Acoustics: Real Life, Real Time—Why the Flutist and Flute Had to Evolve

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ABSTRACT

The author describes a long-term process in which a growing awareness of acoustics led to a profound evolution of his conception of the flute. In turn, this reconception led to an evolution in the flute's design and ideas for further development of the instrument and its music.

This article describes the process through which acoustical awareness enabled me to transform my perceptions of the flute and, indeed, to spearhead innovations that have taken place in its design, with visions of greater changes yet to come.

Back in the early 1970s, when I decided to unburden myself from traditional preconceptions about the flute and its music, I knew very little about the acoustics of the instrument. Equipped with a basic knowledge of the open pipe series, a self-developed ability to produce multiphonics and an inquisitive, inventive drive, I set out to map the flute's sonic possibilities. In making the explorations that resulted in my book *The Other Flute: A Performance Manual of Contemporary Techniques* [1], I took a very methodical but totally empirical approach.

The preconceptions to be shaken free of were:

1. The flute has only one basic tone quality, and its ability to vary that quality is sharply limited.
2. The flute can produce only one note at a time.
3. The mechanical construction of the Boehm flute allows production of only a few microtones.

From the present-day perspective, that these limitations have been eclipsed is beyond question. Multiphonics, microtones and a host of extended techniques have become part and parcel of the flute repertoire and are considered a necessary part of very many flutists' training. In composition and performance, the norm has been redefined. However, even this new "norm" still refers to the flute that the overwhelming majority of professional players use, the Boehm flute with open holes and a low B footjoint.

As I embarked on using the wealth of new sonic materials available in composition and improvisation, I was still thinking of the Boehm flute as a given, and there was no shortage of material to exploit musically. And yet, it took no more than 3 years from my first multiphonic composition, *Afterlight* (1973) [2], for me to begin to become frustrated with a new level of limitations that manifested themselves as the demands of the music came up against the construction of the flute's mechanism.

The process occurring was driven by an evolution in my acoustic understanding of the flute. Like that of most players, my consciousness of the flute began with a focus on blowing the flute, and all that was involved with breath and embouchure, and on its keys—an unexamined acceptance of the instrument as a whole. I began to realize that awareness of what was happening with the *holes*, not with the keys, was the necessary leap forward to cognition of what was going on with the air, and thus the sound; it is where the air is vented, not where keys are depressed or lifted, that affects the sound.

For a string player, this might seem childishly obvious. Knowing that the vibrating body or bodies in an instrument originate the sound is basic to tone production. On an instrument like the guitar, for example, the lengths of the vibrating strings can be clearly seen as well as heard. Not so on the flute (and other woodwinds).

Because woodwind instruments have more holes than woodwind players have fingers, mechanisms were developed. A flute with a low B footjoint has 16 holes, and thus linkages between various holes were created to enable nine fingers (the right thumb functions only to hold the instrument) to manipulate 16 holes [3]. The design of the Boehm flute's mechanism often mandates that fingers and sound do not move in a one-to-one relationship. On a string instrument, the sound goes up when the finger moves toward the bridge, but on a flute there are numerous instances in which a lower key is depressed to make a higher sound. The fingering system obscures the real action, which is the one-to-one relationship of opening and closing holes to the direction of the sound. (See video demonstration 1 at <www.youtube.com/watch?v=EXmF83R9d2A>).

After the basic perception crystallized that it was the pattern of open and closed holes that mattered, not the fingering pattern, I had taken the first step toward being able to transpose multiphonics and other sonorities. The second step was the cognition that, from a musical perspective, the flute has but two sizes of holes, which can be empirically treated as simply large and small. While the main tone holes are graduated in size, becoming slightly larger toward the low end of the instrument, they can be thought of as identical in terms of their effect on pitch, which is by design [4]. Through serendipity, not intent, the size of the center holes in the five perforated keys are close enough to the size of the small C# hole and the two trill holes so that they can be treated as the same in terms of musical effect, even though there are very slight differences.

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Videos related to this article are available at <youtube.com>; see the body of the article for specific links.

Having made this perceptual leap, I was equipped to map any sonority as a pattern of open and closed holes, overlaid with the perception of how to manipulate the mechanism to produce the pattern. Indeed, when I need to visualize the flute while playing, I see its holes in my mind, not its keys [5]. This speeds up the realization of musical decisions by obviating a clumsy thought process—that of translating mechanism into acoustic reality.

With this (for me, at least) new way of understanding that sonorities can be thought of as a consequence of patterns of small and large holes, open and closed, I found transposition of these patterns was the logical next step, and here the genius of Boehm's 19th-century thinking resulted in an irrational obstacle course for the late-20th-century musician. The linkages between keys that so brilliantly enable realization of the vision of the flute as an instrument that plays the pitches of the chromatic scale, one at a time, result in a plethora of situations where, because when one key is depressed, another key or keys move with it and it is not possible to open the holes of the linked keys when the activating key is closed. (See video demonstration 2 at <www.youtube.com/watch?v=W21lWuBROUI>).

As multiphonic music developed, the obvious material that the flute presented got used. Of course there is more to do with these sonorities—there are, after all, several thousand of them. However, deeper levels of composition and improvisation call. The creative ear wants the freedom to place sonorities at the pitch level the music asks for, not just the spots that are a largely accidental consequence of a mechanism introduced in 1847.

In 1978, I worked at IRCAM in Paris toward developing a flute of my design with a new mechanism that would be free of linkages, allowing any arrangement of open and closed holes. A prototype of my design was built by the English flute maker Albert Cooper. While the flute was successful sonically, its design clearly showed that it was created by someone (me) who understood sound but was inexperienced with the subtleties of mechanism. To date, this design concept remains unrealized, as several design problems still need improved solutions. (See video demonstration 3 at <www.youtube.com/watch?v=NsUwxuzgTnc>).

On the perforated keys of the Boehm flute, it is possible to choose whether to use a large hole (by lifting the entire key) or a small hole (by depressing the ring of the key and leaving the center hole open). The Boehm flute's mechanically operated keys not only present the problem of lack of independent action, but present only the large hole option, a major stumbling block to musical progress. Very many multiphonics, for example, require small hole venting in the center joint. The odd mixture of keys—those that have the small hole option with those that do not—breaks up transposition of these sonorities.

The Dutch flute-maker Eva Kingma, in collaboration with the American maker Bickford Brannen, introduced the Kingma System flute in 1994. This design, originally conceived to facilitate quarter-tone production, solves the problem of the lack of the small hole option in keys that are not closed directly by a finger. Kingma developed an ingenious system of small keys seated atop large ones, enabling a choice of small or large holes throughout the keys on the flute's center body joint. Kingma and Brannen succeeded in adding major sonic capacity to the flute while preserving Boehm's system. Any flutist can pick up a Kingma System flute and immediately play traditional music on it. (See video demonstration 4 at <www.youtube.com/watch?v=rbX_v11UhfA>).

Where and how to go forward? I still dream of a flute with an ergonomic identity between the finger action and the movement of the sound. While the Kingma System flute is an exponential jump in the flute's sonic potential, the Boehm system it is based on still requires frequent key combinations where finger motions and pitch direction are in opposition. It is a huge inertial load to overcome in memorizing sets of multiphonic transposition, quite in contrast with the elegant directness of grid system instruments like the guitar.

Parallel to thinking about the mechanism of the flute, I have developed a telescoping flute mouthpiece, or headjoint. Named the Glissando Headjoint®, it was prototyped in the 1990s through collaboration with Eva Kingma and Kaspar Baechi of Zurich. Bickford Brannen later developed a design that is now in commercial production [6]. The Glissando Headjoint® makes glissando from every note on the flute possible without significant timbral change. It also allows freely produced multiphonic glissandi, opening a new sonic area for flute music. (See, once again, video demonstration 4 at <www.youtube.com/watch?v=rbX_v11UhfA>.)

My hope is that musicians, be they composers, composer-performers, improvisers or performers, will be inspired to transcend conceptual and technical limitations and will engage with the learning curves that increased potential requires, freeing them to create the flute music of the present and future.

References and Notes

1. Robert Dick, *The Other Flute: A Performance Manual of Contemporary Techniques,* 2nd Ed. (New York: Multiple Breath Music, 1989). The original edition was published by Oxford Univ. Press, New York, in 1975.

2. Robert Dick, *Afterlight,* for flute alone, New York, Multiple Breath Music Company, 1985. *Afterlight* was composed in 1973 and originally published as an insert to the Oxford Univ. Press edition of Dick [1].

3. For a superb description of how and why the Boehm flute is what it is, see Theobald Boehm, *The Flute and Flute Playing in Acoustical, Technical and Artistic Aspects* (New York: Dover, 1964). First published in German in 1871, the work was translated into English by Dayton C. Miller in 1922.

4. Typically, the main tone holes on a flute are made in three sizes, the smallest being on the left hand, toward the top of the instrument, with slightly larger holes in the right hand and against the bottom of the flute on its footjoint.

5. One of the frustrations—and joys—of playing the flute is that the instrument is invisible to the player. I was a passionate table tennis player in the 1970s and drew a connection between the advice found in Tim Boggan's classic *Winning Table Tennis* (Chicago: Contemporary Books, 1976) and my explorations on the flute. Boggan stresses that the player should have the vision of the table memorized and should never need to look at it. Excellent advice, that, and I took it to the flute by memorizing the positions and functions of the keys so that I do not need to visualize them, accelerating my perception of what is happening with the holes.

6. For information on the Kingma System flute, see <www.kingmaflutes.com/mySite/kswhat.html>. For information on the Glissando Headjoint®, see <www.glissando.biz>.

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Through his writings, compositions, performances and contributions to the development of the instrument, Robert Dick has devoted the bulk of his career to advancing the potential of the flute and its music. His book The Other Flute: A Performance Manual of Contemporary Techniques *has become a standard reference for composers and performers interested in extended techniques.*