be discussed in greater detail later in the paper.

The third subcategory is small and involves those multiphonics that contain combination tones in their sonority. These tones are exceedingly soft dynamically and many times not audible at all. Figure 62 is an example of a multiphonic that produced a difference tone, of which the frequency is very close to the difference between the upper two tones' frequencies.

9 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 61.



1258.4 $e\flat_3$ frequency
1006.4 $c\flat_3$ frequency
252.0

- difference tone 251.6 given frequency of $c\flat_1$

Figure 62
Multiphonic with difference tone

With a knowledge of the basic acoustical principles involved in the flute's construction, this classification system becomes a simplistic resource that can provide the wherewithal for composers and performers to readily acquire access to the varied types of flute multiphonics. It is not the intent of this writer to list all avaliable multiphonics and categorize them, but rather to present a method through which an understanding of these sonorities can be easily achieved.

As with numerous contemporary practice techniques, multiphonics as a device of avant-garde literature can be used in combination with many of the other contemporary techniques as discussed in CHAPTER IV. Under Monophonic Sonorities the most commonly used device in conjunction with multiphonics is the area of trills and tremolos. The idea of rapidly alternating between pitches or in this case, sonorities, is theoretically feasible. Unfortunately, it is also extremely difficult to execute. Shifting between multiphonics involves precise lip

adjustments. To do so in rapid succession would by necessity have to involve multiphonics that were very similar in their compositional design and response allowing the performer to achieve this effect with a minimal amount of physical compromising. Trills that would accomodate these requirements fall into the group of trills or tremolos on single pitches and on microtonal pitches (see figures 33 and 34). The combination of these two devices yields an interesting if somewhat problematic effect. Notation of this technique should include the necessary fingerings and some form of explanation. An example of this effect can be seen in figure 63.

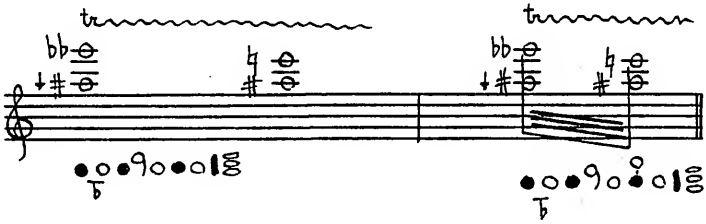


Figure 63[10]
Multiphonics with trills

The remainder of the techniques under the subheading of Monophonic Sonorities are either incorporated into the design of multiphonics, such as harmonics and pitch changes, or are unavailable with multiphonics, such as glissando/portamento and vibrato. It seems rather out of place to imagine a flute sound devoid of vibrato (unless

10 Robert Dick, The Other Flute: A Performance Manual of Contemporary Techniques (London: Oxford University Press, 1975), p. 120.

one is specifically called to eliminate it), but in order to produce a multiphonic, the air flow (stream) must be stable. The fluctuation caused by vibrato production tends to disrupt the multiphonic sonority.

Under the subheading of Special Effects, the most commonly encountered device to be used with multiphonics is that of fluttertonguing (under the category of articulation). Since this technique by its very nature tends to interrupt the air flow (though not as drastically as vibrato), it can cause problems and is best used on strong multiphonics (see figure 64-A) or as an articulation device to begin the sonority (see figure 64-B).

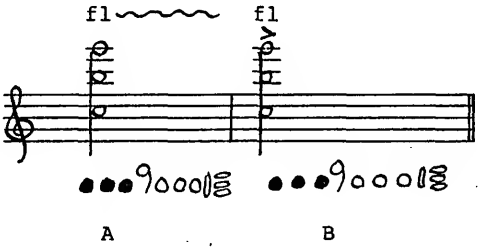


Figure 64
Multiphonic with fluttertonguing

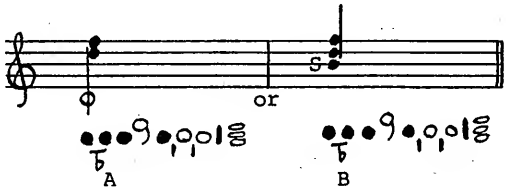
Of the other articulation devices, some can be used with multiphonics, such as key clicks. But since most multiphonics are difficult to initiate, the more percussive articulation techniques do not easily lend

themselves to usage with these sonorities. An unusual aspect of the softer articulation devices is that tonguing seems to reduce the time required by the multiphonic for all of the pitches to sound. This is especially true in the case of rapid passages containing multiphonic sonorities.

The second category under Special Effects is that of noise elements. In this area, the techniques of vocalized and non-vocalized sounds can be incorporated into multiphonic sonorities. The use of vowels as well as shouts, grunts, groans, etc., from the non-vocalized area can be incorporated into the production of the multiphonic. These techniques require advanced control on the part of the performer and composers might consider offering alternative lines for those unable to achieve these effects.

Under multiple sonorities, the only device that is effective with multiphonics is that of singing and humming. The problem encountered here is much the same as with singing and humming with single sonorities. As discussed in CHAPTER IV, the disruptive force of opening and closing the throat to initiate sounds can have an unequalizing effect of the production of the multiphonic. By combining two techniques, both exhibiting inherent difficulties, the job of performers is compounded, but this double sonority (humming with a multiphonic) can be achieved and

is very effective. The notation used is a combination of the two and should provide fingerings and an explanation of the desired effect (see figure 65).



A = unspecified sung pitch - performer's discretion
B = specified pitch indicated by S (octave displacement allowed

Figure 65
Hum and play multiphonic notation

This aspect of contemporary literature that allows for the unrestrained combination of new and old techniques provides a much larger set of resources from which composers and performers can choose sonorities.

With all of its applications and possibilities, multiphonics incur many inherent and somewhat new problems. These difficulties arise not only from the area of notation, but also from the multiphonic itself or the restrictions it places upon the performer. In traditional playing, the performer establishes a set of dependable conditions between the various aspects of his ability and the requirements of performance. With multiphonics, the normal relation of "pitch, timbre, attack, noise (non-pitched) content, and dynamic shape goes into a state

of flux,"[11] and the previous set of conditions, which the performer is accustomed to and dependent upon vanishes. This necessitates a greater familiarity with these techniques and their various responses.

Another problem encountered with multiphonics is that most of these sonorities can only be produced at low dynamic levels. This drastically reduces the composer's and performer's flexibility. Also, the larger intervals are more easily produced in the lower register. This is acoustically based because in the harmonic series the lower intervals appear first and thus lower. It is also easier to sound adjacent partials, whether their distance between each other is great or small, rather than to try and skip an overtone and sound only odd or even numbered partials (refer to figure 6).

Multiphonics, if isolated within the piece are fairly easy to produce. Unfortunately, these same sonorities become problematic and sometimes unresponsive if placed in direct succession with other multiphonics. This is caused not only by the response difficulties encountered with these sonorities but also from the unusual and often times awkward fingering positions needed to produce these sounds.

11 Thomas Howell, The Avant-Garde Flute: A Handbook for Composers and Flutists (Los Angeles: University of California Press, 1974), p. 32.

In the area of notation, it is absolutely necessary that the composer be aware of what structures are possible on which flutes and what results they will yield. The next step is then to indicate properly the correct fingering patterns that will produce these sounds. This process is important because it is necessary for the fingerings to be clearly specified in order to reduce the bulkiness of the manuscript. Alternate fingerings (for greater ease or for closed versus open-holed flutes with or without b foot) should be available to the performer along with a simply defined fingering chart which the composer is utilizing.

With regard to multiphonics, traditional notation displays several drawbacks that are inherent in its system. As we know it, traditional notation does not indicate tone quality, intensity, or noise content. In multiphonic usage, the various pitches involved in a sonority differ among themselves and the present system of notation does not aid the performer in distinguishing between these subtleties of timbre. An additional complication is that traditional notation was devised and implemented with a system of whole and half steps at its basis. The introduction of microtonal intervals was not allowed for in this graphic arrangement and <u>exact</u> notation of these pitches becomes problematic. The previously discussed quarter tones (the pitch midway between half steps) would

constitute an easy solution to the problem. Unfortunately, the microtonal intervals afforded on the flute do not precisely match the mathematical quarter tones, at times being larger or smaller. For example, between the notes d_2 and e_2 (a whole step) there are theoretically two pitches, $d\#_2$ and $e\flat_2$. One says theoretically because from a technical standpoint, $d\#_2$ has a slightly higher frequency than $e\flat_2$. Functionally, as on the piano, they are the same note, but in theory they are different. With this in mind, it stands to reason that between two pitches a half step apart, such as e_2 and f_2, there are also two theoretical pitches: $e\ddagger_2$ and $f\natural_2$. Altered fingerings on the flute produce these two pitches (see figure 66).

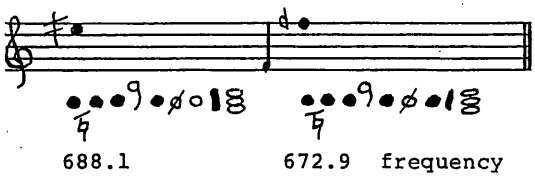


Figure 66
Theoretical pitches with frequencies

As can be seen, their frequencies are different from each other. Also, both frequencies differ from the quarter tone frequency found between e_2 and f_2 which is 678.6 ($e\ddagger_2$). An exact quarter tone scale on the flute is not feasible by its construction and notating the microtonal

discrepencies has yet to be successfully accomplished. Giving the actual frequencies of the pitches (a_1 = 440, a_1 = 452.9, etc.) would constitute a partial solution, but would require that the flutist have access to a frequency counter and an excellent memory for pitch discrimination. The use of ususual shaped note-heads has been suggested as an indicator of those pitches which do not conform to the standard twelve-tone system of notation (see figure 67).

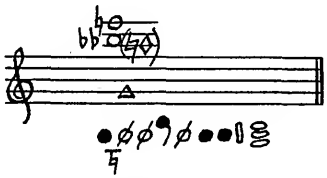


Figure 67
Shaped note-head multiphonic
microtonal notation

It looks interesting on paper and does point out which notes are unusual in either their frequency (being slightly higher or lower than traditional pitch) or their timbre, but it does not give any indication as to the exact pitch of those tones. The square-shaped note head (□) has been used by various composers to show the fingering of the multiphonic when it corresponds to that sonority (see figure 68), but this could cause problems with the shaped-note suggested notation.

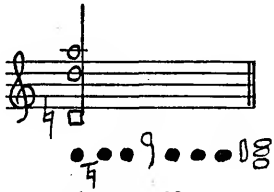


Figure 68
Square-shaped note head as
fingering indicator

One last problem area of notating multiphonics concerns indicating pitches that are hummed in conjunction with the sonority. The composer should offer two pitches, one high and one low to accomodate the voice ranges of performers. Also, octave displacement should be allowed for since both male and female flutists would be performing the effect and obviously cannot all sing the same pitch. This will affect the timbre of the overall sonority, but not detrimentally.

CHAPTER VI
NOTATION

Traditional notation is a visual representation (or graphic means) through which musical concepts and ideas are transmitted. Its most important function is "to communicate the intentions of the composer to the performer as concisely and as accurately as possible."[1] In its conventional form, notation was not designed to convey the more subtle intricacies of style which in turn underlie the intrinsically musical aspects of the performance of a piece. These various elements were left to the performer to discern and communicate to the listening audience. Any notational system possesses several basic characteristics. First, it imposes a variable time limit upon performance. Secondly, notation has been a one-way directive for many years. It establishes an authoritarian view of the composer as the creator and the performer as the recreator, a view that has been accepted for some time. This also implies a third basic characteristic, that of the performer's responsibility faithfully to comply to the best of his

1 G. Read, "The Dilemma of Notation," Composer (US), Vol. 3, no. 1 (1971), p. 22.

ability with the intentions of the composer.[2] Traditionally, notation has been occupied with the graphic illustration of the two major areas of prominence: pitch and time. The more refined nuances of timbre, texture, articulation, dynamics, and subtle tempo alterations have always maintained a subordinate role in the scheme of written music.

It was necessary for traditional performance that the composer sufficiently notate those various aspects of a musical composition that would insure a competent rendering of his piece. These areas include pitch, rhythm (meter), tempo, and articulation. Traditional notation was and still is capable of fulfilling these obligations, but the advent of avant-garde philosophies and techniques has completely altered the purpose and function of notation. The newer concept of notation is that it is no longer merely a means of conveying the composers wishes and intentions, but rather it is more oriented toward the idea that notation should serve as "a primary stimulant to musical expression."[3] The performer is no longer cast in the role of simply a recreator of compositions, but now must often participate in the actual decision making processes during performances. This collaborative effort between composer and performer has resulted in various

2 H. Cole, Sounds and Signs: Aspects of Music Notation (London: Oxford University Press, 1974), p. 18-21.

3 G. Read, "The Dilemma of Notation," Composer (US) Vol. 3, no. 1 (1971), p. 23.

alterations of notational practices, from the use of supplemental markings for extra instructional information to aleatoric systems of notation.

Problems of Traditional Notation

The intrusion of avant-garde techniques into the traditional scheme of notation has created many new problems and has accented and expanded a few of the inconsistencies that are inherent in this older system of writing music. One of the previously mentioned characteristics of notation as a one-way authoritarian view seems to have become a prime focus for a philosophic approach to a specific style of notation. Its culmination in terms of control of a piece is represented by the style of notating every possible aspect of a musical composition, giving the composer complete control of a work. It is referred to as determinate notation. The counter view to this manner of thought is indeterminate notation in which complete freedom is accorded the performer in his rendering of all aspects of a composition. These two opposing attitudes constitute the main avenues of thought in contemporary compositional techniques. Alone, each style imposes difficulties and impossibilities for the traditional notation system as composers alter and newly create symbols to represent new sounds and ideas.

The merging of the two styles by a composer does not alleviate this problem, but rather increases its propensity for ambiguity.

The more specific problems encountered in traditional notation practices in flute music can be readily observed through the framework of Jan LaRue's guidelines for style analysis (SHMRG - see CHAPTER I, page 2). In the area of sound (S), traditional notation's major fallacy is that it does not allow for indications of timbral change. Supplemental markings are necessary to indicate the desired output plus directions on how to achieve this effect. One of the most obvious traits of timbral change is that of vibrato. Traditional notation provides no means for indicating the exact microtonal width of vibrato and whether or not this width should remain constant or vary. It also does not allow for the dictation of the speed of the vibrato or its consistency. Composers of contemporary literature are requiring a specified and controlled approach to notating the more subtle nuances of their music and find that they must add instructions to the performer to aid in his interpretation. Harmonics, muting, altered fingerings, color trills, and all of the various contemporary devices that fall into the category of timbral changes require additions or alterations to the traditional system of notating music. Of course, this does not apply to the composer of many aleatoric (chance)

pieces as indeterminate notation does not require the composer to establish control but rather allows the performer to express his own interpretations of the music.

The area of harmony (H) seems out of place when discussing solo flute literature, but traditional notation has imposed some interesting considerations upon this category. The older system of notation is primarily diatonic in its approach using a set unit of intervals, the half step. With this in mind, the traditional attitude has been concerned more with the overall tonal-harmonic structure than with individual intervals. Avant-garde composers, having "discovered" microtones, are becoming more and more concerned with exact interval size and involving themselves less and less with tonal considerations in the harmonic (traditional) sense. The traditional system of writing down music does not allow for intervals other than the 1/2 step and must therefore depend upon the composer's ability to adapt or create new symbols (see figure 29) to represent these pitches. These new symbols are not as yet standardized and can vary considerably, even to the point of the same symbol representing two different micro-intervals (for example: the symbol has been used to represent a 1/4 tone flat and also 3/4 tones flat). This ambiguity which is prevalent warrants some type of uniformity to help performers decide exactly what is expected of them. Also

under the area of harmony one should consider multiple sonorities. These sonorities must include fingered andsung pitches, dynamic markings as applied to individual notes, correct fingerings to achieve the effect, resultant sounding pitches, timbral indications, microtonal notation, and any other instructions (such as articulation) that accompany the figure. Traditional notation is incapable of handling these effects clearly without the addition of various extraneous markings as seen in CHAPTER IV (Multiple Sonorities, pages 96-108) and CHAPTER V (pages 109-131).

The traditional handling of melodic notation (M) as presenting in simple form a diatonic melody receives adequate treatment. Notation had many years to develop a thorough set of practices concerning this aspect of music as melody has dominated almost every phase of musical compositions since its recorded history began, especially in the eighteenth and ninteenth centuries. Many twentieth century composers no longer hold melody in the dominant position over the other elements of musical compositions and its demise from the leading role has freed melody to be explored by the newer avant-garde techniques. The logical progression from chromaticism to microtones presents the same problems for notating melody that were discussed under harmony. At present, there is no uniform way precisely to notate pitch changes, whether they are

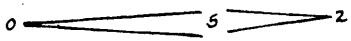
1/4 tones or some such micro-interval or whether they involve timbral changes to the actual pitches. The major ambiguity of notating melody lies in the lack of direction given to the performer in interpreting phrasing, articulation (see rhythm), and dynamics. Musical interpretation has always been a matter of personal insight based on stylistic knowledge and musical tastes. To the contemporary composer who wishes to control the outcome of a composition, this freedom accorded the performer is one more feature of music which needs to become more explicit in its design. Traditional notation, with its use of verbal commands such as dolce (sweetly) or pesante (heavily) is by no means precise. The traditional indication of dynamics (pp to ff) falls into this category. Avant-garde composers have begun adding numerals and verbal instructions to the traditional dynamic markings (see figure 69) in hopes of helping performers to be more accurate in their interpretations.

ALAP - as loud as possible

ASAP - " soft " "

 - crescendo, diminuendo ad lib.

 - from or to nothing - not ad lib.



 - use of beam to indicate dynamic levels

 - note head to determine dynamics

Figure 69
Notations of various dynamic indicators

Again, these are not precise standards. Placing dynamics on a numerical scale is worthless unless the performer has at his disposal some means of measuring the amplitude of the pitches and comparing that level with other notes. Interpretation, phrasing, and dynamics are very elusive qualities of music and composer control here is, and will probably remain, minimal.

One last aspect under melody is that of the extended ranges that are being employed in contemporary literature. Traditional notation is capable of handling the addition of higher or lower notes. The only problem (other than if they incorporate microtonal intervals) is that many times verbal instructions or fingerings to indicate how to achieve these pitches are required.

The area of rhythm (R) is where many problems with traditional notation are found. Rhythm implies a tactus or fixed beat and some type of organizational system around this pulse. Traditional notation incorporates a system of bipartite values (1, 2, 4, 8, 16, etc.) where non-bipartite values can be expressed only through the addition of dots, slurs, and ties to the existing bipartite values or by indicating the new subdivision of the beat through numerals (5, 3), thus changing the basic value of the individual notes. The more intricate and precise the rhythms become, the more confusing traditional notation appears, especially if several people are playing diametrically opposed rhythms simultaneously (polyrhythms). The complexity of the system becomes unmanageable when a high degree of precision is required. This is evident when intricate rhythms proceed simultaneously at different tempos (obviously only in ensemble situations - polymeters).

Traditional notation imposes another problem. It is not equipped to handle improvisation. Many contemporary composers try to work around this inconsistency by eliminating the basic pulse - meterless music is produced. The resultant problem of meterless music (other than ensemble difficulties) is that of phrasing. To remove this complication, many composers use beams or brackets to group notes into their proper units or phrases (see figure 70).

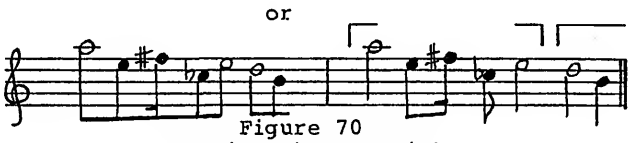


Figure 70
Notating phrases with
beams and brackets

In music that uses measures and bar lines in addition to beams, composers utilize broken phrase marking (.-------.) to help indicate note groupings across bar lines where beams would be inappropriate.

This idea of grouping has carried over into the literature that uses complex or unusual meters (such as 11/8 or 15/16). Figure 71 shows some of the more common methods of illustrating groupings or beat patterns.

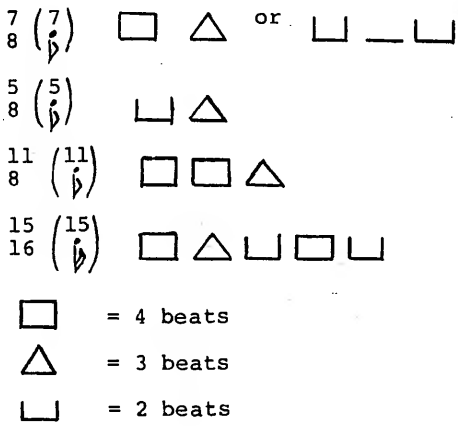


Figure 71
Illustration of beat pattern figures

These graphic depictions are used to aid the performer in recognizing beat patterns. This also overcomes a problem that often occurs with traditional notation practices, that of poor spacing of rhythmic patterns within the measure. Often times notes are placed evenly throughout a measure to avoid a cramped or lopsided visual effect. The graphical representation of these rhythms should have spacial connotations which a leveling or evening-out effort would totally obliterate.

The most significant inadequacy found in traditional notation is its inability to express precisely controlled accelerandos and ritardandos. The use of verbal commands (accel. and rit.) can initiate the correct responses but

has no control of the degree to which they will be executed. Metronome markings can be used once tempo changes are stabilized, but are of no help with gradual changes except perhaps for the mathematical approach of Elliot Carter's metric modulation as in his Double Concerto and string quartets. Figure 72 illustrates several of the methods composers are using in an effort to establish control.

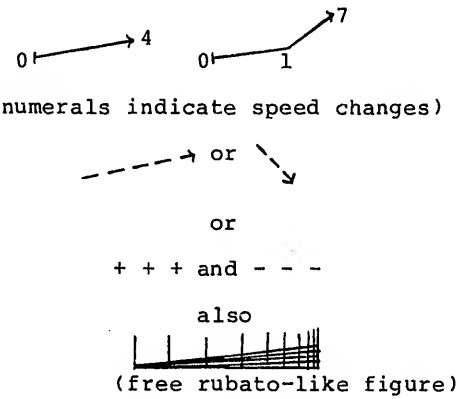
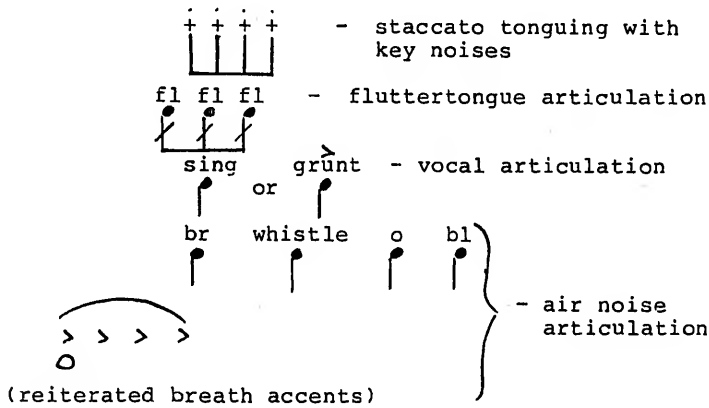


Figure 72
Notation of controlled tempo changes

These examples are clearer than the older system, but are still ambiguous and not very precise in their delineation of controlled change in tempo.

The remaining area of rhythm that exhibits difficulties with traditional notation is articulation. It is in this area that the need for clarity and precision has been most

needed. The existing symbols for the many forms of articulation have become complicated and over-abundant. Various listings of articulation indicators usually arranged in either ascending or descending order of intensity have recently appeared in an effort to aid composers and performers. Adversely, many of these symbols have become ambiguous in their meaning, be it implied or inferred. For example, the staccato marking (·) means separated. This same symbol is also being used to indicate the point of release for the articulation of the end of a note. A confusing use of the same symbol. Another example is the dash over a note (-). This can be interpretted as either a soft attack or an indication to "lean on" the note, depending upon the individual performer. The area of articulation becomes more complicated when composers combine various symbols in an effort to clarify their intent with regards to the beginning of notes. For example, (^) is the marking for a very harsh attack. Trying to be too specific or precise leads composers to indicators that only serve to "muddy-up" the music, such as (^), very harsh and separated or ($\overset{sfz}{\wedge}$), harshest and separated, which when played in faster passages would most likely be indistinguishable from one another. Modern composers also seem inclined to combine various effects with articulations. Figure 73 shows some of the more common combinations found in today's literature.



(and any other combinations found in CHAPTER IV)

Figure 73
Notation of articulation
and contemporary devices

One of the major concerns of contemporary composers involving articulation is the failure of the present notational system to indicate the decay of the tone and its exact point of release. By incorporating the existing symbols of articulation from (sfz) very harsh to (⌣) smooth, and applying them to the end of notes with a sloped down-stroke (╲) to indicate note endings, composers are finding methods through which to indicate the release of tones as effectively as they notate their beginnings. Again, the major problem lies in the various ways that performers will interpret the same symbols and how objective their interpretations of these markings will

be. For example, how much difference is there between ( ) very harsh and short and ( ) detached and very harsh? These are the more subtle nuances that were once the sole domain of the performer, but which composers now strive to control using a notational system that is proving to be inadequate.

The final area of investigation is termed growth by LaRue and refers to the overall (or macro) form of a piece. In this area the composer of determinate notation is quite at home as traditional forms, such as rondo and sonata allegro are established patterns that contain or at least provide the basic framework of a composition's development or growth. For those composers of improvisation-based music, this style of tradtional form is too restrictive. "Most notation is designed so that the performer will react with a high degree of predictability."[4] It is precisely this "predictability" from which avant-garde composers wish to escape. This need for freedom not only from the "tyranny of the bar line", but also from beat, overall form, and a general degree of stable equilibrium, has given rise to many new methods or ways to indicate the form of a composition. Unfortunately, traditional means of notating pitches and durations are totally inadequate in this area. To attain the freedom for which composers and performers alike are searching,

4 D. Cope, "Contemporary Notation in Music," Instrumentalist (May 1976), p. 28.

new overall forms and an accomodating means with which to convey these forms must be created.

Various Solutions

"The present confusion about notation is highly welcome, since it shows clearly that conventional methods of notation are no longer adequate."[5] Many new systems have been proposed as solutions to the numerous problems that are encountered in contemporary literature. The following is a general survey of a few of the more significant proposals.

Pitch

One of the first problems encountered in avant-garde literature regarding pitch is the use of microtones. With the adaptation of old and the inclusion of new symbols, many composers realized that this was rapidly becoming too confused. Complete systems for notating microtonal intervals through numerous accidental changes were proposed by Alois Haba, J. Carillo, and Harry Partch, but none of these notational revisions has become popular with other composers. The fault might be partly with

5 E. Karkoschka, Notation in New Music: A Critical Guide to Interpretation and Realization (New York: Praeger Publishers, Inc., translated by R. Koenig, 1966/1972), p. 7.

performers in that too many see no reason why they should learn completely new systems of notation for one particular piece. It is for this reason that some form of standardization is necessary.

It has been proposed that rather than changing the existing accidentals, it would be simpler to adjust the staff itself to accomodate microtonal intervals. Several major proposals have emerged in this area. The first involves using a seven line, six space chromatic staff. Figure 74 shows this new arrangement of pitches.

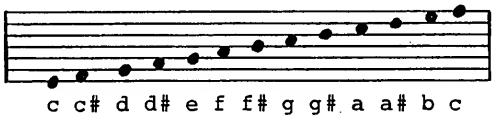


Figure 74
New seven line staff

The drawback is the visual aspect of the increased number of lines and spaces, plus the fact that no real provisions are made for the inclusion of microtonal pitches. The second suggested revision is called equitone. Equitone was developed in 1962 by Erhard Karkoschka based on an original proposal by Rodney Fawcett in 1958. It reduces the staff to one linear octave (see figure 75), with the "clef" at the beginning indicating which c the line is to represent (see figure 76).

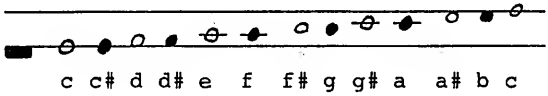


Figure 75
Equitone linear octave

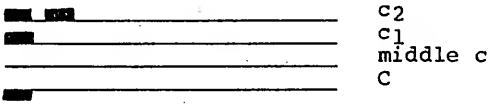


Figure 76
Equitone clef designations

Obviously, traditional duration notation would be totally inappropriate to this system. Proprotional spacing of note values must be used (and will be discussed further under Duration). The difficulty with this system is that it makes no provision for microtonal pitches and is therefore only rearranging the present system into a new and different arrangement without eliminating any of its major problems. To aid these two systems in microtonal inclusion, it has been suggested that the shapes of the note-heads be altered to facilitate recognition of intervals that are smaller than the 1/2 step, or to include the various mutated accidentals to indicate the non-diatonic notes. None of these systems have become very popular with either composers or performers.

The most popular revision has been to the accidentals themselves. The use of arrows to indicate the raising or lowering of a pitch in increments smaller than a 1/2 step is the most common adaptation as it can be used with either of the above mentioned revisions or with traditional notation (see figure 77-A). The problem is that arrows do not precisely indicate the exact size of the microinterval. Some composers advocate the use of cents to indicate whether pitches are 1/4 tone or 3/4 tones flat or sharp (see figure 77-B).

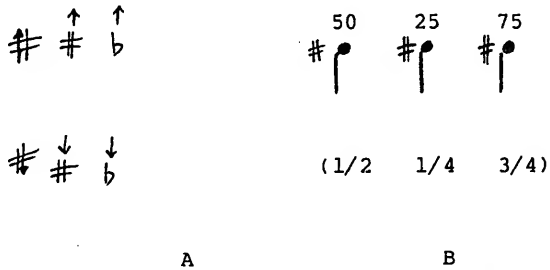


Figure 77
Microtonal indicators

Duration

One of the problems with duration is its bipartite-based construction. The use of ties, dots, and slurs to augment the values of notes has been considered by some contemporary composers as too cumbersome and

inflexible. Two suggested revisions or alterations that were offered as solutions to this problem are as follows. First is a system proposed by Bruno Bartolozzi. It incorporates five existing duration values (, , , ,) and the dot to augment the values necessary to complete notes in unusual meters (see figure 78).

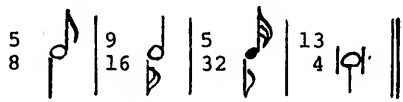


Figure 78
Bartolozzi's durational revisions

These new values are added either above or below the existing note (or beside in the case of the dot) to complete the note value according to its meter. This system has not become popular perhaps because of its unusual visual effect.

Another suggested revision of these bipartite values was offered by Henry Cowell in 1917. He borrowed the idea of shaped note-heads from old American shape-notes. It retains the use of dots and ties but does eliminate numerals (see figure 79).

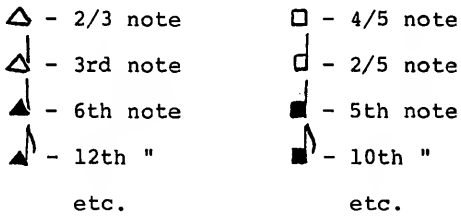


Figure 79
Cowell's durational revisions

Neither one of these systems has found much acceptance in contemporary literature as they are only partial solutions.

One of the most widely accepted reforms in duration has been the adaptation of proportional notation. Proportional notation is a spatial representation of duration into a horizontal orientation. It eliminates the distinction between black and white noteheads, beams, flags, dots, and numerals. It also allows for gradual accelerandos and ritardandos simultaneously. Visually, it accounts for legato slurs, staccato dots, and other forms of articulation. Its problems arise out of the space necessary for accidental indicators and the lack of metric designation - performers are free to judge the placement and duration of notes. Basically, there are three types of proportional notation. The first uses regular note heads followed by horizontal lines to represent their duration (see figure 80-A). This is only a partial solution as ties, slurs, and dots remain in use.

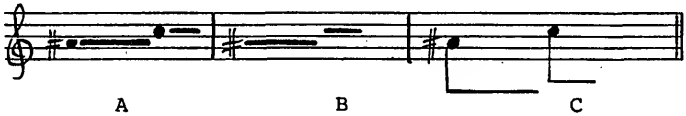


Figure 80
Proportional notation

The second type of proportional notation is often referred to as time notation, as developed by Earle Browne. The note itself becomes the duration. It eliminates the need for slurs, ties, dots, etc., but again runs into the problem of placement of accidentals. The accidentals take up space and thus throw the exact placement of the durations off (see figure 80-B). The final and most often encountered use of proportional notation is a combination of the traditional stemmed black note-heads with the beams used to indicate the proportional durations (see figure 80-C). The addition of tactus marks allows this form to indicate regular pulses that can be given metronomic markings. This system also frees the note-head from durational implications (as with traditional notation) and could possibly therefore allow it to take on the responsibility of accidental or microtonal representation.

Survey of Avant-Garde Notational Practices

Choosing between the different styles of notations that are available depends a great deal on the degree of latitude afforded the performer by the composer. Basically, there are two major styles of notational practices found in the avant-garde literature. The first is determinate notation. In compositions written in determinate notation, the composer dictates every aspect of the piece, from rhythm to dynamics and phrasing. The performer has little or no freedom in his interpretation and is "reduced to the status of a gramophone record."[6]

The second area is that of indeterminate notation. It is characterized by the composers deliberate avoidance of control of the various nuances and aspects of a composition. The performer has complete freedom in matters of interpretation, ranging from the more subtle areas of tone and phrasing to the more obvious area of pitch, rhythm, and overall structure. This includes such pieces as aleatoric or chance music and the more avant-garde notations of graphics or "eye music". First of all, chance music is controlled improvisation in that one or more of the parameters of a composition are left to chance. The versatility of the performer is tested here

6 T. Dart, The Interpretation of Music (New York: Harper and Row, 1963), p. 14.

as he must adapt to whatever "chance" happening occurs, such as if the parameter of rhythm was left to the roll of dice. Graphics or pictoral notation is presented to the performer as one of the more completely free and up-for-grabs style of composition. The interpretaion or translation of the various shapes, designs, and symbols into actions is left entirely up to the performer. It is really the extreme view of the concept of the notation acting as a stimulus to the performer, similar to a musical rorschach, testing the creative ingenuity of the individual. Graphics are unique in that there is really no way that their notation could be standardized.

The third area of form falls under implicit notation. Implicit notation provides a stimulus or guidelines for the performer without defining the complete product or the exact means with which to achieve this end result. There are three types or forms of composition that are common in this area. The most popular is that of frame notation. Frame notation often occurs in combination with conventional notation. It offers the freedom that many composers are seeking without abandoning the older systems of writing music and it is much more accessible to the performer. Frame notation is really controlled chance in that the composer allows the performer "free or flexible interpretation within a set, controlling framework."[7]

7 K. Stone, "Notation," in Dictionary of Contemporary Music, Edited by J. Vinton (New York: E. P. Dutton and Co., 1974), p. 521.

Usually, these areas of freedom are enclosed within a box, bracket, or some other such structure (see figure 81).

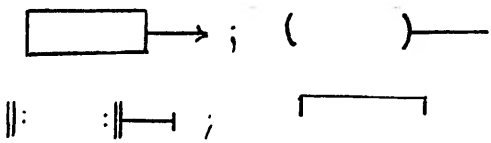


Figure 81
Frame notation indicators

Rhythm, repetition of pitches, order of pitches, dynamics, and articulation within the frame and the duration of the frame itself are the areas which the composer specifies in his instructions or leaves up to the performer to interpret at will. These freer sections alternate with the more controlled areas of the piece and are usually determined in terms of duration by the composer indicating the number of seconds the frame is to exist.

The second type of implicit notation is the use of mobiles. Mobiles allow the performer to choose his own route or pathway through the piece. It is a freer approach to performance as the player progresses from idea to idea as permitted by the different options set down by the composer. Mobiles can use either traditional notation (set up in frames or groupings with various pathways of motion available) or it can incorporate graphic notation as its basis. Many of the parameters of the piece such as

tempo and dynamics, are left up to the interpretation of the performer.

The final area of implicit notation is indicative manuscript. This style of writing music is not as common as the other two, but it is often seen in avant-garde compositions. Indicative notation is seen as the solution to tempo changes without the necessity of verbal commands. The entire staff is used to indicate tempo changes whether they be accelerandos or ritardandos (see figure 82).

Figure 82
Indicative notation

The slanting downwards of the staff indicates a slowing of the tempo and the upward slant implies an increase in the speed. It is not a very precise notation, but then it is not meant to be. The performer's freedom of interpretation is the important issue, with the notation only serving as a stimulus to his musical imagination.

Contemporary Notational Systems

As evidenced by the numerous attempts at revision and creative additions to the notational scene, it becomes obvious that the present situation regarding contemporary literature's notation warrants improvement. There seems to be a need on the part of many composers to reject the traditional notational system and its permanence. It is compounded by an abundance of new symbols and an intoxication with the visual aspects of written music. In order for a new standardized notational system to emerge, it must meet the following requirements. Since conventional notation has survived centuries of use, any new system must exhibit the technical capacity of the present notational system. It should strive to create a balance between symbols and verbal commands, eliminating ambiguity and duplication of signs. It should aim more towards symbols that are clear, visual representations or translations of the expected auditory phenomenon. A new system should not attempt to replace or contradict the former schematic arrangement without just cause or logical reasons. It should, however, strive to reduce the musical and technical complications that arise all too often in the present system. This new notational system should be much broader in its approach to the various patterns of composition, showing no preference for any

particular style or method. It must be flexible, allowing for the use of several different types of compositional modes within the same piece (such as determinate and indeterminate). Lastly, it must allow provisions for microtonal intervals and have the capacity of expansion and growth for future developments.

In recent years several attempts have been made to standardized the various notational systems. Music publishers have tried to standardize or at least create some type of uniformity based on the works of their composers. One of the most successful publisher attempts took place in Krakow, Poland, the Polish Music Publishers Organization, or Ars Polona. Unfortunately, it is limited only to their published scores and has not been universally accepted. In 1970, on a grant from the Rockefeller Foundation, the Ford Foundation, and with the Music Library Association as the sponsoring organization, the Index of New Musical Notation was established. It is an international attempt to identify those newer innovations in notational trends that can be standardized. Its director is Kurt Stone and the organizaion is located at the music division of the New York Public Library at Lincoln Center. In 1974, at the University of Ghent in Belgium, the International Conference on New Musical Notation met. The emphasis of this group centered on clarity, practicality, and necessity from the performer's

point of view. It is from organizations such as these that the more common usages of avant-garde notation will become clarified and known enabling performers to more readily acquire the new language of contemporary literature.

CHAPTER VII
SUMMARY AND RECOMMENDATIONS

Summary

The creative atmosphere of twentieth century musical literature has led to many new and unusual developments in the techniques employed by avant-garde composers. With this prodigious output of special devices, it becomes necessary for the performer to provide himself with a method for quickly analyzing these contemporary idioms. Since these new techniques are all based on established acoustical principles, the logical approach to learning avant-garde literature is through an understanding of the basic principles of acoustical theory, the theoretical aspects of the flute's construction, and how these two are combined to produce the various devices now being introduced into the literature.

Performer apathy towards avant-garde literature is understandable from several points of view. First of all, many of the newer devices are seemingly unrelated to the more traditional methods of flute playing and many performers are unwilling to experiment with the traditional approach to tone production for fear of endangering their established embouchure technique. Much

of this attitude arises from unfamiliarity with the contemporary practices of twentieth century literature and the lack of exposure, either as listeners or performers, to these types of pieces. The major stumbling block comes from the misunderstanding that occurs between what the composer wants as the end result and the ability of the perfomer to achieve the desired product. This lack of communication is primarily the result of the inadequacies of the present notational system to indicate these newer devices. The many different and imaginative approaches to indicating these new techniques makes it difficult for the performer to ascertain the intentions of the composer. The inability of the traditional notation system to handle these avant-garde techniques, the complex intricacies of rhythm, and the freer approach in performance styles is a major difficulty in establishing a consistent or "core" repertoire of contemporary solo flute literature.

Recommendations

"The performer of contemporary music . . . is faced with an overwhelming richness of challenges and apparent contradictions from all sides. But, at the same time, few periods in recent music history have granted him so great an opportunity to participate in the creation of new

musical idioms."[1] To cope with these many new experiences, several basic postulates should be followed in order to anticipate and alleviate the problems which performers and composers encounter with the language of avant-garde music.

One of the more prominent aspects in this area that demands immediate attention is the need for instruction in the science of acoustics and the acoustics of musical instruments. Once basic acoustical knowledge is mastered, these newer techniques can be analyzed and presented in logical form rather than confusing the composer and performer with verbose explanations of these phenomena that are incorrect or misleading.

Once this background information is assimilated, the next logical step is to utilize these acoustical principles and knowledge in gaining exposure as a performer to as many different styles of avant-garde literature as possible. Before the performer can convincingly present a composition, he or she must first be familiar with the various facets of the piece. It is absolutely imperative that the performer have some method of analysis or categorization principles on hand with which to accomplish this goal, and the acoustical approach is a logical and simple course of action. By making the

1 Leonard Stein, "The Performer's Point of View," Perspectives on Notation and Performance. Edited by B. Boretz and E. T. Cone (New York: W. W. Norton and Co., Ind., 1976), p. 50.

contemporary techniques more accessible to the players, it is hoped that more "polished" performances will result helping to expose larger audiences, listeners and performers alike, to avant-garde music.

One final area of recommended study concerns notation itself. Since asking for an immediate standardization of the existing contemporary practices found in notation is ludicrous from the standpoint of logistics and economics, the next best thing is to request that composers be as explicit as possible in their directions concerning avant-garde devices. This requires a fundamental knowledge on the part of the composer of these newer techniques as to what is feasible and how to indicate clearly and simply the desired results. Until a standardized contemporary notational system is accepted, composers wishing to have their music performed must make their compositions easily attainable from the performer's point of view. Conversely, the responsibility of the performer is to achieve a high degree of familiarity with the notation and principles of avant-garde literature in order to assure competent renderings of these pieces. Cooperation and understanding before and during performances are the key attitudes on the part of both composers and performers and will do much to avoid problems that arise from the inadequate notational system that is employed in twentieth century avant-garde music.

Additional research or follow-up studies should be implemented. The areas that are most in need of further investigation are multiphonics and notation. In the area of multiphonics, the exact location of the various nodes and antinodes within the tube of the flute would help to solve mathematically many questions that the use of multiple tube-lengths have created. In the area of notation, a consistency in style based upon the best graphicial description of the desired acoustical product is needed and would help to alleviate many of the communication problems encountered in contemporary literature.

APPENDIX A
LISTS OF BOOKS AND ARTICLES THAT SUPPLY FINGERINGS FOR MULTIPHONIC SONORITIES

Bartolozzi,B. New Sounds for Woodwind. Translated and edited by R. S. Brindle. London: Oxford University Press, 1967. 78 p.

Dick, R. The Other Flute: A Performance Manual of Contemporary Techniques. London: Oxford University Press, 1975. 154 p.

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Fischer, P. "New Sounds for Flute," Lecture-recital College Park, Maryland: Sunday, February 8, 1976.

Heiss, J. C. "For the Flute: A List of Double-Stops; Triple-Stops; Quadruple-Stops; and Shakes," Perspectives on Notation and Performance. Edited by B. Boretz and E. T. Cone. New York: W. W. Norton and Co., Inc., 1976. pp. 114=116.

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Heiss, J. C. "The Flute: New Sounds," Perspectives on Notation and Performance. Edited by B. Boretz and E. T. Cone. New York: W. W. Norton and Co., Inc., 1976. pp. 207-212.

Howell, T. The Avant-Garde Flute: A Handbook for Composers and Flutists. Los Angeles: University of California Press, 1974. 290 p.

Pellerite, J. Modern Guide to Fingerings for the Flute. Second edition. Bloomington, Indiana: Zalo Publications, 1972. 62 pp.

Read, G. "Extending the Tonal Resources of Wind Instruments: Some Contemporary Techniques," Music Educators Journal, Vol. 63, September 1976. pp. 50-55.

Stokes, S. and R. Condon. Special Effects for Flute. Santa Monica: Trio Associates, 1976. 20 p.

APPENDIX B
LISTS OF BOOKS AND ARTICLES CONTAINING SUGGESTED AND ACCEPTED SYMBOLS USED IN CONTEMPORARY AVANT-GARDE NOTATION

Boustead, A. Writing Down Music. London: Oxford University Press, 1975. 137 p.

Cole, H. Sounds and Signs: Aspects of Musical Notation. London: Oxford University Press, 1974. 162 p.

Cope, D. "Contemporary Notation in Music," Instrumentalist, Vol. 30, May 1976, pp. 28-32.

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Dart, T. The Interpretation of Music. New York: Harper and Row, 1963. 192 p.

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Smith Brindle, R. The New Music: The Avant-Garde Since 1945. London: Oxford University Press, 1975. 206 p.

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APPENDIX C
LIST OF SELECTED COMPOSITIONS FOR SOLO FLUTE

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Berio, Luciano. Sequenza for Solo Flute. Milan: Suvini Zerboni.

Bozza, Eugène. Graphismes pour Flûte seule. Paris: Alphonse Leduc.

Dick, Robert. Afterlight for Solo Flute. Appendix B of The Other Flute: A Performance Manual of Contemporary Techniques. London: Oxford University Press, 1975. 154 p.

Durant, David. Music for Unaccompanied Flute. Available from the composer: Gainesville, Florida.

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Hovhaness, Alan. Sonata for Flute Solo. New York: C. F. Peters Corporation.

Huston, Scott. Three Chimeras (for Unaccompanied Flute). Available from the composer: College-Conservatory of Music, University of Cincinnati, Cincinnati, Ohio.

Jolivet, André. Cinq Incantations Pour Flute Seule. London: Boosey & Hawkes Music Publishers Ltd.

Knussen, Oliver. Masks for Solo Flute with Glass Chimes (ad lib). New York: G. Schirmer.

Levy, Burt. Orb with Flute. Available from the composer: Department of Music, State University of New York at Albany, Albany, New York 12222.

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Pompilo, Jan. Wedding Piece for Flute Solo. San Antonio, Texas: Southern Music Co.

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Salzedo, Carlos. Volute and Rondel for Flute Alone. Cincinnati, Ohio: Albert J. Andraud, Wind Instrument Music Library.

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Varèse, Edgard. Density 21.5 for Solo Flute. New York: Ricordi.

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BIOGRAPHICAL SKETCH

Morya Elaine Willis was born in the quaint hamlet of McIntosh, Florida, where she resided for two weeks while her mother recovered from the occasion. Life was somewhat uneventful in her new home town of Gainesville until at the tender age of seven she moved with her family (two parents, one grandmother, a younger brother, and a canary named Cedric) moved to Brooksville, Florida. Typical of many small southern towns, the school was a focus of the cultural life of the community, and the band program was large, supported, and begun at an early age. The discovery of a class where the teachers had absolutely no intention of asking questions to which one must reply "out loud" was a heaven-sent relief. Unfortunately, after only one year of "fluting", the family by command of "Ma Bell" returned to Gainesville, where children were not given the advantage of instrumental music until the seventh grade. Fortunately, now, that has been remedied but at that time in history an enforced two year hiatus from the flute was instituted.

Junior high school introduced Joe Johnson and Dorothy Reaves as band and orchestra conductors, and the magical world of constructive sounds was again created. If memory serves well, constructive sounds is a better description than musical ones, but it was a beginning, or at least a

continuation. Serious work began in high school with Bardwell M. Donaldson, a new interest in chamber music and musicals, and several flute teachers: Sally Rice, Terence S. Small, and Sarah Baird Fouse.

After she had survived high school, summer band camp, and a motor cycle wreck, the University of Florida was the next order of business. Performing flute in the orchestra, bands (Marching, Symphonic, and Jazz), chamber ensembles, and musicals, along with playing various and sundry Renaissance instruments only served to heighten a growing interest in matters musical and historical. Upon her graduation after three years of study, the College-Conservatory of Music in Cincinnati was the next objective. A full scholarship and three years of intense study with Robert Cavally were extremely informative. He is an outstanding teacher who perhaps, unknown to himself, created within this student an undying respect and complete admiration for his talents and abilities as a teacher.

Enough cold and miserable weather (Cincinnati has plenty of both) drove the climate oriented southerner back to the Sunshine State and the University of Florida with the intent of one day teaching and performing at a college level. In addition to her many private students, she was given assistantships to teach courses in Introduction to Music Listening and to assist the Dean in his Fine Arts

Class which helped to emphasize the enjoyment she found in teaching. No musician should ever neglect performances and with this in mind, participation in chamber music, solo recitals, orchestras, conducting a reading orchestra, assisting the conductor of the opera orchestra and the orchestra for musicals have kept Ms. Willis very busy and satisfied with matters musical.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Gordon Lawrence, Chairman
Professor of Curriculum and Instruction

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

David Z. Kushner, Cochairman
Professor of Music

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Edward C. Troupin
Professor of Music

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

S. Philip Kniseley
Professor of Music

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adaquate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Albert Smith
Professor of Curriculum and Instruction

This dissertation was submitted to the Graduate Faculty of the Division of Curriculum and Instruction in the College of Education and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1982

Dean for Graduate Studies
and Research