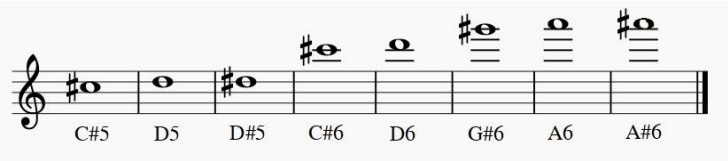
CONTINUING THE BOEHM TRADITION: THE NAGAHARA C# MECHANISM

To the flute player no marvel of engineering surpasses the Boehm flute in beauty and design. Aesthetically simple, yet deceptively complex in structure, the instrument released to world in 1847 by Theobald Boehm has remained relatively unchanged for almost two centuries. In rejecting the conical-bore system for a cylindrical bore, Boehm unleashed a revolution in flute design resulting in new timbral opportunities. Despite initial reluctance to embrace change among fans of old-system flutes, the radically different fingerings of the Boehm flute proved vastly superior in terms of technical fluidity, allowing composers to innovate in ways never possible before.

Fig. 1: Photo of Theobald Boehm (right) with Italian flutist Antoine Sacchetti

For all its ingenuity, the modern flute remains an imperfect instrument. One such imperfection familiar to flutists is the note C#5. Notoriously sharp and hollow-sounding, this note has created headaches for flutists since the inception of the Boehm flute. This deficiency results from a compromise Boehm was forced into making when designing his flute. This compromise also resulted in a flat D6, and other pitches that require venting tend to be out of tune. On the piccolo, these problems present themselves in exacerbated fashion.

Boehm describes his thinking process in his treatise, *The Flute and Flute Playing*. In order to allow for the higher octave pitches to speak with optimum intonation, he selected a tube of slightly smaller diameter than would be ideal for the length of the instrument. This resulted in making the pitches D5 and D#5 sound stuffy in comparison with the surrounding pitches. Boehm then drilled a small vent hole nearer to the top of the body, determining to allow that hole to serve as a multi-function tonehole, venting D5, D#5, D6, G#6, A6, and A#6, but also serving as the primary C#5 and C#6 tonehole, thereby permitting these notes to be controlled by the first finger in the left hand. To create a truly in-tune C#5, however, the tonehole should be located lower on the tube, and it should match the other toneholes in diameter. Brilliant compromise notwithstanding, flutists are left to make embouchure adaptations to maintain evenness in tone quality and intonation when playing through these pitches.



Flute players have devised manageable solutions, such as depressing right-hand keys and lipping the note down, but the ideal instrument would feature a special C# tonehole of the correct size and in the right location. Over the years, flute-makers have experimented with mechanical solutions, with a typical outcome of either requiring new fingerings to engage the new tonehole, or with the addition of an inordinate amount of metal parts, contributing to a heavier weight and general clunkiness of the flute. The now-common C#-trill mechanism, typically available as an additional option on flutes, places a correctly-sized C# tonehole in the appropriate location, but the first finger of the right hand must be engaged in order to operate the mechanism, making it an ineffectual solution in faster passages. The problem of out-of-tune vented pitches also remains unsolved.

CONTINUING THE BOEHM TRADITION: THE NAGAHARA C# MECHANISM

Fig. 2: (above) standard Nagahara Mini; (below) Nagahara Mini featuring C# mechanism

Fig. 3: (above) standard Nagahara Mini with mechanism partly removed, exposing C# tonehone; (below) Mini with C# mechanism. Note position of larger C# tonehole on left, with small venthole on right.

In keeping with its continual commitment to innovation and the evolution of the flute, Nagahara Flutes has developed a new C# mechanism (U.S. patent 9,257,105) that solves the tonehole dilemma. The Nagahara C# Mechanism (currently available on the Nagahara Mini and soon to be available on Nagahara flutes) features a normal-sized C# tonehole, placed in line with the other primary toneholes and in the proper location for intonation, and a smaller venthole placed just above the C# tonehole. The venthole remains closed until the keys for the pitches which require venting are depressed. A lever then engages in a "see-saw" motion and opens the venthole while closing the C# tonehole. With this mechanism, C# no longer requires special attention from the flutist. The vented pitches are also brought into proper intonation. No extra fingers are required to operate the Nagahara C# Mechanism, therefore no new fingerings need to be mastered. The mechanical parts are small and simple, adding very little extra weight to the instrument.

Fig. 4: Venthole remains closed when C# tonehole is open

Fig. 5: When fingering D6 (above) and A6 (below), C# tonehole closes while venthole opens.

Innovation in the cause of bettering the flute permeates the culture at Nagahara Flutes. Led by master craftsman, Kanichi Nagahara, the staff at Nagahara thrives on solving longstanding problems that inhibit technical and musical facility. Inventions such as the Nagahara Mini, the C# Mechanism, and the Full-Concert Flute, to name but a few, complete the process that Theobald Boehm began so many years ago and free flutists to reach their maximum musical potential.

Fig. 1: *Antoine Sacchetti and Theobald Boehm, 1794-1881*. Photograph. Retrieved from the Library of Congress, <http://memory.loc.gov/diglib/ihas/loc.music.dcmphot.a0432a/enlarge.html?from=default>.