# 플루트에서 제대로 소리가 나고 있으신지요?
# Is the flute sounding properly?

Always together 16.02.05 625



This article is about the scale that you must know and move on if you want to expand your knowledge of flute to some extent.

Before writing the actual article, ask various flutists and repair shop owners about the scale and how to change the scale.
I asked, but there were few people who knew exactly and were interested.

In other words, many flute majors and lesson teachers are only interested in the sound of each flute brand, and are they actually sounding properly?
I am unexpectedly indifferent to it.

Also, there is a problem with the scale of the old flute and how to make the flute sound correctly.
I don't know.

However, if you are majoring in flute or are interested in the fundamental "sound" teachers who teach flute, you must know
I think it is the content.

So, like the Lesson Info Cafe, I think a lot of teachers need to know and inform the students properly.

The text has been transferred from the text in another cafe.

It was quite difficult to write this article.

Hope you enjoy reading.

Start scale.

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First, let's talk about the role and definition of scale.

# The role of the scale and the structure that affects the scale

First of all, let me briefly talk about what a scale is. This post is a blog run by Powell, where important posts are
It's like an overflowing treasure house.

Let's see what the scale plays in the flute and what structure of the flute controls this scale.

http://www.flutebuilder.com/2013/02/flute-scales.html

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**Friday, February 1, 2013**

## Flute Scales

By Steven Wasser

The flute scale determines how well the notes play in tune to each other, octave to octave, and also determines
the timbral balance of the notes.  From a mechanical standpoint the flute scale is a function of the following:
the diameter of the flute tube or “bore”
the size of each tone hole
the linear location of each tone hole along the flute tube

the height of each tone hole
The flute scale is how a note (scale) can be played correctly (correctly, correctly to scale) from one octave to another.
It determines whether there will be and a sense of balance in the tone of each note. From a mechanical point of view, the scale is
Function.

* Diameter of the flute's tube (or hole)
* Size of each tone hole
* Arrangement along the long axis of the tube (difference between) (the location of the tone hole and the distance between the tone hole in the whole tube)
* Height of each tone hole

Theobald Boehm developed the basis for today's flute scales. Verne Powell initiated an improved scale when he
started producing his own flutes with the Powell Scale in 1927. The next major improvement in scale design was
accomplished by Albert Cooper in 1974. Powell was the first major flute maker to introduce the Cooper Scale, and
did so in 1975. There are several other “modern” scales in use today, including the Bennett Scale used by one
Japanese flute maker, and the Deveau Scale used by Haynes.

Theobald Böhm developed a scale used for flutes these days. Powell's 1927 flute brand
As we made it, we started applying a more advanced scale called the powell scale to the flute. Then in the scale design
A major improvement (change) was made in 1974 by Albert Cooper. Powell introduces the Cooper scale, the first large flute
It was the production company. Nowadays, there are several different scales, such as the Bennett scale used by Japanese production companies and the Deveau Scale used by Haines.
There are "modern scales". (Bennett scale is not only used by Japanese flute makers, but also by other country makers.
I use it a lot, and recently I read that Haynes switched from the Deveaux Scale to the cooper scale.
http://cafe.naver.com/withflute/232 )

Today Powell uses a modified and (we believe!) improved version of the original Cooper Scale which we call the
Modern Powell Scale (or just Powell Scale, for short). When testing instruments for scale we strongly recommend

that you consider not only intonation, but timbral balance as well. A new flute should sound like one instrument,
not three separate instruments.

Today Powell uses a modified scale, which is an improved version of the original Cooper scale. This is what we call the Modern Powell scale (powell scale for short). When demonstrating an instrument to check the scale
We are not only concerned with intonation (a song or performance is made into the correct pitch or pitch), but also a sense of balance (between each octave).
It is strongly recommended to also check the overall harmony?). The new flute should sound like an instrument,
It shouldn't sound like each of the three flutes (probably different instruments between each octave zone in the tone,
It seems to mean that you should not create a tone that gives a different feel to each octave of 1, 2, 3 octaves)

Scale should not be confused with the pitch of an instrument. Pitch relates to which “A” the instrument has been
designed to produce (eg, A-440, A-442, etc.) Powell instruments made for the US market are typically pitched
at A-442, and play well in tune from A-440 to A-444.

The scale should not be confused with the pitch of the flute. When the instrument is designed, the pitch depends on whether the A note of that instrument is 440 or 442.
Related content. Powell flutes are usually made with a pitch of 442, which works well in the pitch range between 440-444 (without major problems).
You can play.

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# Scale's historical evolution

Here are a few articles on the historical changes in scale. You can see what makes a difference in those changes.

There are cases where the contents are overlapped, but the core of organizing the contents is slightly different depending on the author, so you have to read each article one by one.
Get together in two to understand the exact content later.

http://www.justflutes.com/blog/scales-an-incomplete-look-at-what-every-flutist-should-know-2/

http://www.larrykrantz.com/wyept2.htm

https://prezi.com/npex4fz8bkft/the-evolution-of-flute-intonation/

http://www.fluteworx.co.za/articles/Flute%20Options.pdf

http://www.trevorwye.com/cooper1.html
http://www.trevorwye.com/cooper2.html
http://www.trevorwye.com/cooper3.html

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First of all, I will look at the article linked below. A great pioneer in scale. Great footsteps. It's about the great spirit.

This article first appeared in the spring 2012 issue of The Flutist Quarterly , the membership magazine of the
National Flute Association , and appears here with permission.

This article was  published in The Flutist Quarterly , a flute magazine for NFA members  .

http://www.justflutes.com/blog/scales-an-incomplete-look-at-what-every-flutist-should-know-2/

# Scales: An Incomplete Look at What Every Flutist Should Know

April 26th 2012 Eldred Spell No comments

**What's in a scale? More to the point, what's in “the Cooper scale”? This short primer on scale — and why every flutist needs to understand its importance — includes a heartfelt appeal for the open information-sharing that defined the character of the late Albert Cooper.**

What does scale mean? Going further, what does the "Cooper scale" mean? And why all flutists This brief guide to what you think is important about this is the character of the deceased Albert Cooper.
Contains a sincere impression on open information-sharing. (Albert Cooper uses all of his knowledge
Do not hesitate to open and share your know-how to all producers and performers who come to you.
I did not say)

The crucial concept of “scale” in the lives of flutists began, more or less, with Theobald Böhm — and, sadly, its technical understanding largely ended with his death in 1881.But throughout much of the 20th century, a gang of mostly British flutist-technicians (along with myself as a token American), searched for ways to improve the tuning (and with it the sound quality) of the modern flute.

An important concept for Scale usually began in the life of Deowald Böhm. And sadly this important technical interest (understanding)
With his death in 1881, it can no longer be continued. Then, in the 20th century, many British flutists and repair experts
I started to study how to improve the quality and tone of sound in groups.

Following the death in 2011 of the group's key member, Albert Cooper, the man whose name will be forever linked with the flutemaker's Holy Grail — the Cooper Scale — there has come a renewed interest in explaining, disseminating, and perfecting the details of this approach, so that future flutists can continue the work that Cooper and his friends began.

Albert Cooper, who was a key member of the group, and who died in 2011, is the "Holy Grail" for flute makers.

It is associated and the name remains forever. There are several new interests in explaining, disseminating, and more perfecting his achievements.
And so that future flutists can continue the research that Cooper and his friends started.

## In the Beginning

“Scale,” for our purposes, means a set of proportions that can be seen in the different placement of frets on a guitar
fingerboard and the curve of a rank of organ pipes or piano strings. In equal temperament, these follow a simple
mathematical formula. Multiplying by 1.06 (or 1.0594630948 or 12,-2.) increases the overall length proportionately to
eventually reach the octave — exactly.
Stringed instruments are well behaved and follow this rule closely. Sadly, flutes are not well behaved. Because we
move our lips, intonation is a moving target.

To compare the scale we are going to talk about to another instrument, the different arrangement of frets on the guitar fingerboard
It means something like a series of ratios in terms of organ rank or piano string bend ( http://egloos.zum.com/organhouse/v/7569228 ).
In equal parts average rate (等分平均律) (a scale in which octaves are divided into equal semitones of 12) , it follows a simple mathematical formula. 1.06
Multiplying by (or 1.0594630948 or 12,-2.) increases the total length, proportionately eventually reaching the correct octave. (What I mean
I don't know^^;;;)
For string instruments, this formula works pretty well. Unfortunately, however, the flute is not properly reflected. We play the flute
As we play, our lips keep moving, so the intonation changes.

Holes, the crux of the matter. Top to bottom: Figures 1A, 1B, 1C, and 1D.

Before Theobald Böhm, the concept of “scale” was lost on flutists. Figures 1A and 1B in the photo above show two
one-key flutes pitched at A=427 and 442, with nearly identical hole placement. While flutemakers were not concerned
with mathematical abstractions, they were not ignorant. With the finger position decided on, tuning could be dealt with
by changing the size of the holes. A larger hole raises the pitch and a smaller hole lowers it. Makers sometimes also
undercut the tonehole, making it larger and raising the pitch without changing what you see on the outside. Remember
this principle, as there will be a quiz later.

Prior to Theobald Böhm, the concept of scale did not exist for flutes. In Figures 1A and 1B above, the pitches are 427 and 442.
It shows two one key flutes with pitch but almost identical hole locations. Even when the flute maker didn't have a mathematical concept
I wasn't very ignorant of this. When determining the finger position (hole position), the notes were tuned while changing the size of the hole.
The larger the hole, the higher the pitch, and the smaller the hole, the lower the pitch. Flute makers sometimes look from above (outside)
To make it look like there is no size change, undercut the tone hole

http://cafe.naver.com/withflute/530 ) to make the (inside) hole bigger
I raised the pitch. Remember this principle. It will be a quiz later.

The larger holes of our modern flute absolutely require an accurate “scale.” The photo's figure 1C shows a Nicholson
model flute, with the usual placement and wildly enlarged finger holes. Figure 1D shows an 1832 Böhm model flute as
made by Rudall & Rose. This is Böhm's direct response to the Nicholson instrument. Notice the absolute regularity of
tonehole size and placement. Böhm's understanding of “scales” must have been extraordinary, but the knowledge
largely died with him. Flutemakers were left to copy existing instruments and make the occasional tweak.

In modern flutes, the larger the hole size, the more accurate scale is required. Fig. 1C makes a pretty big finger hole
This is a picture of the Nicholson model flute with a typical arrangement. Fig. 1D is an 1832 Böhm model flute made by Rudall & Rose
It shows another look called the Nicholson model flute. In other words, it can be confirmed that there is a certain regularity in the size and arrangement of the tone hole.
There is. Boehm's understanding of this scale must be extraordinary. However, this knowledge is much
Disappears. Flute makers have only been eager to replicate existing instruments, and sometimes instruments that have slightly modified the concept of Böhm.
I made it.

**A New Era**

In the United States, we can easily imagine what happened with scales in the early 20th century. As the French style
of playing became fashionable, so did French-style flutes — namely those made by Louis Lot. Most of these were
intended for diapason normale, or A=435. These can be played at A=440 by shortening the headjoint, but this leaves the
holes too far apart. If A is in tune, C-sharp will be sharp and the low notes will be flat. This is what the famous flutists
played, so customers wanted a copy, and makers did their best to provide. A flutemaker might tweak something here
or there, but they would have been crazy to deviate significantly from the “ideal.” Players learned to

adjust for the errant
notes (with mixed success), creating a paradox: a theoretically perfect flute would have been unacceptable, because
established players would find the low notes sharp and the C-sharp flat! And this is exactly what happened.

In England, it's easy to imagine what happened to the scale in the early 20th century. French style in playing
As the playing method became popular, the french style flute made by Louis Lot and others became popular. ( http://cafe.naver.com/withflute/613
In the middle of the article, there is a french model and a german model). These flutes are tuned to the international standard sound at the time or A=435.
Is produced. These instruments can be used by shortening the head joint (either by adjusting the depth of the flute body in the tenon or
By shortening the length), you can play up to A=440. However, for these instruments, the toneholes are still too far apart.
So, if you tune the notes based on the A note, the C# note will be too sharp (higher), and lower at the lower scale. This is famous
Since it was an instrument that flutists played (although it was actually a problematic instrument), those who would like to buy an instrument
They wanted a replica of the instrument, and the makers (without trying to improve the flute) just tried to make it.
Of course, flute makers sometimes tried to modify some of the existing flutes on their own. However, these
The attempt was only taken rather seriously from the ideal (complete) situation. (As these wrong instruments continue to be produced,
Players who use instruments) had to learn a playing technique to adapt to the flute that deviated from the original note.
In some cases, it was successful (well adapted). However, this leads to a paradoxical situation. Many existing players
In a situation where wrong notes need to be corrected (through the process of making a flute with a perfect scale),
It was theoretically (mechanically) corrected through the playing technique so that the low note can be played higher and C# can be played lower through the playing method.
Paradoxically, situations could be created where the perfect flute (a flute with a more accurate scale) could not be accepted. This is actually
Occurs as.

Albert Cooper in the doorway of his shop.

In 1974, Bickford Brannen visited Albert Cooper in London, brought the scale back to Powell Flutes, and so contributed to
an historic decision. Powell, at the height of prestige and with no need to innovate, introduced not just a new scale but
an entirely new instrument and approach to flutemaking. It is difficult today to appreciate the controversy this created.
This pivotal moment in our history deserves a separate article, if not a book. Suffice it to say that we are all deeply
indebted to Bick Brannen for taking the first step on this groundbreaking journey.

In 1974, Bickford Brannen visited Albert Cooper in London and made a historic decision to apply his scale to a Powell flute.
Do it. Powell, a flute maker who didn't have to make any other changes at the peak of flute at the time, simply took this new scale.
It does not stop at introducing, but applies it to creating new instruments. The value of the controversy created by these decisions today
It's hard to tie. This important moment in our flute history opens up a new chapter in flute making. We (flute
It is enough to say that we are greatly blessed with Bick Brannen, who made the first step in an epoch-making).

**Across the Pond**

One does wonder why this new scale came from London and not some American corporation or university. The answer
seems to be found in our different histories and attitudes. In the US, flutes were (and are)

considered art objects. Tampering
was strictly forbidden and so experimentation was discouraged. Verne Powell left us with many colorful quotes, one of
which nicely sums up the American attitude toward innovation: “I made it, it's right, go play it!”
The situation in England could not have been more different. Like the Powell scale in the US, the Rudall & Carte “schema”
was presumed perfect. However, Rudall & Carte made quite a few “HP” (high pitch) flutes, and with the establishment of
A=440 as the international standard (1939), these became obsolete. R&C could have sold many new flutes but instead
transplanted the old mechanism to a new tube at the new pitch. This in itself was not “experimentation”; the concept of
repurposing flutes was well established. Further, London flute players are arguably (pun intended) more critical of flutes
and flutemakers. Everyone seems to have strong opinions and “agreeing to disagree” is an absolute tradition.
By the 1950s, R&C had gone into decline and then folded. This removed the sort of central authority the US had in Boston
and also left a number of highly skilled craftsmen to fend for themselves, most notably Albert Cooper.

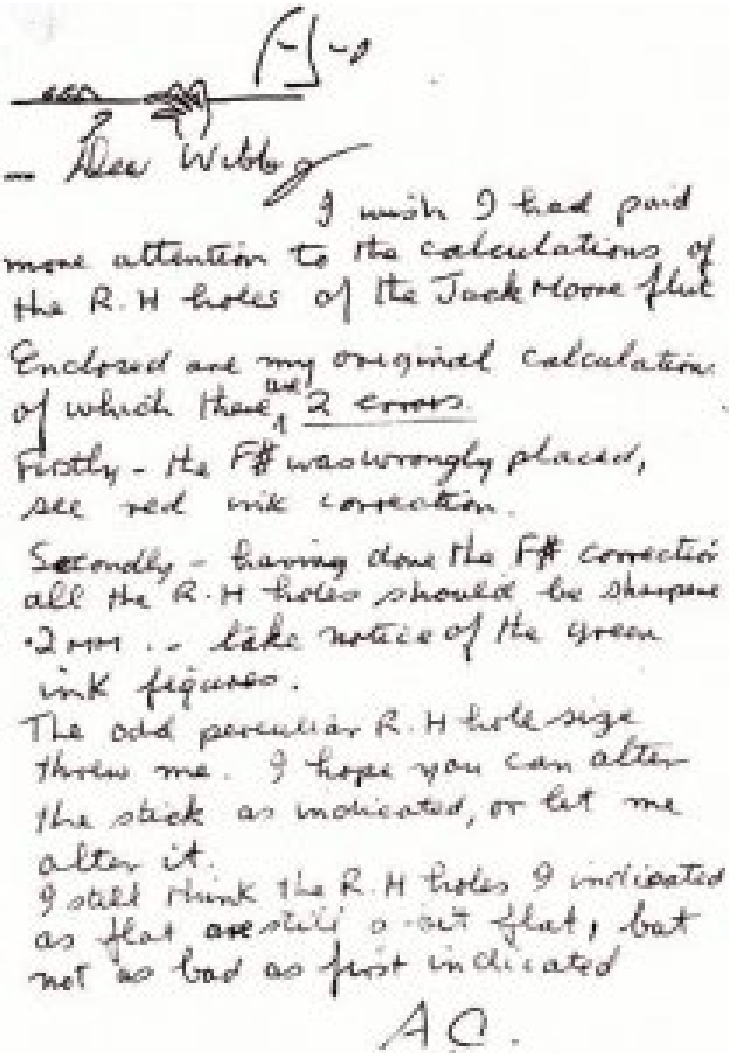
You may be wondering why the new scale is coming from the UK and not from the American production company or university. The answer is each other
There seems to be a difference in perception of the flute with other historical situations. In America, the flute was considered a work of art,
I think so. Therefore, it is strictly forbidden to change the existing musical instrument at will, and it is a standard (which is the standard for production).
It was not an atmosphere that allowed further experimentation with the instrument. Flute maker Verne Powell has told us a lot of different things.
Left. Among them, the phrase that best represents the American representation of innovation is "I made it, this is right, so
Play it.” In the UK, the situation seemed no different. Like the American powell scale, the Rudall & Carte
It was considered perfect for its production style. Rudall & Carte made a rather high pitch flute. By the way international
As the standard note is set to A=440, all of these instruments become obsolete. Rudall & Carte made many new flutes
Sold it. However (in the situation where the international standard sound is set to A=440, instead of making flutes to a new pitch)

In line with this, we moved the old mechanism of the old instruments to the new tube. This is not essentially a new experiment, but a flute
It is a concept tailored to a new purpose (pitch). Moreover, flutists in London are more controversial about flute and flute making.
I saw it. It seems that all the performers had their own strong opinions. However, to acknowledge differences of opinion and fight
The method of controversy that did not exist was the traditional way of conversation. In the 1950s, the Rudall & Carte productions began to fall and disappear.
This is an opportunity to lose the authority in the production method that has traditionally been handed down to the Boston production company. After that, break away from the existing authority
Independent high-level flute makers who claim their own production methods will appear. Among them, the most notable producers
This is Albert Cooper.

**The Cooper Scale “Brand”**

When Powell (and later Brannen Brothers) invested in the Cooper scale, it became a brand — and should have. The
companies took risks, and Cooper certainly deserved financial reward and every bit of credit. That said, Albert Cooper
did not invent the scale out of whole cloth. What became “the Cooper scale” evolved as a group effort, with input from many
different players. What in the United States became an industrial property remained “Cooper's scale” to those who had played
a part in its development.

When Powell and later Brannen Brothers invested in the Cooper scale (the cost of applying the new scale), this
Became a brand. It had to be a brand again. The company had to take the risk of introducing this new scale, and Cooper
It certainly deserved economic rewards and had to cover all credit (in terms of brand value and utility). In other words, Albert Cooper
The scale was not created in the absence of anything. Called the Cooper scale, the advice of many other players
It has been developed through the efforts of many people through the process. Intellectual (manufacturing) ownership of the Cooper scale in the US
It's up to those who were involved in the development.



Dear Wibb

I wish I had paid more attention to the calculations of the R.H holes of the Jack Moore flut

Enclosed are my original calculations of which there are 2 errors.

Firstly - the F# was wrongly placed, see red ink correction.

Secondly - having done the F# correction all the R.H holes should be sharpened .2 mm . . take notice of the green ink figures.

The odd peculiar R.H hole size threw me. I hope you can alter the stick as indicated, or let me alter it.

I still think the R.H holes I indicated as flat are still a bit flat, but not so bad as first indicated

AC.

A letter to William Bennett
from Albert Cooper.

The best known of these is William Bennett (aka WIBB), author of the William Bennett scale. Cooper and WIBB agreed to
disagree on some details but were long-time friends who shared information and opinions freely. It was WIBB who first
said, “If the hole is in the wrong place, move it!” And he did, beginning in 1954.In 1956 he invented the technique of
“Patching” toneholes. This allowed an incremental approach to tuning flutes rather than building an entirely new instrument
to test every possibility. The process has always been one of trial and error, and without this expediency, progress would
have been slow indeed.

One of the most important people involved in developing this scale was William Bennett (WIBB), the creator of the William Bennett scale.

is. Cooper and WIBB admitted to each other's differences in details, but on the basis of which they have long been friends.
There is a point in which information and opinions were freely shared. "I think I have to change this because the tone hole is in the wrong location."
The first person I talked to was WIBB. And I started putting these ideas into practice in 1954. In 1956 he patched the tonehole
(patching: a way to move the position of the tone hole) develops a technique. This is a flute to test new possibilities (changes).
Rather than completely rebuilding it, it took a progressive approach to retrofitting the flute. The testing process is always of trial and error.
It was continuous. However, without this technology of WIBB, the progress of flute production technology would have come out more slowly. (WIBB's
patching technique: http://www.justin-young.net/wiki/var/upload/anon_moving_flute_tone_holes.pdf
MOVING FLUTE TONE
HOLES -Appears at the end of this article.)

Cooper left R&C and began making his own flutes around 1958.Both he and WIBB experimented with fixing the worst notes,
but a systematic approach was needed.
The person who most deserves recognition here is Elmer Cole, principal flutist with the English National Opera Orchestra for
nearly 35 years. (Cole also invented the convertible footjoint, an improved system of trill keys, and who knows what else.)
Cole had ordered a flute from Cooper around this time, and as it was being made, Alex Murray (inventor of the
Murray-system flute) suggested Cole look into Böhm's book. He did, but unfortunately, the flute was finished too soon to
incorporate the new ideas.

Copper left the company Rudall & Carte and started making his own flutes around 1958. He and WIBB are the quietest
I did several experiments to make the notes sound good. However, it needed a systemic approach (like the collaboration of others). Where that
The one who deserves the most credit is Elmer Cole, who has been flutist at the English National Opera Orchestra for 35 years. (Cole
We also developed convertible footjoints, improved the Trillkey system, and did many other things that people know. ) Cole
At that time, I ordered a flute from Cooper. By the time it was made Alex Murray (the founder of the Murray system flute)

http://cafe.naver.com/withflute/613 There is an article about the Murray system flute in the article). I suggest you take a look. So he looked at Böhm's findings and tried to apply a new idea, but unfortunately, the flute already
It was after it was completed.

**The Cole Factor**

Regardless, Elmer Cole set the entire effort on a straight course by insisting that, whatever else, the scale must have an
underlying mathematical basis. He coined the term “octave length” and laid the groundwork for everything that followed.
And octave length continues to be a subject of discussion. It determines the overall pitch of a scale (A=440, 442, or whatever)
—And small uncertainties still continue about the best starting measurement and how, exactly, to proportion the tonehole
placement.

He insisted that the scale should be built on a mathematical basis, even if he couldn't apply new ideas to his instrument. He octave
When I came up with the word length, I proceeded with the basic work accordingly. His octave length continues to be the subject of discussion.
This determines the overall pitch of the scale (A=440, 442, or whatever). But still, where do you want to start measuring?
(Is this the best way to measure the starting point?), depending on the location of the tone hole, how to accurately measure
It has some inactivity.

Obviously, Albert Cooper made the largest contributions to the effort. Among many things, he developed a “displacement
graph” that enabled makers to substitute different-sized toneholes in a predictable way. Just one example of Cooper's quiet
genius: When the strict “Böhm schema” was tried, the left-hand notes were found to be flat—a very serious problem. Instead
of belaboring theory, Cooper simply (but rationally) jumped to a workable solution. In essence, he grafted two different scale
s together—what we now call the “Cooper stretch.”

Certainly, Albert Cooper has contributed a lot to this endeavor. Among these many contributions, he said that different flute makers

We developed a displacement graph as a way to predict the results in advance when using a sized tone hole. This is Cooper's
As a cross-section showing genius, the Boehm schema (Boehm schema: Boehm's production formula?) is strictly applied to the flute production.
As you can see, there was a serious problem with the notes on the left hand being low. Instead of a lengthy theory, Cooper is a simple but logical flute.
We have presented a solution that can be applied. Essentially, Cooper grafted (fusion?) two different scales together, which is now
This is what we call the Cooper stretch.
(Cooper's swaging technique; http://www.justin-young.net/wiki/var/upload/anon_moving_flute_tone_holes.pdf MOVING FLUTE TONE HOLES -Appears at the end of this article.)

This was a major breakthrough, and one that Cooper could well have kept to himself. Instead, all developments were shared,
discussed, and incorporated into the general effort. This attitude of sharing both effort and credit seems difficult for American
s to understand, ie: “My scale is better than your scale!”

This was a great step forward, and it was something that Cooper could have on his own. But if he shared all his development (knowledge),
Discussed and tried to apply to everyone in general. His shared spirit or belief is understood by American producers.
It is difficult. That is because American producers say, "The scales they make are better than those made by others."

This is not to say there was agreement on every item. Everyone was working toward a common goal — better flutes — but
not necessarily a common solution. There are myriad compromises, and everyone had slightly different opinions. Quite
remarkably, there was a common understanding of what the compromises were and why certain choices were made.
As an example, the octave between low and middle D tends to be wide. If you make the low D “in tune,” the middle D will be
sharp. Conversely, if the middle D is “in tune,” low D will be flat. What to do? Cooper reasoned that since third-space
C-sharp also tends to be sharp, putting two sharp notes together might lead players astray. WIBB reasoned that if the player
is already adjusting the C-sharp, why not humor the D as well?

This does not mean that everyone agrees on everything. All people come together towards a common (ultimate) goal of a better flute
Studied. However, you don't just need a common (one) solution. (There is not only one correct answer/answer). Numerous compromises
There was (compromise) and everyone had a slightly different opinion. What's unique is what are the compromises to this opinion?
Also, most people understood why that choice was necessary. For example, between the low and mid range D
The scales of's tended to be too wide. If the bass D is properly tuned, the mid-tone D will be higher. Contrary
The bass D will be low if the mid-tone D is properly tuned. What should I do in this case? Cooper is the third space
(3 octaves???) C# tends to be higher, so putting two # notes together (a semitone high note?) would confuse the player.
(I'm not sure what this means???) In the case of WIBB, people adapted to C#, but why not
I asked if there was any reason I couldn't adapt.

They were both right.

Both of them were right.

To be clear: despite superficial differences, both Cooper and Bennett scales were always based on these same underlying
concepts and measurements. I last saw Albert Cooper at the 1998 NFA Phoenix convention (at which, along with Charles
DeLaney, he received the NFA's Lifetime Achievement Award). He was his usual cheerful self, but a bit contemplative. He
said quite clearly that he thought “the scale” was essentially complete, yet there were still details to be worked out, and that
WIBB would likely run those to ground. There was nothing about “his scale”—it would have been out of character.

To be more clear, there was a difference on the surface, but whether it was the Cooper scale or the Bennett scale,
Was created. I last saw Albert Cooper at the 1998 NFA Phoenix convention (he was there with Charles DeLaney.
Together, they received the NFA Lifetime Achievement Award). He was as cheerful as usual, but he was somewhat contemplated.

He spoke pretty clearly. "The scale still has a bit of detail to look at, but now
It is the completion stage. And WIBB will find a solution after a long study." In his words, the story of his scale (story of achievement)
There was no. Probably, that's a behavior that doesn't suit your temper.

Keeping the Scale Alive

Edred Spell, left, Jack Moore, and
William Bennett in 1978.

More than a decade ago, WIBB voiced concern that as the principal characters age and die, the process leading to "the
scale" would be lost. This started me on a mission to document as much as possible. Sadly, this was about the time that
Albert stepped in front of an oncoming car. He never really recovered, and WIBB's fears were partially realized. Fortunately,
WIBB kept detailed notes from the start. In reviewing five decades of his research, I noted a pattern of uncertainty about the
tonehole displacement graph and the adjustments needed for open holes. Trevor Wye (another significant contributor and
the engine behind our present effort) had built a mechanical flute player in the early days and got it working well enough to
prove that things were actually headed in the right direction. It seemed a simple project to build another, take a few
measurements, and settle matters.

Ten years ago, the WIBB said that if the key figure, Cooper, ages and dies, the research on scale will disappear.

When I listened to him, I decided to write down as much as I could. But sadly, Cooper was on the approaching car
It was the moment I stepped on. And he never recovered. Concerns over WIBB's scale study after he died are some facts.
It came. Luckily, WIBB continued to work on fine tuning of tones in scale. Reviewing his 50 years of research
I am talking about the uncertain pattern of the tonehole displacement graph and the correction (tuning) required for the open hole.
I recorded it. Another important contributor and key behind the currently revealed efforts (research), Trevor Wye, who plays the flute in his youth.
Made a machine. Working hard enough to prove that scale-related research is going in the right direction through the machine.
(In order to obtain accurate results by experimenting with flutes in various scales), we demonstrated. Through these efforts, we made another opinion
It seems to have brought about some additional measures (changes, trade-offs) and solved the problem again.

Judith Gilbert with a version of Wye's
flute player, dubbed “Trevor 3.2.”

Right. Wye's students called his machine an “Automated Trevor.” Borrowing computer technology, I dubbed mine
“Trevor 3.0.” Years and sleepless nights later, “Trevor 5.3” is
beginning to behave predictably, and the open-hole corrections are taking shape. The displacement graph just might come
together in the next year.

Yes. The students at Trevor Wye called his mechanical flute player Automated Trevor.
Borrowing computer technology, I nicknamed it Trevor 3.0. Trevor 5.3 predicts after a long time
It started to work like (expected), and the appearance of the correction method for the open hole that I pointed out earlier was revealed.
Compared to the closed-hole flute, it should have a difference in scale, and we have found out what difference). For these differences
The displacement graph will come out together next year. (A chart will appear for the exact scale of the open hole flute)

**Everybody Else**

As the initial controversy subsided, other makers were left to make tough choices. A few companies really did try to develop
their own scales from scratch, with mixed success, but a simpler approach was to copy a “Cooper scale” flute and use it
without giving credit.

Even when various early controversies subsided and some common opinions were gathered, some other production companies made different difficult choices.
Through the Cooper scratch (without following the approved scale) (moving the tonehole position through the Cooper swaging technique)
I tried to make the scale of the manufacturer's own. However, without paying any special price, it is better to just bring the Cooper scale for free.
It was the simplest approach.

Or they could get the William Bennett scale for asking.

Or, if you weren't using this Cooper scale, the Bennett scale could have been requested by WIBB.

Or they could copy either and announce their new “Brand XXX” scale.

If they didn't do this, they would have to duplicate another scale and add their own brand name to claim "XXX scale".
Will.

Or they could tweak something (usually for the worse) and claim to have invented the thing entirely.

Or they would have had to twist the existing scale a bit (although most of them failed) and insist they would develop a new one.

In any case, these came after the fact. It was the initial concept that mattered, and once the idea of improved tuning was
accepted, anything seemed possible.

Anyway, the various things mentioned above have actually happened. What was important was the early (organized) concept, then on a new scale
If the idea for this was accepted, it seems that new attempts (compromise) were possible.

Sadly, in the past few years WIBB, Trevor Wye, and I have become increasingly concerned (annoyed/frustrated) at having
students with expensive flutes that are obviously (in our opinion) out of tune. We don't mean to appoint ourselves the “pitch
police,” but it's been a long road, and the desire to make everyone's lives easier remains.

Sadly, over the past few years WIBB, Trevor Wye and I, in our opinion, do not sound well
Worries (annoyance, dissatisfaction) have gradually increased for students with expensive flutes. To investigate whether we are on the pitch
It does not mean that you have been appointed as a police officer. It took a long time, but in our minds we can see everyone’s life.
I still have thoughts that I want to be comfortable with.

We hoped that if we published the actual numbers, flutemakers could use them directly or at least compare their numbers
to ours and note the differences.

When we formally share the actual figures (data, results of the completed experiment, and the completed scale), we
We hope that the makers can use it directly and compare them to their numbers and let you know if there are any differences.

Thus, we offer — in a gesture of the openness and sharing that was a hallmark Albert Cooper's character — our most
recent numbers for all to view and use. You can find them (and much more useful information from Wye, a 2011 Lifetime
Achievement Award recipient) at trevorwye.com . They also are available in one easy-to-find location at
eldredspellflutes.com/scales/index.htm

So, like the way we share and open the knowledge that has shown Albert Cooper's character, we have all the
Provides the latest figures (data). You can find these at trevorwye.com ( http://www.trevorwye.com/cooper4%20figures.html )
You can check the contents and get more useful information from Wye. These are
You can also easily find it at eldredspellflutes.com/scales/index.htm .

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Who played what role in the scale and how later flutists and flute makers tried to inherit their spirit I saw it. At the end of the article, the actual number required for making the flute scale appears, but it goes directly to the scale number.
Before we go, I want to talk a little bit more about the historical background of the scale.

The following is the text The Intonation of the Modern Flute , available at http://www.larrykrantz.com/ .

Eagle also with trevor wye
It is relevant. In the preface of the article it is written as follows

This is a summary of a talk given by Trevor Wye at International Summer School, Ramsgate in 1979 and revised in 1997,
though it should be pointed out that this article is for the general reader who wishes to know why and how the flutes of the
middle part of this century were not very well tuned

This is a summary of conversations with Trevor Wye at the International Summer School in Ramsgate in 1979.
I have modified the content a little bit. This article is a general purpose of trying to find out why flutes in the mid-20th century don't pitch well and why they don't.
This article is intended for readers. (Please read the article considering the year of writing)

Also, it is easier to understand the text below by reading the above text. So it's a good idea to carefully read the above text. For the contents, Cooper et al.
It will show you how to experiment and check the scale you thought.

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http://www.larrykrantz.com/wyept2.htm

Some years ago, a flutist asked his piano tuner to call to correct a flat C sharp on his piano. After the tuner had complied,
the flutist complained that it was still out of tune. The tuner was summoned once more and with scepticism, re-tuned the
C sharp. The flutist complained again which prompted the tuner to ask'What are you comparing the C sharp with?' "My flute,
of course", the flutist replied.

A few years ago a flutist asked his piano tuner to tune his piano to a flat C# (low degree). Tuner
After the flutist was still dissatisfied that it was out of tune (it didn't sound right). The tuner comes again
I re-tuned C# again to look skeptical. But the flutist complained again, and the tuner told the flutist
When asked, "What are you comparing C# by?" the flutist replied, "Of course, by my flute."

(There was a problem with the flutist's flute)

Flutists rarely suspect that their flutes can be wrong. 'Surely the manufacturers must know what they are doing, especially
so since these flutes are being played by the leading players of the country'!

Flutis seldom doubts that his flute is wrong. So the flute makers themselves
You need to know exactly what you are making. Because the leading flute players are using their manufacturer's flutes.
because of.

Over the past few years, the name'Cooper's Scale' has entered our vocabulary. To show what changes have been made
to the flute since the late 50's, it is necessary for us to go back to the days of Theobold Boehm. When Boehm designed his
flute in 1847, he also devised a method by which the'scale', or hole positions could be calculated with great accuracy.
This same method was also used for calculating the correct positions for the frets on stringed instruments such as the guitar.

Since the last few years, we have come to use the word Cooper scale. What has changed in the flute since the late 50s
To see if it happened, we need to go back to the days of Deowald Böhm. When Boehm designed his flute in 1847,

Invent a way to calculate the tonehole location with very high accuracy. The same method as this is to locate the fret of a string instrument such as a guitar.
It was also used to accurately determine.

In the mid 19th century, there was no standard pitch such as the A=440 widely recognised today. The most common pitch
in Europe was A=435 though the pitch in England was A=452. The great flute makers of this time, Rudall Carte, Louis Lot,
Lebret and others, made excellent flutes to this pitch which -though modified-are still in use. At the turn of the century,
new makers appeared on the scene in the USA and it seems as though they copied the existing'scales' (tone hole
positions) used by the great European makers. And why not? Louis Lot flutes, for example were widely recognised as the
best money could buy. During the early part of this century, the standard pitch began to rise until, in the '30's there was
international agreement that the pitch worldwide, should be A-440.

In the mid-19th century, there were no international standard pitches such as A=440 that were recognized worldwide as these days. Most commonly used in Europe
The pitch was A=435. The exception was the A=452 pitch in the UK. Rudall Carte, the great flute maker at the time,
Several other manufacturers, such as Louis Lot, Lebret, and others, have produced great flutes with these pitches. These flutes are still
Used. (It needs to be slightly modified/modified for use in performance these days.). In the 20th century, new production companies emerge in the United States.
However, it seems that the scale (tone hole position) used by the great existing European flute manufacturers was copied as it is. Why
Wouldn't it? Musical instruments such as the Louis Lot flute, for example, were widely recognized as being only available at the most expensive price. 20th century
At the beginning, discussions about the standard pitch began, and A=440 was recognized worldwide as the standard pitch of the 1930s.

To return to the manufacturers: as the pitch rose first to A=438 and finally to A=440, the flute makers-responding to the
complaints of players about flat flutes-shortened the head joints on their instruments without changing the relative position
of the holes, one to another. This has the effect of raising the pitch of the left hand notes too much without raising the right

hand notes enough! This may explain why flutists to this day complain that the C sharp is too sharp, for example, and that
the low notes are too flat. The scale is too long to be played comfortably at A=440.

Back to the manufacturer, when the pitch went up from A=438 to A=440, flute makers used the standard of A=440 with the existing flute.
Without trying to change the position of the tonehole to solve flutists' complaints that they had to produce a low sound (the fundamental solution
Without finding) First of all, I shortened the length of the head joint. This was enough to increase the pitch of the left hand scale, but
The pitch of the scale was not raised enough. This is why flutists these days say that for example C# is too high and low notes are too low
Explain why you are dissatisfied. In other words, in the case of conventional instruments, the overall scale of the flute (tonehole position, spacing. scale length?) is A=440
It was too long to be played comfortably (accurately) at standard pitch, which was unsuitable.
It means there is no problem)

Obviously, different makers responded to their advisors-the players of the day-in differnt ways, but the principal is the
same.

Obviously, different producers have different ways of responding to their advisors (the performers who want to fix it).
But the principles (response, conclusion?) were the same.

When players complained that the foot joint notes were too flat, the clever manufacturer-(understanding almost nothing
of scales!)-shortened the foot. This has the effect of raising only the low C, C sharp, D, and Eb. The equivalent action on a
fretted instrument would be cutting out a section of the fingerboard and gluing the two pieces back together!

When the footjoint's sound became too low, some manufacturers didn't understand the scale at all, so just shorten the footjoint's length.
I did. This only has the effect of raising low C, C#, Eb. The same thing on a fretted instrument
To explain how to do this, cut a part of the pinker board (the long neck of a string instrument) and glue it back to the two pieced finger board.

Perhaps other players complained of sharp, or even flat top notes. So, the manufacturer again obliges by moving the tone
holes to help these notes and the performer, a foolish thing to do: it can correct a third octave note, but alters the pitch of two
notes in the middle and lower registers. The flute can only be worse after such treatment. Perhaps each maker, aware of
changes and claimed'improvements' to the scale by their competitors, copied these defects and'improved' them with
resutant chaos. It is small wonder that flutists are not renowned for good intonation! Let us also remember, though, some
excellent flutists of the past who, in spite of the anomalies of their instruments, have succeeded in playing in tune.

Perhaps other players were dissatisfied with high or low treble (three octave notes). So the makers make these sounds sound right
So I just moved the tone hole without thinking to help the performer. This was, in a word, stupid.
This is 3 octaves
The note could be corrected, but the remaining 2 octaves and 1 octave notes were rather broken. In other words, after the manufacturer's action, the instrument will become worse.
It was. Perhaps each producer was aware of this change (action) and other competitors asked for scale improvement.
If you take any action from the other competitor, you think it is improved (although in reality such action is rather flawed),
Cloning and making flutes resulted in a confusing situation. Intonation related to flutists
It is not so strange that the problems are not well known. Because for some of the talented performers of the past, their instruments
Despite having problems, it was possible to play the notes properly.

A curious fact should be mentioned here. After Boehm had introduced his flute of 1847-the one we all play today-the
English performers began to make keywork or fingering'improvements' both to Boehm's flute and to the old'simple system'
eight keyed flutes. More than that, they began to invent entirely new key systems, some of which have survived to the
present day! [FOOTNOTE: the author still performs regularly on a Radcliffe Systen flute made in London in the 1920s].
This seems to be a peculiarly English activity still carried on to the present day. Other countries' makers have experimented
in different aspects of flute design, but is is rare for performers to do so. This fact has often been

commented upon by
others around the world.

Here's an interesting fact. Since Böhm introduced his instrument in 1847, the British producer
Are you a performer or mean both?
I have been trying to improve my fingering. Further, they began to develop an entirely new key system. And
Some of those results remain to this day. (For reference, the author is still Radcliffe, made in London in the 1920s.
It is played periodically with a Systen flute) This seems to be a unique British trait that has continued to this day. From other country's production companies
We have experimented with different aspects of flute design, but it is very rare for players to play with it. These facts are several
Mentioned by people and known all over the world.

Back to our story: in the early 1960s, Albert Cooper, at that time an employee of Rudall Carte and Co., was dissatisfied with
the current flute scales, and began to experiment with new tone hole positions. He was also of the (correct) opinion that
open hole flutes should have a different scale to closed hole flutes. His experiments were done by calculation. At the same
time Elmer Cole, (still principal flute at the English National Opera today!) also recalculated Boehm's'schema'- his method
for determining the correct position of the tone holes-and was also able to check out these experiments as a performer.
William Bennett was also dissatisfied with the'scale' of his old Louis Lot. He solved the intonation problems by simply
moving the holes according to the dictates of his excellent ears. Of course, these three persons, and others such as Richard
Lee who were doing the same thing, talked freely to each other about their experiments, unlike the US where such talk
would be regarded as of commercial interest.

Returning to the point of view, in the early 1960s, Albert Cooper, who worked at the production company Rudall Carte and Co at the time, used the flute scale at the time.
I was very dissatisfied with it. So I started an experiment to find a new tonehole location (batch). He is also a closed hole
We had an accurate view that different scales were needed for flute and open hole flute. (open hole flute = open-key,

ring-key, french-key flute) His experiment was done by calculation, rather than a fist-fight. Contemporaneous Elmer Cole
(To this day, the chief flutist of the English National Opera) also analyzed the Boehm style production style (Boehm schema Boehm production formula) again.
We have created a way to determine the exact tonehole location. So other flute makers can check the results of these experiments.
I did it. William Bennett was also dissatisfied with the scale of his old style Louis Lot. He these
He listened directly to his fine ears to judge the problem of intonation and solved it with a simple method of relocating Tonehorn. Of course with these three
Others, such as Richard Lee, who did the same work, freely discussed their experiments with each other, and this tendency to debate
In the US, it will be impossible due to economic interests.

In 1959, Albert Cooper left Rudall and Carte to set up on his own, making flutes with a sharper scale. Gradually, as his flutes
became better known, people began to take an interest. Bennett, Cole, Lee and Cooper all agreed on the same principle,
that the flutes currently being manufactured were made on a scale of about A=435, whilst performers were trying to play
these flutes at A=440! The scale was too long.

In 1959, Albert Cooper left the production company Rudall and Carte to start a workshop to create his own flute with a more precise scale.
Established. Gradually, his flute becomes famous, and many people are interested. Bennett, Cole, Lee and Cooper
All "Existing flute makers had scaled up to A=435, whereas players tried to play these flutes at A=440 pitch.
I agree with the basic principle of "So the scale of the existing flute is too long" for this kind of performance .

If the reader's knowledge of scales and of acoustics is scant I will explain the concept of'scales'. Imagine an instrument
consisting of a piccolo joined on to the body of a flute, which in turn is joined to the body of a bass flute. If you were to move
your eyes from the foot end of the bass flute towards the piccolo head joint you would notice that the holes become
gradually closer together. This principle of the holes becoming closer together is most important to the understanding of what
is to follow. If the holes on all woodwind instruments-and similarly the frets on string instruments-

were an equal
distance apart, then a piccolo would simply be a flute with a very short headpiece! It follows that an alto flute would be an
ordinary C flute with a much longer headjoint!

If the readers have no knowledge of scale or acoustics, I'm going to explain the concept of scale.
Flute piccolo head
Imagine an instrument connected to the body. In particular, consider an instrument connected to a bass flute body. And bass flute
Try moving your gaze from the foot joint to the Piccolo head. Then you can see that the tonehole is gradually closer
Can be seen. The principle that these toneholes are located closer together is very important in understanding what will happen. all
If the toneholes of a woodwind instrument are all positioned at equal intervals (in the case of string instruments, the fret spacing is the same), Piccolo will use a very small head joint.
It will be a flute with. This means that the alto flute will also be a regular C flute with a longer headjoint.

Therefore, if the pitch of an instrument is to rise, the holes must be moved closer together or to put it another way, the scale
lenght must contract. Of course, if you wish to make a flute with a much sharper scale, on e so sharp that the A on this flute
corresponded to A sharp on a concert pitched flute (one made to A=440 ), then your new flute would be a semitone sharp
and, unless the part is transposed, this flute would be useless for performance with others. (Many flutes were made in this
way earlier this century and are known as'sharp pitched'instruments, though they are not exactly a semitone sharp). If you
were to pull out the headpiece to lower the A by a semitone, you would soon discover that the relationship of all other notes
to A is wrong.

Therefore, to raise the pitch of the instrument, the toneholes must be located close to each other, or in another way: scale length (C1 when playing the flute).
It is necessary to reduce the required scale length???) to sound up to C2. Of course you are equivalent to the A# of the flute of the concert pitch of A=440
If you make a flute with a higher scale, like a flute that makes the note A sound, your new instrument will be a semi-high instrument.

If the pitch (or situation, playing part) changes, these flutes will become useless when playing other songs. (Many flute makers
At the beginning of this century, flutes were made in this way and were known as sharp pitched instruments. Although these instruments are
(Semitone #) wasn't a semitone sharp instrument, but it's difficult to translate???) If you want to lower the A note on these instruments
If you take the headjoint a little from the body, you will find that all notes other than A are wrong.

Before reading any further it would helpful for you, the reader, to pause and take out your flute and pull out the head as far
as it will go without its falling out. You will soon discover that the scale is decidedly strange. Starting from low C, the scale
becomes progressively flatter as you ascend. Compare the octaves, low C to upper C, and low C sharp to upper C sharp.
A moments reflection must establish beyond all doubt, that a flute can be made to play accurately at only one pitch. Other
slight pitch changes can be made, depending on the skill of the performer.

Before reading further, the following will help you. Pause reading and bring your flute. And
Try removing the head joint until the head joint is about to come off the body. At that time, when I played the instrument, the scale became obviously strange.
You can see right away. Starting with a low C, the scale gradually decreases as you go up gradually. Various
Let's compare the octaves. Try playing from low C to high C, then low C# to high C#. Without a doubt, on only one pitch
It will immediately come to mind that the flute only plays correctly. Any other slight pitch change depends on the player's skill (ability).
Some may be possible depending on.

I first became interested in flute making in the '60's, largely as a result of meeting Messrs. Bennett, Cole and Cooper, and
as a aresult, tuned my flute to a new scale - what we called the 'Cooper's Scale' of that time.,. I was fairly satisfied with
the figures arrived at, but decided to set up a practical experiment to prove the theory. My scepticism arose from discovering
that flutists - like all artists - will readily 'prove' that a note is sharp or flat by making small, almost undetectable
adjustments to their lips. What was needed was a machine to blow the flute: one which could make no such alterations and

which had no artistic temperament! This machine was duly set up using a borrowed school laboratory vacuum pump
(plugged in the mains reverse), an air reservoir, a simple on-off valve, and a flute strapped to an 'L' shaped piece of wood
on which were mounted plasticene (playdo) lips. Through the generosity of the late Eric McGavin of Boosey & Hawkes Ltd.,
I obtained some flute tubes with holes already in place. In one plain tube, I cut oval shaped holes in approximately the
correct position of the expected note and mounted patches with tone holes attached cut from another flute tube, on to this
tube. By using some thick grease to prevent air leaks, the tone holes were capable of being moved short distances up and
down the tube thereby varying the pitch of the note. To visualise this more clearly, stretch out your left arm. Place your right
hand on your left arm and imagine a tone hole sitting on the center of the back of your right hand. Slide your hand up and
down your left arm; this is how the tone holes (saddles) were moved according to the pitch required.

I'm Messrs. Bennett, Cole and Cooper met and talked very much about the 1960s flute making.
Has been. As a result, I changed my flute to a new scale. This new scale was called the Cooper scale. (Discussed
I was satisfied with the figures (data related to the Cooper scale) that arrived at the time (as a result), but eventually proved this theory.
I decided to do a practical experiment. One of my concerns is that flutists use their skills to make lips very fine.
It came about knowing that you can adjust the note higher or lower by adjusting it. (In other words, the test results are affected by subjective ability.
It seems to mean that I thought it was difficult to secure objectivity because I could be crazy). So, it does not give a variable to the experimental results, and the artistic temperament
We needed a flute blowing machine that was invisible (from an objective standpoint). In making this machine, a school laboratory vacuum pump
(plugged in the mains reverse), an air reservoir, a simple on-off valve, and also a wooden with craft clay lip plate.
It is set with a flute with an L-shaped head joint. With the help of Eric McGavin of the deceased Boosey & Hawkes Ltd.
I got some flute tubes with holes already. And the exact sound that was originally planned to come out in one tube
Drill a round hole close to the tone hole location, cut out a part of the tube in the shape of a tone hole from the other flute tube, and insert it into the drilled tube.

And use a sticky grease between them to prevent air from leaking out. In this way, cut out into a tone hole
Part of the tube makes it possible to move the tone hole position up and down (toward the head or foot joint) little by little, so that the tone hole position is changed according to the pitch of the sound.
It made it possible to experiment with changing. If you are not sure how to do this experiment, stretch out your left arm and place your right hand on the left arm.
Imagine that the tonehole is on the back of your right hand. And the right hand with the tonehole on it slides up and down on the left arm
Try moving. In this way, part of the flute tube in the shape of a tone hole moves in a tube with a hole according to the pitch.

In any form of test, one should ask,'Who tested the tester?' You, the reader, might wish to measure a piece of paper, for
example, but how can you be sure that the ruler is itself accurate? Before trusting my ears, I obtained a two octave signal
generator with switched semitones, (a completely new invention in the middle sixties!), together with a chromatic set of
tuning forks with which to check and adjust (with capacitors) the tuning machine. I was taking no chances.

In some types of experiments, you may ask who is testing the machine being tested. You, the reader who reads,
How do I check if the measuring machine is correct? Rather than trust my ears I'm 2 octave with switched semitones
signal generator (a completely new invention in the mid-1960s, probably with the ability to adjust/measure/reproduce semitones)
I got a machine???), and also a tuning fork that can produce chromatic scales to tune and check the tuning machine (like the experimental machine mentioned above???).
Equipped. I had to be careful.

The experiment was set up and after some initial difficulty in getting the mechanical player-known later as an'Automatic
Trevor'-to make a real flute tone, the tone holes on their patches were slid up and down until they matched the notes on the
tuning machine. The tone holes were tied down and their distances from the end of the flute were measured using a steel
rule and vernier gauge. The resulting figures were compared with'Cooper's Scale' as supplied by Messrs. Bennett and
Cole.

All preparations for the experiment are in place. And when it comes to finding a flute-blowing machine (later called'Automatic Trevor'),
It was a bit difficult, but it was even equipped with an'Automatic Trevor' to make the actual flute sound. The experiment is a tone hole corresponding to each pitch
Tested by moving some of the shape tubes up and down until they match the sound of the tuning machine. When the exact location is confirmed,
The tonehole tube was fixed in place, and the distance from the end of the flute to it was measured with a steel ruler and a vernier gauge. So came out
Messrs figures. Compared to the Cooper scale sent by Bennett and Cole.

The figures were very close-so close. in fact, that when one compared this scale with the flutes currently being
manufactured in Europe and the USA, there was a most dramatic difference and a very reasonable basis on which to begin
making, and tuning flutes. You might ask why it was not 100% accurate, but remember that each player has his own
personal embouchure which means that some players cover a little more or less, of the mouth hole which in turn flattens or
sharpens the notes-but not uniformly. The left hand notes A, A sharp, B, C and C sharp are progressively sharpened by a
more open embouchure, Further, each player is not consistent; they cover more or less of the hole each day as the mood
takes them. Some change the amount of covering depending on the octave and air pressure. Therefore, an absolutely
'perfect' scale could be built for one person and for one occasion.....perhaps at one temperature!

As a result of comparison, the experimental and Cooper scales were very similar. In fact, flutes made in the United States and Europe recently
When comparing the scales, there were so many differences, and there was a convincing basis for making and tuning flutes. Maybe why
You might wonder if it's not 100% accurate. However, every player has their own unique embosser, It closes the lip plate hole more or less, and it makes the note higher and lower, meaning that everyone sounds the same.
You can't fly. The less you open the ambusher, the higher the A, A#, B, C# notes of your left hand will come out. Moreover, the condition of all performers
It is not constant. On that day, depending on the mood of the day, the hole may be closed more or less. Some people block according to the octave and cantilever pressure

Adjust the degree. Therefore, a perfect scale can be made temporarily for one person, at a certain temperature (situation).
Will.

But we must be practical. In orchestral work the pitch is constantly shifting and it has to be flexible, according to the key,
the temperature, and the mechanical curiosities of our instrument design, as well as an open, watchful ear for the other
players-not to mention the condition of the liver of performer.

But we have to be practical. When playing an orchestra, the pitch keeps changing little by little, so you need some flexibility. I.e. height, temperature,
In addition to the mechanical curiosity of the instrument design, it must change while carefully observing the performances of other players. The player's condition is
There is no need to say.

The Cooper's Scale was, then, as far as could be ascertained by this experiment, a good basis on which to construct,
and tune, flutes. Over the next ten years I tuned about 110 flutes to this scale occasionally making small adjustments to it in
the light of criticism and suggestions from colleagues. I had hoped that in doing this I might persuade the great flute makers
to construct new flutes with a correct scale in the first place. That was my hope.

The Cooper scale was an excellent basis for making and tuning flutes, as demonstrated in the experiments. After the experiment, I have been
Taking into account the suggestions and criticisms of my colleagues, I tuned 110 flutes on the Cooper scale, occasionally making minor adjustments (compromise, correction).
In doing this, I convinced great flute makers to first make a new flute to the correct scale. That is
It was my hope.

During this time I saw a flute made by an English maker which had engraved upon the socket of the head three lines,
marked 440, 442, and 444. (!) The purchaser was assured that this flute would play at three different pitches. That a maker
should peddle this kind of drivel, beggars belief.

During this period, I used flutes marked 440, 442, and 444 in 3 rows in the socket of the head joint of a flute made by a flute manufacturer in England.

I saw it. Buyers would have been convinced that this flute could be played in three different pitches.
The flute maker made this bullshit
I couldn't believe it had spread.

One US maker expressed anger at my having'butchered' their craftsmanship. My reply was,'If you had done your job
properly in the first instance,'butchery' would have been unecessary!

At one American flute maker, I was angry at my criticism of their production method. My answer is
It was like this "If you had made the flute right from the start, I wouldn't have had anything to blame for your flute.
Will"

A few years ago, Albert Cooper addressed a gathering of the world's flutists in the United States on the subject of flute
tuning. The result was that one of the two flute making giants in the USA soon began offering flutes made to his scale.
I understand that since that time they have made more flutes to Cooper's scale than to their own'traditional' scale. The
other major maker refused to alter the scale with the result that sales fell to a point where the company was in serious
financial trouble. This maker finally capitulated, later offering a flutes built to a'new scale' and, since then, their fortunes
have improved.

Several years ago, Albert Cooper contacted the world-famous flutists in the United States on the subject of flute tuning.
There was. As a result, one of the two famous flute manufacturers in the United States used a model with the Cooper scale to make flutes.
Began to produce. I have since applied the Cooper scale to more flutes instead of their traditional scale.
I think. One of the two famous flute makers refused to change their scale (to the exact Cooper scale).
As a result, sales plummeted and the company faced financial difficulties. This maker eventually surrendered and later became a new scale
The flute was produced, and then the company situation improved again (probably Powell was the adopted maker, and Haynes was the
Maybe not. Haines adhered to the Deveau Scale for a long time and recently adopted the cooper scale to produce it)

Why don't all makers change now that the facts are known? The answer is probably pride. It must be galling to a famous
maker to have to admit that they have been wrong for 60 years during which time they have produced thousands of flutes.
(It might encourage the US national pastime of legal redress!). It may also be true that insufficient pressure has been exerted
on the makers by the players themselves. A very skilled player, given an out of tune flute, will play it in tune and, because he
has grown accustomed to its irregularities, will soon assert that the scale of the instrument is correct!. It does seem
regretable that the makers don't swallow their pride and'adjust' their scale for the benefit of the large mass of flute players
who are not so gifted. There are exceptions, of course.

Why aren't all manufacturers changing the scale even when everything is known? Probably because of pride. Probably famous
The flute makers have produced thousands of flutes for over 60 years, and to admit that the scale of these flutes is wrong
It must be annoying. (If approved, you will have to pay legal compensation.) The flutists themselves
It is also true that the pressure was not applied. Very talented players will be able to play in tune with flutes that are not in tune.
And as they gradually adapt to this inaccurate situation (instrument), the scale of the flute (which is actually wrong) is correct.
Convinced. The flute makers abandon their pride and scale their scale to benefit many less talented performers.
It is deplorable not to replace it with a new exact scale. Of course there are exceptions.

The Boosey & Hawkes Group, in association with Albert Cooper, have been manufacturing their entire range, including
student and beginner flutes to this scale for some time. They are also manufacturing their head pieces to Albert Cooper's
design. In the USA, Verne Q. Powell offers a Cooper Scale flute as do several small companies. Brannen Brothers offer a
Cooper's Scale flute made in association with Albert Cooper. Altus of Japan, however are far ahead of the field in my opinion.
They offer a flute to Bennett's latest scale which to my ears is as near perfect as it is likely to be. I have my Lot tuned to this
scale. Altus also make Jupiter flutes for sstudents to this scale. Some of the private US makers,

Almeida, Jack Moors and
Arista also make flutes to good scales. The majority of the Japanese don't. Their scales aren't bad, they could simply be
much better.

In connection with Albert Cooper, the Boosey & Hawkes group has been using the Cooper scale for some time in all model lines, including student and beginners.
Applied. They also adopted the Cooper design for the head joint as well. In the US, Powell's Cooper scale flute
It was produced and produced by several small production companies. The Brannen Brothers maker also partnered with Albert Cooper to scale the Cooper scale.
I made a flute. In Japan, we know that altus makers are leading the way in this change. Altus maker is the most
I applied the latest Bennett scale and it sounded almost perfect in my ears. I fixed my Louis Lot flute to this scale
(retunning). Altus makes flutes under the brand Jupiter for students, which also applies the Bennett scale. Some of the US
Personal flute makers, such as jack moore, Almeida, Arista, also make flutes with a good scale (Bennett scale???).
Most production companies in Japan do not. Their scale is also not bad. Simply put, it can be much better.

The differences in the new (Cooper's or Bennett's) scale is hardly a small one and can clearly be seen by the expert naked
eye.

The differences between the new scales, such as the Cooper scale or the Bennett scale, are very subtle and can only be seen with the careful eyes of an expert.
It is about.

A flute that is properly in tune enables the beginner and the young student to get on with the practicalities of music making
without having to do battle with an imperfect instrument. After all, a pianist doesn't have to cope with intonation difficulties.
Neither, within reason, should a flutist. It's up to each and every one of us to persuade the makers to make what we want,
not what they think we should have.

A properly pitched flute allows beginners and young students to play the flute without being stressed out by an imperfection instrument.
Do it. Eventually, the pianist doesn't have to struggle with intonation, and the flutist doesn't have to. So individual
For everyone, the flute maker does not make the flute that the performers should have in their opinion, but the instrument the player wants.
You have to persuade them to make it.

Now for some practical advice. The universally admired Yamaha-and they do make good beginners flutes -can be
considerably improved by pulling the headjoint out from its socket by about 3/8 of an inch to conform with the normal flute
length. (Why the heads are so short, I don't know.) Indeed some players would advocate pulling it out further than this. The
headjoint on these flutes is and if played pushed right in, and tuned with a piano, the player is forced to'turn in', producing
a small, squashed tone. Measure the flute against any other make of flute and you will see the difference. A further
improvement can be gained by placing a little plasticene in the C sharp hole (LH) on the side nearest the headjoint, which
will flatten this otherwise very sharp note [FOOTNOTE: Further advice on this subject can be found in Practice Book for the
Flute, Vol. Four-Intonation]. The C naturel next to it is flat and can't be changed without a knowledge of metalwork and a
sharp saw!

Just a little practical advice: Yamaha makers who make good beginner flutes, try to match their normal flute length.
If you pull out the head joint about 3/8 inches, it will improve considerably (I don't know why the head joint is short). Moreover, depending on the player
You will have to subtract more than this. If the Yamaha flute's head joint is in its original position, make sure to match the pitch with the piano.
Then the player is forced to tune into a small, twisted tone. If you compare it with other flute brands, You can see the difference. Make a C# tone hole on the left hand side closest to the head joint with a little plasticene (= plasticine).
If you take action with a material like clay) (correcting the tonehole), the C# sound will be a little lower (otherwise it will sound too high), so it is better
Will show improvement. (This will be mentioned again in the Practice Book for the Flute, Vol. Four-Intonation). C next to C#

The natural note is low, which does not change unless you saw the flute based on your knowledge of metalworking.
It seems to mean that it can't be solved)

Other flutes: most flutes can be improved by flattening the C sharp and pulling out the foot joint. Before enthusiastically filling
your flutes with plasticene, try the experiments on pp 16-17 in Practice Book Four. Generally speaking, all older flutes have
a sharp C sharp, C naturel, and sometimes the A sharp in the left hand. Flatten them with plasticene by the method
described above, and, if you are satisfied, make the job more permanent with fiberglass paste, or modeling paste. (Visit
your local model making shop). You will find that the head can now be pushed further in to raise up the lowest notes a little.
Sadly, there is no simple solution to sharpening an already flat low note. Open hole flutes do offer extra possibilities: the
open hole has a sharpening effect on the hole beneath it, therefore, a piece of scotch tape over the finger hole will flatten it
that note.

For other flutes, most flutes lower C# and pull potjoints to get a good improvement. Your flute
Before filling the (tone hole) with plasticene enthusiastically (as if it was a measure to correct the tone hole mentioned above), first of all, see pages 16-17 of the 4th Practice Book.
Experiment with the content and play it, generally all older flutes have high C#, C notes. Sometimes the A# of the left hand
There are cases like that. Use plasticene to lower these notes in the way mentioned above. And if you get satisfactory results
Fix it permanently using reinforced fiberglass dough or modeling dough to fix it.
Please visit). If you fit the head joint tightly, the lowest notes may go up a bit. But sadly, the already lowered
There is no simple solution to boosting the bass (to a normal level). In the case of open hole flutes, there may be room for further improvement.
There is. The open hole has the effect of increasing the tone of the tone hole below it. Therefore, if you stick scotch tape (glass tape) over the finger hole, the sound
It will be lowered (as if it means to cover the open key hole with glass tape)

Many of today's manufacturers continue to make flutes which must be considered out of tune no matter to what school or
style of flute playing one is attached. Pride, ignorance and prejudice are the only barriers to change.

Some makers have
produced their own'scale' which goes under different titles, but there can only be one'equal temperament'.

Many modern production companies make flutes that don't match, regardless of what school they're going to use or who's playing what style.
There is. Pride, ignorance, and prejudice are just obstacles to change. Some manufacturers say they make flutes with their own scale
But there is only one equal temperament in the world (i.e. different scales with names like this or that)
Likewise, it seems that the correct scale is actually only one after all???)

The story doesn't end there. Players, having equipped themselves with a decent in-tune flute, should stop dancing around
the concert platform and learn to properly control the pitch of notes when playing loudly and softly, one of the worst defects
of the modern player. But that is another story.

The story doesn't end here. Performers with appropriately tuned flutes refrain from performing while dancing in the concert hall.
Learn how to properly adjust the pitch of the notes when making the sound louder and when making it smaller, the biggest drawbacks of players.
Do it. But this is another story.

The history of equal temperament should be re-written to add that, in the 1980's, flute makers finally succumbed to a
movement reputed to have first been invented 5000 years ago by the Chinese.

In addition to this, the story of equally divided averages should also be rewritten. The flute makers in the 1980s eventually
Yield to the movement (views) that were first known to have been invented.

As a Greek philosopher remarked 2,000 years ago: As a Greek philosopher remarked 2,000 years ago . (Maybe you only know how to play the flute
It seems to point out that no head thinks about the flute.

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How to verify the scale and find out what position flute makers were at that time.

This time, I will first look at what major changes have occurred in the history of flute, and then I will explain the classification of scale.

A man named Carmen Ritchie has posted an article entitled The Evolution of Flute Intonation, and he is concerned with flute intonation, scale, and historical progress.
I brought it so that I could see it at a glance. Duplicate content was not translated separately.

https://prezi.com/npex4fz8bkft/the-evolution-of-flute-intonation

# The Evolution of Flute Intonation

**Intonation Factors**

Length of the air column (especially the distance between the embouchure and the first key), cork placement, moisture in
the air, density of the tubing, location, size and shape of the tone holes

The length of the air column (especially the distance from the hole in the lip plate to the first key), the cork (the stopper stopper position), the degree of humidity in the air, the flute
The density of the tube material, the location (arrangement) of the tone holes, the size and shape.

Flutist factors: unfocused tone (poor tone is the primary factor in bad intonation, bad breath support (low notes become
more flat and the high register is sharper because the player over blows) and poor posture (effects the angle of the
airstream).

Factors influenced by the player: unfocused tone (a bad tone is the most basic element of bad intonation), bad breathing (the player
Low tones come out lower, higher tones come out higher because of excessive/inappropriate wind blowing), bad posture (air column
Affects the angle)

**Theobold Boehm**

German court musician (1794-1881)
Developed the "Boehm Flute," (also know as the modern flute) known for it's keys and levers responsible for opening and
closing the tone holes
“Nobody ever thought about trying to improve the intonation… the player was told they had a good instrument and it was up
to him to play it. Nowadays the player tells the maker what he thinks is wrong with his instrument and demands that it be
made to his requirements.”

**Albert Cooper**

Began working with Rudall Carte Co. in 1938 until they went out of business and then began designing his own flutes
The Cooper Scale was devised in 1973 (created the Cooper scale in 1973 )
Began with a mathematical calculation, like Boehm, but then altered each tone hole to make up for the intonation
discrepancies of each pitch.
Decided that in order to get the best overall intonation, some of the tone holes need to be adjusted--change the diameter
or location on the flute.

**The Cooper Scale**

The traditional scale has an octave that is too wide between C4 and C5 and is also too high in the 3rd range.
The Cooper Scale lowered the traditional sharp pitches and raised the lower flat pitches, allowing the flutist to play an equal
tempered scale without having to adjust so much in the embouchure.

Albert Cooper joined forces with: (those contributing to scale improvement)
William Bennett--former principal flutist of the London Symphony
Eldrid Spell--American flutist, professor at Western Carolina University
Elmer Cole--principal flutist of English National Orchestra
Trevor Wye- -freelance chamber musician and professor at the Royal Northern College of Music

**The Collaboration**

US vs. England--"I made it, it's right, go play it." (본 카페글중에 내용 나옴)
Haynes-->Powell-->Brannen/Burkart & Phelan (미국 플루트 제작사 설립 과정)
Bickford Brannen (브란넨브라더스사의 창업자의 역할)
French style flutes (professional)--sharp C# and flat low register (기존 뵘플루트의 french model의 단점)
High demand meant flute makers continued to make these flutes, making tiny adjustments on their own.
Powell & Brannen

Patching--removing tone holes and then soldering them onto scrap tubing which allows them to be placed in a new
position
(톤홀을 개조하는 방법중 하나로 Bennett이 개발함)

Swaging-- pushing or persuading the softened silver to partially refill the tone hole, allowing the tone hole to be
repositioned.
(톤홀을 개조하는 방법중 Cooper가 개발함)

The Automatic Trevor--was created with moving tone holes and a blowing apparatus to prove that the Cooper scale was
correct

(본 카페글중에 관련 내용 나옴)
Patching, Swaging and the Automatic Trevor
Robert Dick, professor of flute at NYU Steinhardt
"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."
"It is where the air is vented, not where the keys are depressed or lifted that effects the sound."
(http://muse.jhu.edu/journals/lmj/summary/v022/22.dick.html 이 카페글의 가장 마지막에 언급됩니다)

Understanding the sonorities of small and large tone holes (작은 톤홀과 큰 톤홀의 소리 울려퍼짐에 대한 이해)

Created a flute that allowed any combination of open and closed tone holes--a prototype created by Albert Cooper

Kingma System Flute--Bickford Brannen and Eva Kingma--helped facilitate quarter tone production (킹마 시스템 개발)

Glissando Head Joint (글리산도 헤드조인트 개발)

The Future

**The Evolution of Flute Intonation**

**The Boehm Flute**

The tone holes were placed based on the law of acoustics. (음향학적 기반에서 톤홀의 위치가 정해졌습니다)

Created a fingering system and improved the flute mechanism by adding clutch keys, key rings and needle springs.
(운지법을 만들어 냈으며 clutch key, ring-key, needle spring 개념을 도입했습니다.)

Boehm's fingering system is still used on flutes today with the exception of the split-E mechanism, created by Julliot and
Taffanel
(뵘의 운지법은 Julliot and Taffanel에 의해 창안된 split-E mechanism는 예외이지만, 현재까지 여전히 사용됩니다.)

**The Boehm Flute Obstacles(**뵘플루트가 가지고 있었던 문제점**)**

Graduated tone holes vs identical tone holes
20mm vs 19mm (third octave)
Moveable cork--distance between the center of the embouchure and the cork

**The Boehm Schema (**뵘 플루트 제작 양식에 관련된 참고 문헌들 **-** 지금 쓰고 원글에도 포함된 자료가 있습니다**)**

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이번 내용은 scale의 분류에 대해서 이야기 하려 합니다. http://www.fluteworx.co.za/articles/Flute%20Options.pdf 글의 일부인데 나름 scale에 대해서 분류를 잘 해 놓았습니다. scale의 각 타입의 장단점에 대해서도 정리가 잘 되어 있습니다.

전에 영문글을 그대로 옮긴 카페 글이 있기는 한데 영문으로 되어 있어서인지 잘 안 읽으셔서, 마침

scale 자료 정리하면서 함께
번역하고자 합니다.

## Flute Scales

This article looks at another-perennial favourite of flautists: Scales. Many words are bandied around in this regard; modern
and traditional, Bennett, Cooper, etc. These words inevitably confuse the situation, as very few flautists actually understand
their meaning. This article will look at the situation from a number of points of view and will attempt to clarify firstly, in which
way these scales are different, and secondly, the reason for these differences.

이 주제는 플루티스트 들 사이에 계속해서 이야기되는 흥미로운 주제인 scale에 대한 글입니다. 이 단어와 관련된 많은 용어들이
있습니다. 예를 들어 modern 그리고 traditional, Bennett, Cooper 등의 단어들이 있습니다. 이러한 단어는 약간 혼동스러운 면이
있어 결국 매우 소수의 플루티스트만이 실제로 정확한 의미를 이해합니다. 이 글은 여러 관점에서 분석해서 첫째로는 각 scale이
어떻게 다른 것인지 명확하게 분류했고 두번째로는 이러한 차이가 왜 생기는지에 대해서 이야기하고자 합니다.

### The Traditional/Modern Dichotomy

using the words traditional/modern does not really tell us much about the difference between scales. However, when the
descriptive words long/short are paired to traditional/modern, we are well on the way to understanding the difference
between the two scales.

전통적인/현대적인 표현상의 이분법

단순히 tradition/modern 이런 식으로 나눈 방법(표현)이 실제로 여러 scale 간의 차이를 설명하지는 않습니다. 다른 표현법인
long/short 의 경우는 두 scale 간의 차이를 이해하는데 도움이 됩니다. (traditional = long, modern = short)

### The Traditional or Long Scale

The basis for the traditional or long scales are the original scale Louis Lot Flute and, to a certain extent, a number of original
Boehm or Boehm & Mendler Flutes. The key to understanding the long scale is that these flutes were built to be played at a
pitch of A=435 Hz. At this pitch they were fairly in tune throughout the three registers. Problems with intonation, however,
start occurring when attempts are made to play them at sharper pitches, specifically from A=438 Hz upwards.

The best form to show the traditional (long) scale is the Louis Lot flute's original scale, and to zoom in a bit, some original
It can be seen on the scale of a Boehm flute, or a Boehm & Mendler flute. The key to understanding long scale is
The flutes are built based on the A=435 Hz pitch. At this pitch, the pitch fits well across all three ranges.
An intonation related problem arose when trying to play with this instrument at a higher pitch, especially A=438 Hz or higher.

At this stage it is necessary to explain the influence on scales of head-joint positioning (pushing in or, pulling out, to either
sharpen or flatten). It is generally accepted that a flute can be pulled out to play at an average pitch of 3 Hz flatter or pushed
in to play an average pitch of 3 Hz sharper than the flute was originally built for; this with only minimal distortion to the scale.
For example, a 440 flute can comfortably be played from A=437 Hz to A=443 Hz. When a head-joint is pushed in too far, the
notes to the left of A (B-flat, B, C, C-sharp, C-sharp vented notes, the trill keys and trill key vented notes) become
progressively too sharp; conversely, the notes to the right of A become progressively flat. Due to the fact that many of the
third register notes are based on left -hand harmonics and venting by the C-sharp and trill keys, the third register becomes
too sharp.

In this situation, by changing the position of the head joint (to increase or decrease the sound by removing or adding the head joint)
You need to explain if it affected the scale. In general, the head joint is removed from the Lroot body.

Or lower the sound by an average of 3 Hz below the intended default pitch. It is known that you can raise the note by 3 Hz by pushing it further. About 3Hz

Changes are known to have only a very small effect on the overall scale. For example, with a flute with A=440 pitch, A=437 Hz

At pitches from A=443 Hz, it is possible to play comfortably without major problems. If the head joint is pushed too much, A negative

The left note (B-flat, B, C, C-sharp, C-sharp vented notes, the trill keys and trill key vented notes) gradually increases. Conversely, negative A

The notes on the right gradually decrease. Many treble notes are based on the left hand's harmonics and breathing associated with C# and trill keys.

Because of this, the 3rd range is too high.

This description describes the typical intonation problems of the flute in general, but of the traditional or long scale flute in
particular. The basic rule of flute-making, which was not realized before the work of Albert Cooper, although Boehm
developed the idea, was that the higher the mean pitch at which the instrument is to be played, the shorter the instrument
must be.

This is an intonation problem typical of a typical flute. However, especially in long scale flutes
It stands out. Although Böhm came up with the idea, the basic idea of the flute makers before Albert Cooper's work was to play the instrument.
The simple idea was that the instrument had to be shorter if I wanted to do it with a higher pitch.

In addition to this the proportions must change in that the tone holes should become smaller and move closer together to
retain the correct pitch relationship between the notes. A considerable number of flutes ranging from cheap student flutes
through to the most expensive hand-made models were, until recently, built to the traditional long scale. (These are still
available-so be aware of this when buying a second-hand instrument.) The only concession made to higher pitch
requirements being a shortening of the head-joint or of the body section between the barrel- joint and trill keys. This meant
that while A could be played at a higher pitch, the intonation of the other notes becomes progressively worse. Once again,
this results in a very flat right-hand and a very sharp left-hand and third register. The distance from A to C left-hand is too

long so it plays sharp. The distance from A to C footjoint is too long, so it plays flat.

In addition to this concept, in order to maintain an accurate pitch between notes, the toneholes should be smaller and be located closer to each other.
You have to change to some extent with the thought of doing it. From cheap student models to expensive handmade models, until recently, they were made with traditional long scale.
There is. (I.e. this scale is still in use, so be aware of this when buying used instruments). topping
Only the concept of reducing the length of the head joint or the length between the trill key and the barrel in the body part as the pitch is required.
There was. This allowed the A note to be played at a higher pitch, but the intonation of the rest of the notes gradually worsened.
At one time, this concept resulted in instruments with very low notes in the right hand and very high notes in the left hand and in the 3rd range. A and C notes
The sound was high because the gap was too far. And if the distance between A and C footjoint is too far (long instrument length), the sound
Shredded low.

**The Modern or Short Scale**

The modern or short scale is, as the term indicates, flute scale which is shortened to the scale-length which is appropriate
for the mean pitch at which the instrument is to be played. Most makers advertise their flutes in, for example, A=440 Hz,
442 Hz, 444-Hz and 446 Hz. These flutes, while they might look essentially similar, have different lengths of tubing and,
ideally, different sizes of-tone-holes and differential positioning of the tone-holes. Simply stated, the sharper the basic pitch,
the more the flute is scaled down in terms of length, tone-hole size and position.

As the term suggests, modern/short scale. This scale ensures that the flute has a scale lenghth suitable for the average pitch to be played.
Shortened. Most flute manufacturers advertise for example A=440 Hz, 442 Hz, 444-Hz and 446 Hz. Such
The flutes look similar on the outside, but the length of the flute tube, the size of the tone hole, and the location of the tone horn are different. Simply put
기본 피치가 높으면 높을 수록 플루트 scale length, 톤홀크기, 톤홀 위치가 작아집니다.

**Variations in the Modern Scale**

## modern scale의 변형

The modern scale stems very largely from the brilliant work carried out by Albert Cooper, which in a sense is the
modernization of Boehm's work, and most short-scale flutes are, at the very least, similar in conception to the Cooper
Scale.

modern scale은 크게는 Albert Cooper의 위대한 업적에서 나왔습니다. modern의 의미는 옛날 Boehm의 업적을 보다 현대화했다는
뜻을 가지고 있습니다. 대부분의 short scale 플루트는 기본적으로 Cooper scale의 개념과 유사합니다.

The pure Cooper Scales (there are a number of variations by Cooper himself) tend to focus on a very exact tone-hole
placement with tone-holes that are not overly large. The results are scales which are very even and smooth, have
impeccable intonation and hold their pitch well in dynamic extremes. Tonally the scales are very well balanced and because
of this they are extremely flexible in terms of colour. Because of the hole sizing and placing, the response is very even and
smooth.

순수한(오리지날) Cooper scale(Albert Cooper 스스로도 오리지날 Cooper scale에서 변형을 시도하여 여러가지 Cooper scale들이
있습니다)은 너무 크기가 크지 않은 톤홀의 추가적인 톤홀위치에 촛점을 두고 있습니다. 그 결과로 매우 소리가 고르며 부드러운
scale이 되었으며, 흠잡을데 없는 인토네이션을 보였으며, 역동적인 연주(높고 낮음의 기복이 심한 곡을 연주???)를 할때도 원래의
피치를 잘 유지하였습니다. 음정면에서 Cooper scale은 매우 균형이 잘 맞았으며, 음색면에서 매우 유연성이 좋았습니다. 톤홀의
크기와 위치(배치)가 적절했기 때문에 소리의 반응이 매우 고르면서 부드럽게 나왔습니다.

The other well-known short scale is the Bennett Scale. The Bennett Scale is, in fact, an offshoot of the Cooper Scale. The
scales are essentially identical from the thumb tone hole upwards and from the D-sharp tone-hole downwards. The area of
difference is the body-joint where the essential differences are the use of fractionally larger tone-holes and, as a

consequence of this, different tone-hole placing. The scale is in effect slightly longer because the larger holes sound higher
and the holes are moved downwards to compensate for this and keep the flute in tune.

The Bennett Scale tends to have a slightly darker sound, which is very sought after, intonation and flexibility are however
not quite as exact as the pure Coopers.

Cooper scale 이외에 잘 알려진 short scale은 Bennett scale 입니다. Bennett scale은 실제로 Cooper Scale에서 나왔습니다.
이 scale은 근본적으로 thumb 톤홀 위쪽 방향과 D# 톤홀 아래방향의 경우 Cooper scale과 동일합니다. 차이가 있는 부위는 바디
(bodyjoint)인데, 바디부분에서의 차이는 약간 더 큰 톤홀을 사용한다는 것과, 이것으로 인해 다른 톤홀 위치를 가진다는 것입니다.
scale은 사실상 조금더 깁니다. 왜냐면 톤홀이 크면 클수록 음이 높아집니다. 이를 보완하기 위해 톤홀의 위치가 약간 아래로
You have to go down and place it. So the flute pitch is right.

Bennet scales tend to have a slightly darker tone. This tone will be found by many later. Intonation Department
Flexibility is also not exactly the same as the original Cooper scale.

It is the writer's opinion that the Bennett Scale is the consequence of attempts at retuning old Louis Lot flutes, with existing
large tone-holes, to the Cooper Scale. The results have been excellent.

In the opinion of the author, however, I believe that the Bennett Scale is an attempt to restore the Louis Lot flute, which has a larger tonehorn compared to the Cooper scale.
I think it's a product. The results were very good .

**Playing Characteristics of Long and Short Scales**

A large degree of debate has taken place with regard to the relative merits of short and long scale flutes. Although the short
scale flute is favored by the majority of players, a short comparison of playing characteristics is in order.

There has been considerable controversy over the relative advantages of short and long scales. Although the short scale is for most players
Although preferred, let's write a brief comparison of the characteristics of the performance in order.

Short scale flutes, because of their greater aerodynamic efficiency, require a large degree of diaphragm support when
played. Where a short scale flute is played with inadequate diaphragm support and too much lip pressure, the tone tends to
be thin, harsh and too bright. Intonation problems such as octaves sounding flat can occur especially with the larger
tone-hole, and undercut tone-hole flutes. A correct approach to playing is thus very important. Short scale flutes are,
however, unrivalled for their overall intonation, volume, tonal flexibility, wide dynamic range, clarity and agility.

In the case of short scale flutes, the instrument's aerodynamic efficiency is so great that more (sufficient) diaphragm movements (support, trust) are required when playing.
It is necessary (meaning that breathing should be sufficiently supported). Short scale flute based on insufficient diaphragm breathing support
If you play it while putting too much pressure on your lips, the tone will become thinner and annoying, and unintended sound will be too bright.
It's possible. The intonation problem in the low-pitched range (flat range???), the flute with a larger tone hole, and the undercut?
This can be particularly noticeable with flutes with a closed tone hole. So when playing, the correct approach is important. Anyway, the short scale flute
Overall intonation, volume, tonal flexibility, wide dynamic range, sound clarity, and agile responsiveness.
It is second to none.

Long scale flutes have considerable intonation problems (as described earlier in the article). They also have a smaller
dynamic range and tend to have less volume than a short scale flute. Because of the inherent stability of the air column
they are capable of extremely subtle shadings across a narrow band of expression. The tone is normally very attractive
and sweet, but certain notes are, however, very dull. When fitted with modern head-joints these flutes tend to become much
more dynamically flexible and even the intonation improves.

Long scale flutes have a significant intonation problem (we talked about at the beginning of the article), which is a narrower
It has a dyamic range (playable range???) and is less loud than a short scale flute. With inherent stability in the air column
Because of this, very small differences can be expressed nicely in the expression of a narrow section. The tone is charming and sweet. But certain notes
Sometimes very dull. Combining a modern head joint and a flute body with this scale shows more dynamic and flexible
Even intonation tends to improve.

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The most detailed information related to the historical facts of the scale development can be found on the following site at http://www.trevorwye.com.
There are some similarities to the above, but they are very specific, so I will finally summarize the historical background.

After this article, I would like to talk about scale-related numbers and data, but this article shows why there were such changes/numbers.

http://www.trevorwye.com/cooper1.html

http://www.trevorwye.com/cooper2.html

http://www.trevorwye.com/cooper3.html

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http://www.trevorwye.com/cooper1.html

# Revised Scale 2012

by Trevor Wye with William Bennett and Eldred Spell.

For those readers unfamiliar with flute scales there is much to absorb in this article. To make this easier, after an **Introduction** , it has been divided into six sections:

People who are not familiar with flute scale need a lot of information to read this article. In order to make this easier, after the introduction, this article is divided into six as follows.

**1.Why a Revision of the Scale is Necessary** . The history behind the formation and calculation of the first Cooper Scales and concludes with how the Revised Scale 2012' was arrived at, together with notes on retuning flutes.

**2. Intonation Control by Flutists** which may help illuminate some of the problems of performers and their flutes.

**3. Twelve Popular Misconceptions about Flutes and Intonation.**

**4. Is Your Flute in Tune?** A simple process using a flute and a tuning machine, by which a player can find out whether their flute has a good scale. Includes advice on buying a flute.

**5. A Plea to Teachers, Players and Makers.**

**6. Revised Scale 2012** : the figureswith some recent amendments.

1. Why should the scaele be changed? The history of how the early Cooper scale was calculated and made, and the Groot flute
A story about the new 2012 scale drawn in 2012 by working hard to match the pitch

2. Intonation control by flutists: Even if there is a problem with the instrument, the flutist's ability
Content that can dilute the problem

3. 12 famous misconceptions about flute and intonation (misconceptions)

4. Is the pitch of the flute right? A player uses a flute and a tuning machine (a tool like a tuning fork) to make his instrument good.
How to check if you have a scale, good advice when buying an instrument

5. Appeal to teachers, performers, and producers

6. Newly updated 2012 scale: Including the recently revised content.

**Introduction:** To understand a flute scale, the tone- <wbr /> hole positions are best seen as related to the layout of the guitar fingerboard, an idea suggested by the brilliant Theobald Boehm and referred to as his “Schema.”:

Introduction: To understand the flute scale, the location of the tonehole is shown in the picture below in relation to the guitar's fingerboard. Such The idea of a scale is called the Boehm schema because it was proposed by the great Devobalt Boehm.

The placement of tone holes must follow a simple mathematical layout – but with certain allowances made for tone hole size,
open/closed keys, key height, and a few more subtle compromises. Up until the 1960s, the traditional high-<wbr /> quality
flutes, such as those by the two famous US makers, and many European instruments too, were built to between A=435hz
and A= 438hz, the performer being expected to play them at A=440hz or, in some countries 444hz. As the orchestral pitch
became higher in the 1930s, makers seemed to have shortened the head joint, but also, as time passed, made alterations to
the existing scale by moving a few holes. Perhaps the reason why a complete revision of the scale was thought unnecessary
was that the rise in pitch was too small, or perhaps the knowledge of how to achieve this was wanting. They should have
calculated a new scale, but the method of calculation seems to have died with Boehm.

When the scale is bad, the player needs to develop special intonation control skills to overcome the faulty

workmanship of the maker .

Some have managed to do this with great dexterity in the same way that a fine violinist might still manage to play a badly tuned
violin in tune. But why should they? The remedy is easy. Buy a flute with a good scale. Older flutes may be well loved and
cherished, but today, it is relatively easy to buy both a first rate flute and separate head joint which would satisfy the most
discerning player who has an open mind.

The location (arrangement) of the tone hole should be achieved through a simple mathematical arrangement, while the size of the tone hole, open/close key, height of the key, etc.
Some adjustments (negotiation, compromise, compromise) are required. Until the 1960s, two famous flute producers in the United States (like Haines and Powell)
For many manufacturers in Europe and Europe, traditional high-quality flutes are made within a pitch between A=435hz and A=438hz. sometimes
Some people wanted to play with A=440hz, and some countries made it with A=444hz. Used in the orchestra
When the pitch became higher from around the 1930s (when the international standard pitch was recognized as A=440), the flute manufacturer solved the problem by shortening the head joint.
It seems to have resolved. However, over time, some of the toneholes are moved to change the existing scale. At that time
The reason why it was thought that overall remodeling (transformation) was unnecessary in scale was probably the required pitch change (increased) compared to existing instruments.
I think it was because the width was too small and the knowledge of how to raise the pitch was so lacking. To make a new scale
It had to be accurately calculated (experimented, planned), but there seems to be no way to calculate it since Boehm's death.

When the scale is wrong, the performers have a skill to specifically adjust the intonation to overcome the wrong flute of these producers.
You need to learn how to play.

Just as great violinists play in tune with off-pitched violins, some flutists are very elaborate.
I've been playing with a flute that's not right in pitch. But why do they have to go that far? The solution is simple. Right
You can buy a flute with a good scale. You may want an older instrument lovingly to keep more in your heart. But
To satisfy today's open-minded (scale-savvy) discerning performers, we have a first-class flute and another

headjoint needed.
It is relatively easy to buy.

# 1. History of the Cooper Scale.

### 1. The history of the Cooper scale

In 1945, Albert Cooper returned from military service back to Rudall Carte & Co, the London flute makers, where he was former
ly apprenticed. There he repaired and overhauled numerous makes of flutes, becoming interested in the difference in scales
between them. In 1959 he left Rudall & Carte to set up a repair service, but soon began making flutes. He devised an initial
scale, based on what he saw as the'faults and virtues' of those flutes he had measured at R&C and his own reasoning and
experience. In 1955, William Bennett was playing a Louis Lot flute rebuilt by Charles W. Morley, probably to a Rudall & Carte
scale.* In 1956, whilst in the USA, he tried Haynes and Powell flutes but was dissatisfied both with the scales of the US flutes
and of his rebuilt Lot, and began changing the scale according to his ears and performing experience. To do this, he devised
a method of removing the tone holes, hard soldering them onto a piece of scrap tube which were then cut out to leave enough
remaining material to allow them to be replaced in the new position, a technique known as ‘patching.’ This ability to adjust
one or more tone holes still remains an essential tool in the search for a perfect scale.

1945년 Albert Cooper 는 군복무를 마치고 처음에 도제로 들어갔었던 런던의 플루트제작사인 Rudall Carte & Co 로 복귀했습니다.
거기서 그는 플루트를 고치고 수많은 제작사의 플루트를 전체수리하면서 점차 각 플루트간의 scale의 차이에 흥미를 갖게 됩니다.
1959년 그는 Rudall Carte & Co를 떠나 수리전문점을 열었다가 곧 플루트제작을 시작했습니다. 그는 본인이 Rudall Carte & Co 에
있을 때 만졌던 많은 플루트들의 장단점과 그가 경험하고 느꼈던 것을 바탕으로 초기(초창기형태의?) scale을 창안했습니다.
1955년 William Bennett 은 W. Morley 에 의해 Rudall & Carte scale 로 개조된 Louis Lot 플루트를 연주하고 있었습니다.
1956년도에 미국에 있을때 그는 헤인즈와 파우웰의 플루트를 시연해 보았으나 2개의 미국 플루트의

scale과 Louis Lot 플루트의
scale 모두 만족스럽지 않았습니다. 그래서 그는 그의 귀와 연주경험을 바탕으로 scale을 바꾸려고 노력하기 시작했습니다. 이것을
하기 위해 그는 톤홀을 떼어내고 새로운 톤홀 위치를 만든후(떼어낸 톤홀 위치 옆으로 구머을 확장해서) 떼어낸 구멍과 새로운 톤홀
위치를 모두 덮을 수 있을 정도로 크게 제작된 새로운 톤홀 모양의 튜브 조각을 떨어진 톤홀 위치와 새로 만든 톤홀 위치에 납땜을
통해 붙이는 방법으로 톤홀을 다시 재배치하는 "patching" 이라는 기법을 창안했습니다. 한 두개 정도의 톤홀을 교정하기 위해
사용되는 이 기법은 오늘날에도 완벽한 scale을 연구하는데 있어 필수적인 방법으로 남아 있습니다. (카페 글의 후반부에 patching
기법에 대한 설명이 나옵니다)

* Rudall Carte had a tradition of altering the pitch of flutes by modifying and fitting old keywork to new bodies, a practice going back for many years but alien to the US makers; it may account for the reluctance of US makers to change the scale.

* Rudall Carte 제작사는 새로운 플루트 바디에 기존의 오래된 키와 메카니즘을 변형시켜서 다시 부착함으로써 피치를 변화시키는 전통이 있었는데 이것은 많은 시간을 필요로하는 작업이었는데 이러한 전통은 미국 플루트 제작사들에게는 매우 이상하게 느껴졌습니다. 이것은 또한 미국 제작사들이 scale을 바꾸는 것을 주저하는 이유가 되었을 것입니다.

A talented and intelligent London orchestral principal, Elmer Cole, calculated the tone hole positions according to Boehm's
Schema. The resulting scale was based on tone holes of an equal diameter, 15.6mm. For tonal reasons, flutes require
graduated tone holes, becoming smaller as the scale ascends. Cole devised a 'correction graph' to enable the position for
smaller diameter tone holes to be calculated, but found that even further adjustments were required for serious performing.
Richard Lee, another London player, was also involved in retuning his flute and, along with Bennett, was in frequent
consultation with Cole. All were in regular touch with Albert Cooper, whose home became a clearing house for information on
'the scales.'

Elmer Cole, former head of the talented and knowledgeable London Orchestra, calculated the tonehole location method according to Boehm's production style.
I did it. So the scale that came out is based on a tonehole with the same diameter of 15.6mm. Due to the pitch problem, the scale of the flute
You need toneholes that gradually change in size, which become smaller as you go up (?). Elmer Cole got a

place for a smaller tonehole
Invented a'correction graph' that can be calculated . However, more adjustments are required for serious (difficult) performance.
I knew I needed it. Another London flutist, Richard Lee, was also involved in modifying his instrument.
With Bennett, I often met Cole for advice. Everyone had regular meetings with Albert Cooper, and their home
It became an information center for exchanging information about scale.

Meanwhile, the Taylor brothers, Christopher and Richard together with Alexander Murray, at that time all London Symphony
Orchestra players, made their own contributions, based on the Cooper flutes they owned and played and their criticisms of
the scale. One of these was that both the top four left-<wbr />hand notes A#, B, C and C# -<wbr /> and the last three
right-<wbr />hand notes-F, F# and G -<wbr /> were too flat. Cole changed his Correction Graph to put this right, curving
his graph at each end in order to sharpen the left hand notes, and sharpen the foot joint notes too. (C, C# and D). Cooper's
pragmatic solution was to use Boehm's Schema but split into two, using a sharper version for the right hand and the usual
one for the left, though he too sharpened the A#1, B2 C2 and C#2. These were really variants of the same idea.

On the one hand (at the same time) Alexander Murray, who were both London Symphony Orchestra players at the time, and Christopher, brother Taylor,
Richard gave their own accurate criticism (evaluation) on the scale through what they felt through the Cooper flute they owned and played.
Do it. One of their achievements was that the upper left hand notes of A#, B, C and C# and the last three notes of the right hand, F, F# and G, were too low.
Is revealed. Cole moved the curve graph at both ends of the correction graph he made to the right, and the left note and foot joint
I changed all the notes (C, C# and D) to be higher. Cooper's practical solution follows Böhm's production style, but in two.
It is divided into a version with a higher right-hand note and a normal version for the left hand. Of course, his solution is also A#1, B2 C2 and
C#2 note was too high. There were many variations of this idea.

The London players decided that the new Cooper scale was easier to play in tune and as well as ordering a new Cooper

flute, asked Cooper to retune their favorite flutes such as Louis Lot, Bonneville, Haynes and Powell, to his scale. Cooper
obliged when he had the time and after removing the tone holes, used both Bennett's'patches' method and also'swaging'
or pushing and persuading the softened silver tube to partially refill the hole, which allowed the tone hole to be repositioned.

London players thought that the new Cooper scale was more comfortable to play to the pitch, so they decided to use the new Cooper scale flute.
I ordered it. And then they tell Cooper they have famous things like Louis Lot, Bonneville, Haynes and Powell
I asked if the instruments could be converted to the Cooper scale. Cooper was happy to make modifications when he had time. Tone hole removed
Later, the patching technique developed by Bennett was used, and the tube material was pushed into the tone hole to partially fill the tone hole.
The location of the tone hole was relocated using the swaging technique. (We'll talk about the swaging technique later in this cafe article)

During the 1970's, Trevor Wye began retuning his own flute and was later asked to retune many British orchestral player's
flutes to Cooper's Scale using a mixture of Bennett's'patching' and Cooper's swaging method. During this time, Bennett,
Cole and Cooper continued suggesting small amendments to the Scale in the light of criticism and performing experience.
Wye incorporated these amendments in his retuning. He also built what became known as an'Automatic Trevor', a tube
with movable tone holes and a powered blowing apparatus. This experiment was conducted to confirm that the Cooper Scale
was indeed correct and although several interesting assumptions were confirmed, the device seemed unable to play octaves
accurately and was abandoned.

In 1970, Trevor Wye began remodeling his flute. Later, Bennett's'patching' technique and Cooper's swaging technique
In combination, I was asked to convert the flutes of many British orchestra players to Cooper scale.
Bennett at this time,
Cole and Cooper decided to make minor tweaks to the scale based on their criticism and experience in playing. Wye
I have accepted their modifications to my flute mods. He can also move a tonehole called'Automatic

Trevor' and
We made a machine that can be blown and played. This device eventually confirmed that the Cooper scale was correct. Though many
A number of interesting hypotheses (estimations) have been confirmed, but since each range could not be played very accurately, it is no longer used.
Did not.

The correct position of the C#2 hole has been one of the major contentions amongst makers who have struggled over the
years with its exact placement. This small tone hole must fulfil seven functions* and needs special management to play it in
tune. Its diameter and height also play an important role, the latter not being widely appreciated. Players recommend a variety
of ways to control the pitch and color of C#, but none of these replaces having the tone hole in the correct place.

Working at first independently in the US, Eldred Spell joined in after meeting William Bennett in 1976. Initially skeptical of altering
old flutes, he eventually retuned instruments for many of the English principals, including Bennett, Wye, and Geoffrey Gilbert.
Being of a scientific/analytical bent, he was particularly bothered by the need to falsify the numbers in order to get a workable
scale and has devised many experiments to get at the truth. Most recently, his apparatus which simulates the blowing of the
flute, photographed below, is an attempt to refine some of the less well- <wbr /> known aspects of flute making and scales
- <wbr /> such as the displacement graph and the difference in tone hole positions between open and closed flutes. He is
hoping too, to establish more exactly the correct'scale length;' that is the total length of the flute from C1 to C2.

The exact location of the C#2 tonehole is a subject of great debate among many flute manufacturers who have struggled to find the correct location over the years.
Was one. This small tonhol has seven functions to be performed, and ( It is Open for C # 2; D2; EB2; C # 3; D3; AB3; A3) Another negative for
Special measures are required to play. The height and diameter of this tonehole also play an important role.
The question of height is widely recognized
There is not. Players advised on several ways to control the pitch and tones in C#. But among these
No one knew the exact location of the tonehole. Eldred Spell, the first independent flute maker in the United

States,
After meeting William Bennett, I joined the scale study in 1976. Initially, I felt skeptical about renovating the old flute.
He who had, eventually converted many instruments of leading British flutists such as Bennett, Wye, and Geoffrey Gilbert. originally
He was a scientific/analytical inclination, trying to create accurate figures (data, knowledge, information), especially for a playable scale.
Many experiments have been created to get to the truth of this scale (to find out the most accurate scale). Most recently below
In order to imitate playing the flute as shown in the picture, the instrument he made is a displacement graph or between an open key and a closed key flute.
It was designed to clarify the lesser-known aspects of flute making and scale, such as the difference in tone hole location. He also
We tried to establish the correct scale length, that is, the total length of the flute involved in making the C1 to C2 notes involved in the scale.

Meantime, William Bennett's continuous experiments with flute scales and the diameter and height of the tone

holes, resulted
in several important changes to Cooper's original Scale. His dogged persistence in seeking perfection has been largely
responsible for this Revised Scale 2012. Bennett's Scale, which he has already given to several makers, is similar to
Cooper's and the Revised Scale 2012, but with minor personal alterations.

William Bennett continued to experiment with flute scale, tone hole diameter, and height, and found some important factors in the original (early) Cooper scale.
It has made a difference. His continuing stubbornness in pursuit of perfection has helped a lot in the revised scale announced in 2012. he
The Bennett scale, which has already been given to many flute makers, is similar to the Cooper scale and the 2012 revised scale, but with slight personal differences.
There is (correction, change).

As'the Scale' developed and players offered their opinions, Cooper updated his figures and gave the latest revision to anyone
who asked for it. Over time, he gave the latest scale to different makers. Just a few years ago, he said:
'Cooper's Scale?
What's that? There isn't'a' Scale. There is a constant revision taking place so that, at any one time, there is a set of
figures which you can use to design your flute, but these will change in the light of experience. I altered the scale a little as
the years went by, mostly according to certain criticisms levelled at it. I now feel that I have more or less reached the end of
the road scale- <wbr /> wise.'

When a scale was developed and many performers gave their opinions, based on that, Cooper was able to develop his own figures (information, knowledge about the scale).
Has been updated (improved) and provided information about the latest version of the scale to anyone who wants. Over time he's up to date
I gave the scale to other manufacturers as well. Just a few years ago he said, "The Cooper scale? What is it?
Not a single (fixed) scale. There are figures you use to design your flute at any moment and change with experience
As can be done, there may be constant modifications. Based on several criticisms that increase the level (accuracy) of the scale as the years go by
I changed the scale little by little. I think I've almost reached the end of the road scale-wise right now (road scale-wise just

Is it a research process that approaches the final goal of scale research???)

Several versions of Cooper's Scale appear to be used by makers, perhaps passing on the figures to each other, or measuring
sample flutes, but the translation from one maker to another has resulted in inaccuracies. In the past few years, we three have
questioned the most commonly used set of figures of the original Cooper's Scale supplied by Cooper as manufactured by
leading flute makers. These were the general observations : middle D seemed to be a little flat; the left hand Bb and B are too
flat; both C2 and C#2 sharp are too high- <wbr /> perhaps because the open hole correction had not been correctly
calculated.

It appears that several versions (variants) of the Cooper scale were used by the flute maker. Passing figures (information) to each other's manufacturers
And I measured the flute of a sample (sample) from another manufacturer and used the numerical value.
Has been delivered. In the past few years, three of us used the original Cooper provided by Cooper among the scales used by leading flute makers.
I wondered what version of the scale is the most used (modified scale). Observation showed the following results:
Mid-range D notes were slightly lower, left hand Bb and B were very low, and C2 and C#2 notes were too high. Probably on the scale, on the open key
It is believed that the effect of this was not properly calculated (corrected, corrected). (When making a close key flute that was used a lot in the past
The used scale was used as it is without scale correction when making the open key flute)

The three of us have been in contact over the years regarding changes and improvements, but recently more often because
of our common agreement that some copies of the scale are no longer fit for purpose. Although not absolutely satisfied, we
agree that we have progressed far enough to publicly declare our findings and make this new scale a vailable for use by
make rs if they wish. In fact, we urge them to do so. The Revised Scale 2012 is free to use as required.

The three of us have been discussing change and improvement over the years. However, recently some of these scales
We meet more often because of our common agreement (decision) that it is no longer fit for purpose. Not completely satisfying,
We are able to publish our findings for public purposes and use new scales when manufacturers want.
I think it has produced enough research results. In fact, we see that the manufacturers are taking the new scale of our research.
I'm (coercing) to use it. The revised 2012 scale version can be used for free if anyone wants.

Below is an example of the kind of discussion that used to take place about flute scales:- <wbr />

* A note from Cooper to Bennett, c.1986:- <wbr /> Dear Wibb, I wish I had paid more attention to the calculations of the RH holes of the Jack Moore flute. Enclosed are my original calculations of which there are 2 errors . Firstly – the F# was wrongly placed, see red ink correction. Secondly – having done the F# correction, all the RH holes should be sharpened .2mm. Take notice of the green ink figures. The odd peculiar RH hole size threw me. I hope you can alter the stick as indicated, or let me alter it. I still think the RH holes I indicated as flat, are still a bit flat, but not as bad as first indicated. AC

Below are some of the discussions we exchanged with each other on the flute scale.

From Cooper to Bennett in 1986: Dear WIBB, I am in the tonehole position on the right hand side of the Jack Moofer flute. I want to say that you need to pay attention. There are 2 errors (mistakes) in my original scale, but one is the F# position too Wrong. Look at the correction with red ink. Second, when F# is corrected, all the toneholes on the right hand are less than 2mm. It should be sharpened (should be sharpened???0. Note the figures in green ink. The odd right-handed tonehole size confuses me) Do it. I think I can improve the flute as you pointed out. Or help me improve it
please give it to me. I think the tonehole of the right hand that I pointed out as low is still a bit low. But as I pointed out at first Not bad. From Albert Cooper.

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http://www.trevorwye.com/cooper2.html

# 2. Intonation Control by flutists

2. Intonation control by flutist ( intonation (a song or performance to be exact pitch or pitch))

The intonation of most flute players is inconsistent worldwide, professional players included and varies from country to
country. In many countries, it is masked by a virtuoso technique and a rich tone leading the listener to be captivated by these
attributes, but disguising the underlying problem. The flute doesn't naturally lend itself to big dynamic changes which
persuades the performer to use only small nuances so as to veil changes in pitch. Players avoid playing loudly and softly
because, sensibly, they prefer to steer clear of intonation difficulties. Don't bother with loud and soft playing. It is easier to
play with minimal expression.

대부분의 플루티스트에게 인토네이션은 전세계적으로 일관성이 없습니다. 전문연주자들 역시 마찬가지이고 나라마다 또 조금씩
다릅니다. 많은 나라에서 이러한 진실들이 연주자의 특성(개성, 성질)의 의해 청중을 매혹시키는 고도의 기교와 풍부한 음색으로
가려져 있습니다. 그렇지만 이것은 숨겨진 문제를 위장하는 것입니다. 플루트 그 자체만으로는 큰 역동적 변화를 일으키기 어렵기
때문에 연주자들은 표현함에 있어 보다 작은 변화정도만 줄 수 있게 되고 피치의 변화를 결국 느끼지 못하게 됩니다. 연주자는 크게,
그리고 약하게(부드럽게) 연주하는 것을 피하게 됩니다. 왜냐면 그들은 인토네이션상의 문제를 해결하기보다는 피하는 것을
좋아하기 때문입니다. 즉 "크게 또는 약하게(부드럽게) 연주하는 것때문에 스트레스 받지 마라 그냥 표현을 보다 적게 해서 연주하는
것이 더 쉽다" 라는 생각을 갖게 됩니다.

As the air speed/pressure is lowered to play softly, the pitch drops; when the air speed and pressure rises when playing
louder, the pitch also rises. At the extreme ends of the nuances, the rise and fall in pitch is considerable and apart from the
recorder, the flute is unique in this -<wbr /> unlike the remainder of the woodwinds. Reed instruments have a ‘built-<wbr />
in’ correction which operates to their advantage and which accounts for the fact that other winds don’t have the same pitch
differences when playing loudly and softly as flutes. When the clarinettist wishes to play softly, they blow less hard –which
lowers the pitch -<wbr /> but at the same time they reduce the aperture between the reed and mouthpiece. If they didn’t do
that, the note would be breathy or disappear completely and this action also has the effect of preventing the pitch from
dropping. This is an over-<wbr />simplification, but the same idea works for the double reeds too though players still have to
correct the relatively small changes in pitch between forte and piano, but not to the same degree as flutists. Reed instrument
players indeed have to control the pitch but it is not as variable as on the flute. We flutists have to learn a different technique
to play accurately in tune.

연주를 보다 약하게(부드럽게) 하려면 공기의 속도와 압력을 낮게 해서 불어야 하기 때문에 피치가 떨어집니다. 반대로 소리를 크게
So, when playing, the air velocity and pressure must increase, so the pitch also goes up. When the range of

change in expression is very large (large
When you suddenly weaken while playing, or when you weaken and then suddenly increase), the pitch fluctuates considerably and is preferred by record companies.
Will not be. In this respect, the flute is unique compared to other woodwind instruments. Reed instruments have the advantage of intrinsic correction.
There is no problem due to the pitch change that occurs when blowing loudly or weakly like a flute. If the clarinet player wants to blow weakly
You just need to blow a little less hard, but the pitch may drop at this point, but they make the reed and mouthpiece apertures (holes?)
Reduce it. If you do not perform this operation (playing method), the sound will be mixed with breath or the sound will disappear completely. Conversely, these manipulations
If you do (Play) properly, you can prevent the pitch from dropping. This is a bit oversimplified, but the same concept
So far, in a doulbe reed (double reed instrument) that requires players to correct small changes in the pitch of the forte and piano.
Apply. Of course, it's not as difficult as flutists face.

What is important is not how to correct a flat or sharp note, but the perfect control of intonation which allows the player to
use loud and soft notes, crescendos and diminuendos to be truly expressive, something exceptional amongst flute players
worldwide.

The important thing is not how to correct the high or low notes, but rather the increasingly important thing that allows the player to play the sound louder or lower.
Perfect intonation control is important to ensure that these loud or softer performances can be expressed naturally without any pitch related difficulties
Will.

This technique involves using the jaw and lips to raise the air stream and uncover the mouth hole when making a diminuendo
to prevent the pitch from dropping and has been set out in detail elsewhere(Practice Book One – Tone. Trevor Wye. (Novello)
pp 34 -<wbr /> 37 ). Some teachers suggest that moving the jaw is wrong; others suggest that the lips must remain relatively
still; others again that pitch is controlled by a procedure called'support' (the Holy Word of Teaching); others again suggest
correcting the pitch by rolling the flute in and out; some performers suggest,' Think sharp' ; another well-<wbr />known player

confessed, ' I have had the socket of the headjoint highly polished so that I can move the headjoint in with my left hand
when a pp passage is imminent! 'A famous professor was more than once observed tugging his ear lobe when the student's
intonation was appalling, though no practical corrective solution was offered.

This intonation control technique uses the chin and lips to speed up (raise) airflow or open the lip plate holes. In this way, the pitch is prevented from dropping, making diminudendo playable. see
For detailed instructions, see Practice Book One – Tone. Trevor Wye. (Novello) pp 34 -<wbr /> 37 I wrote this in detail. which
Teachers teach that the way to move the jaw is bad, while others teach that the lips should be kept in place. Other teachers have to adjust the pitch through a technique called Support, for example in The Holy Word of Teaching.
I teach that. Other teachers explain to adjust the pitch by turning the flute in or out. Some performers
Talking about the think sharp technique, another famous performance is just before I play the pp passage (the part that should be played with pp).
Turn the head joint inward with your left hand to make a groove by poishing the head joint so that you can play it.
I confessed that I did it. A famous professor doesn't tell you other practical solutions when the student's intonation is poor
I've also seen pulling the earlobe several times.

Some of these techniques might help to correct a pianissimo flat note, but are flawed as a method of playing expressively.
Some are just silly. Even so, a number of players have managed to play quite well in tune, perhaps learning to control their
intonation by instinct, or even being forced to do so for survival in our competitive profession.

Some of these techniques can help correct pianissimo low notes (when playing very low notes), but
There are flaws in how to play expressively. Some other things are just silly things. Yes, but some
The performers play quite well in tune. Maybe some instinctively learn how to control intonation, flute
There seems to be some being forced to learn to survive in society's competition.

## 3. 12 popular misconceptions about flutes and intonation.

3. 12 famous false (misknown) stories about flute and intonation

*** Fingers and Key height : ' Keep your fingers close to the key cups; your technique will be faster and neater.'**

This popular culture of keeping the fingers close to the keys -<wbr /> and of repairers keeping the key cups low –
encourages a faster performing speed and a neater technique, a practice found mainly among flutists. Other woodwinds keep
their fingers fairly clear of the holes or the notes would be flat, but this has the same effect on the flute. If the player uses an
open hole (French Model) flute and plays with the fingers almost touching the keys, it will result in a slightly muted tone and
some flatter notes. In fast passages, of course, it is not significant, but in slow tunes, close fingers will affect the intonation.
Players who adopt this technique are in effect playing a closed hole flute with the wrong scale. Repairers and players like the
'feel' of a closer mechanism, but when the key cups are too close to the tone holes, the sound is very slightly muted, more
so on closed hole cups than open. The foot joint cups should be no less than 3.8mm above the tone hole and as much as
4mm; the right and left hands ideally the same This will ensure the clearest tone and correct intonation.

잘못 : 손가락과 키의 높이 : 연주시 손가락을 가능하면 키컵에 가깝게 두어라. 당신의 테크닉이 보다 빨라지고 깔끔해질 것이다

손가락을 키컵에 가깝게 두는 것에 대한, 그리고 수리전문가들이 키컵을 톤홀에 가깝게(키컵과 톤홀 사이 간격을 좁히는) 두는
이 유명한 관습(악습, 문화???)가 더 빠른 연주속도와 더 깔끔한 연주기법에 대해서(대한 환상을) 조장합니다(부추깁니다). 실제로
이러한 모습들이 많은 플루티스트들에게서 보입니다. 다른 목관악기들의 경우 손가락을 구멍에서 완전히 뗍니다. 그렇지 않으면
소리가 낮게 나오기 때문입니다. 이러한 내용은 실은 플루트에서도 똑같습니다. 만일 플루트 연주자가 open key 플루트를
사용하면서 키에 거의 닿을 정도로 손가락을 두고 연주한다면 소리가 약간 죽게(줄어들게, 소리가 낮게, 작게) 되고 일부 음들은
더 낮아지게 됩니다. 물론 빠르게 연주하는 부분에서는 이러한 문제가 크게 드러나지 않습니다. 그러나 느린 부분을 연주할때 이러한
손가락 위치는 인토네이션에 악영향을 미칩니다. 이러한 테크닉에 적응한 연주자들은 잘못된 sclae을 가진 closed key 플루트를

연주하는 것과 같습니다. 수리전문가나 연주자의 경우 closer mechanism(키컵과 톤홀 사이의 간격이 좁은 악기)가 주는
느낌(feel)을 좋아합니다. 그러나 키컵이 톤홀에 너무 가깝게 위치하게 되면 소리가 조금 죽게되고 특히 open key 플루트보다는
closed key 플루트에서 보다 심합니다. 풋조인트의 키컵은 톤홀위로 3.8mm 정도는 되도록 간격을 유지해야 하고 크게는 4mm 정도
의 간격을 유지하도록 해야 합니다. 그리고 바디의 오른손쪽 그리고 왼손쪽 키컵의 경우 동일하게 간격을 유지해야 합니다.
이것이 가장 맑은 음, 가장 정확한 인토네이션을 보장합니다. (나중에 나오는 개정된 2012년도 scale에서는 왼손쪽 키컵 간격은
3.4mm. 오른손쪽 키컵과 풋조인트의 키컵은 3.8mm 로 설명합니다)

* **The C# sharp problem:** 'There is no 'correct place' for the C# hole. It is up to the performer'

There is a very good position in which to place the C#2 tone hole and we three have spent several years of experimenting
to determine where this should be. The note still needs care and practice to centre the tone, but the pitch is adequate. On
most flutes it is too sharp, a common complaint. Putting fingers down in the right hand to correct a sharp C#2 should not be
necessary and in any case, only allows the player to create extra resonance so that the timbre may be altered. Adding fingers
also alters the partials (harmonics) and though it does help with technical stability, it hardly affects the pitch.

잘못 : C# 문제 : C# 톤홀의 정확한 위치라는 것은 없다 그냥 연주자의 역량에 달렸다

C#2 톤홀의 가장 좋은 위치는 확실히 있습니다. 우리 3명은 어디가 가장 좋은, 정확한 자리인지를 알아내기 위해 수년동안 실험을
했습니다. 음은 여전히 신경써야하고 음을 제대로내기 위해서는 연습이 필요하지만 우리가 확인한 C# 톤홀 위치에서 피치는 적절
(적합)합니다. 대부분의 플루트에서 이 음은 너무 높다는 것이 일반적인 불만사항입니다. 높은 C#2 음을 교정하기 위해 오른쪽
손가락을 아래로 내릴 필요는 없어야 하며 특정경우 예를 들어 연주자가 음색을 바꾸기 위해 추가적인 공명을 만드려고 할때에만
허용되어야 합니다(본래의 C# 운지법에서 오른쪽 손가락 키를 모두 누른다는 뜻인듯 한데 정확히 무슨 말인지 잘 모르겠음???).
(이렇게 원래의 운지법에서) 손가락을 추가하는 것은 이것이 비록 연주할때 안전성을 주고 피치에는 거의 영향을 미치지 않지만

부분음(partial tone을 말하는 듯, 부분음)이나 하모닉스를 해칩니다(변화시킵니다)

* ‘Open and closed hole flute scales are the same’

This is a fallacy and irresponsible of flute makers to ignore basic acoustics just to simplify the manufacturing process. It is
more economical for the maker to ‘tool up’ making one flute body for both open and closed hole flutes but is a lazy approach,
and assumes the customer doesn’t care. Manufacturers producing both open and closed hole flutes with the same scale are
surely working on the fact that the customer doesn’t know.
The air vibrates in a curved cone above the tone hole. The top of the cone is interrupted by the key cup and pad but a hole in
the cup allows more venting, resulting in a sharper note. Ideally, all tone holes should have open cups above them and
experimental flutes using this idea are currently available for use by extended technique aficionados, but for the normal
orchestral player, the five open cups*( E, F, F#, A & A# ) as on a ‘French Model’ flute offer several alternate fingerings and
can help to tune otherwise difficult notes, particularly in the third octave. Eldred Spell’s experiments have established that the
left and right hand open cup correction is different.

잘못 : 오픈키 플루트와 클로즈키 플루트의 scale은 동일하다

이것은 잘못 알려진 오류인데, 이 이야기는 제작공정을 단순화하려고 기본적인 음향학을 무시한 플루트제작의 무책임에서
나왔습니다. 그냥 open key 플루트의 바디와 closed key 플루트의 바디를  똑같은 하나의 플루트 튜브로 만드려는 경제적인
접근일 것입니다. 그렇지만 이것은 매우 게으른 접근이며,  구매자를 고려(배려)하지 않는 것으로 보입니다.  오픈키와 클로즈키
플루트 바디를 같은 scale로 만드려는 것은 구매자가 이러한 scale에 대해서 잘모른다는 사실과도 확실히 연관이 있습니다.

공기는 톤홀위의 둥근 원뿔(curved cone 톤홀 기둥/원통내의 열린 공간인듯)에서 진동합니다. 원뿔의 윗부분은 키컵과 패드에
의해 막히게 되지만 키컵의 구멍에서는 더 많은 공기가 venting(공기가 뿜어져 나옴, 움직이게 되어, 진동???)하게 되어 결국 더 높은

음이 나게 됩니다. 이상적으는 모든 톤홀의경우 톤홀 위에 open key cup(오픈 키 컵)을 가져야 합니다. 이러한 아이다어를
이용해서 만들어진 실험적 플루트들이 있는데, 이러한 플루트들은 (일반적이지 않은, 보기 드문) 여러 다른 테크닉(을 구사하는 것을
좋아하는) 매니아들에게는 유용합니다. 그러나 정상적인 오케스트라 연주자들에게는 E, F, F#, A & A# 의 5개 키가 열린 french
model 플루트로 다양한 여러 운지(연주)가 가능하고 소리내기 어려운 음들 특히 3 음역대의 음들이 제대로 나게 할 수 있습니다.
(실제 open key 플루트의 키컵에 모두 구멍이 있는 것이 아니라 E, F, F#, A & A# 의 5개 키컵만 구멍이 있습니다). Eldred
Spell은 실험을 통해 왼손쪽 키컵과 오른손쪽 키컵의 scale(톤홀 위치)이 달라 scale 보정치(correction)가 왼손쪽 키컵과 오른손쪽
키컵의 경우 서로 다르다는 것을 확인시켰습니다.

*Different versions of 'equal temperament'

Examples from makers brochures:-<wbr /> 'A mathematically constructed scale'; '...offers perfect intonation', 'After many
years we have perfected a true scale which allows you...' etc., etc.

Makers inventing their own versions of equal temperament is analogous to making different lengths of a foot rule with the
inches unevenly placed. Guitar frets are uniformly placed by all makers according to equal temperament.

As Elmer Cole, Albert Cooper and other flute makers and designers have revealed, Boehm's Schema, a way to mathematically
calculate the position of the tone holes set out in 1847 to give us a good scale, doesn't actually work quite well enough in
practice. That is to say, the math takes us to a starting point: from there on, there are a number of variables which are not
completely understood, but include the open hole allowance, the key rise and the tone hole diameter correction. This much is
known: we three had to experiment and change the scale figures accordingly. We are not completely satisfied that the
Revised Scale 2012 set out below is the last word, but it is much better than copied versions of Cooper's Scale and better
than most popular flute maker's scales today.

At the time of setting out this scale, (March 2011) we had just acquired a cheap flute allegedly built to a good scale which
required the removal and replacement of no less than eight tone holes to turn it into a playable flute.

잘못 : 동일한 기질(구성, 구조, 천성)의 다른 버전(변형)

예를 들어 플루트제작사 안내책자에 "수학적으로 제작된 scale" " 완벽한 인토네이션을 제공하는" "수년간에 당신이 ..할 수 있는
진정한 완벽한 scale을 만들었다" 등등의 내용이 있습니다.

그렇지만 제작사들이 이야기하는 본인들이 만들었다고 하는, 동일 구조의 다른 버전이라는 것은 잘못된 인치 눈금이 매겨진 다른
길이의 줄자를 만드는 것과 같은 것입니다. 기타의 플렛(fret)은 모든 키타 제작사들에 의해 동일한 구조로 균일하게 제작됩니다.
Elmer Cole, Albert Cooper 와 다른 플루트제작자들과 디자이너들은 1847년에 만들어진, 톤홀의 위치를 수학적으로 계산하는
방법인 Boehm schema(뵘 제작양식)이 실제로 플루트제작하는데 별로 사용되지 않고 있다는 것을 밝혀냈습니다. 말하자면 수학에서
(뵘이 수학적으로 계산해서 만들어낸 scale에서) 우리는 연구를 시작했습니다. 거기서부터 시작해서 여러 버전의 scale 변형이
나왔지만 완벽하게 이해되지 않는 상태에서 scale이 개발되어 왔습니다. 그렇지만 오픈키 플루트를 가능케 했고 키의 높이, 톤홀의
직경에 대한 교정 등의 많은 좋은 결과를 낳았습니다. 현재 이러한 것들은 많이 알려졌습니다. 우리 3명은 알려진 내용을 바탕으로
많은 실험을 해야 했고 그 결과로 scale을 변화(교정) 했습니다. 우리가 2012년도 개정된 scale에 대해서 완벽하게 만족하는 것은
아닙니다. 그러나 여러 제작사들에서 사용되는 Cooper scale의 복사 버전 보다는 훨씬 낫고 오늘날 유명한 대부분의
플루트제작사들의 scale 보다 낫습니다.

이 scale을 정리하려고 했던 2011년 당시만해도, 우리는 나름 좋은 scale로 만들어졌다고 우기는 싼 악기을 보았지만 이들
악기들이 제대로 연주할 수 있는 플루트가 되려면 8개의 톤홀 모두 제거해서 다시 배치해야 했습니다.

* ‘It is not flutes which are out of tune, but flutists’

Actually, it’s both. An eminent flute maker made this statement many years ago while making flutes at

A-<wbr />435 to be played
at A-<wbr />440 or higher! The manufacturing quality of these flutes was beyond question, but like a horse with three legs, a
serious setback for the performer, yet many esteemed players performed on these flutes, perhaps not exploring much in the
way of dynamic change but building a successful career playing them. One wonders how much better it would have been for
them to have an accurately tuned flute rather than spending  a lifetime correcting – with some skill -<wbr /> the mistakes of the
maker.

잘못 : 음정이 안 맞는 것은 플루트 문제가 아니라 플루티스트 문제이다

실제로는 플루트와 플루티스트 모두에게 문제가 있을 수 있습니다.  유명한 플루트 제작사에  A=440이나 그이상으로 연주해야 할 때
A=435 플루트를 만들면서 실제로 위에 나온 소리를 했습니다. 이 제작사에서 만들어진 플루트의 품질은 의심할 여지가 없기는 하지만
다리가 3개인 말과 같이 연주자들이 연주하는데 심각한 문제가 있었습니다.  그렇지만 많은 존경받는 연주자들이 이러한 상을
개선시키려 하지 않고 그냥 성공적인 연주 경력을 쌓는데만 신경쓰면서 이러한 맞지 않는 플루트를 그대로 사용했습니다. 어떤
연주자는 잘못된 제작사의 실수를 고치도록 하기 보다는 기술적으로(연주기법적으로) 문제가 되는 플루트에서 어떻게 하면 소리가
제대로 더 잘 날까 하는 것을 연구했습니다.

* ‘Open hole flutes are better’.

Both can be good: the tone is not affected by only the five open cups(E, F, F#, A & A# ), but if that were true, there would be
five good notes and seven poor ones. Many flutes, both open and closed hole models, have key cups which are not open
enough -<wbr /> in other words, they do not rise sufficiently above the tone hole. As our scale below shows, part of the
Revised Scale 2011 allows appropriate ventilation below the key cup. Keeping the cups closer to the tone holes is splendid for
 speed and dexterity, but muffles the tone and flattens the pitch. Our advice is to ask your repair person to ensure that the foot
joint and right hand key cups are open to 3.8mm. at the front, and the G# and left hand keys and thumb keys almost the same.

This will ensure that the fullest tone will be possible.

Blocking up the open holes because of a faulty hand position should be seen only as a short term solution even for one key
cup. Those with small hands are advised to use this temporarily -<wbr /> or change to a closed hole flute.

잘못 : 오픈키 플루트가 클로즈키 플루트 보다 좋다

오픈키든 클로즈키 플루트 이던간에 모두 좋습니다. 음(음정, 음색??/)이 오픈키 플루트처럼 5개(E, F, F#, A & A#)가 열려진
키컵이라고 해서 달라지지 않습니다. 그렇지만 5개의 좋은 음들과 7개의 나쁜 음이 있는 것은 사실입니다. 오픈키든 클로즈키든
플루트들이 충분히 열리지 않는 키컵을 갖고 있는 경우가 많습니다. 다른 말로 하면, 이러한 플루트들은 톤홀 위로 충분히 높은
위치로 올려져 있지 않습니다.(키컵과 톤홀간의 간격이 적절하지 않습니다). 아래쪽 개정된 2012년 scale의 경우에서는
키컵아래에서 충분한 ventilation(공기의 유통, 환기)가 가능합니다.(즉 오픈키 플루트에 대한 정확한 scale이 나왔다는 뜻으로
2012년도 scale이 2011년 발표된 scale에 비해 오픈키 플루트에 대한 scale 정보가 추가되었습니다). 키컵을 톤홀에 가깝게
위치시키는 것은 연주 속도 및 정확도에 좋습니다. 그러나 반대로 소리(음)을 죽이고 피치를 낮게 합니다. 우리는 당신이 악기를
수리를 맡길때 수리전문가들이 풋조인트와 오른손쪽 키컵은 3.8mm 정도 간격은 유지하도록, 그리고 G#키, 왼손쪽 키, thumb 키는
거의 비슷한 간격(예 3.4mm)으로 위치하게끔 수리해야 한다고 충고합니다. 이 위치(키컵과 톤홀 사이의 간격)가 플루트에서 가장
풍부한 음이 가능하도록 할 것입니다.

손의 잘못된 자세로 인해 오픈키의 구멍을 막는 것은 설령 그것이 단 한개의 구멍을 막더라도 단지 일시적인 해결책으로만 고려해야
합니다. 작은 손을 가진 연주자들의 경우 이러한 방법은 아주 일시적으로 사용하거나 아니면 클로즈키 플루트로 바꾸어야 합니다.

* ‘You can get used to any flute and play it well in tune. I just takes time.’

It is true that a skilled player can get used to a poorly scaled flute and -<wbr /> depending on their ears and ability -<wbr />
can adjust and play reasonably well in tune: others aurally less fortunate may play with faulty intonation but

will probably never
know it, though their colleagues may know. But why start off with a three-<wbr />legged horse? A well constructed scale will
allow the greatest technical and musical freedom.

잘못 : 어떤 플루트 라고 할지라도(잘못된 scale의 플루트라고 할지라도) 쉽게 적응해서 소리를 제대로 낼 수 있을 것입니다. 단지
시간의 문제입니다.

능력잇는 연주자의 경우 잘못된 scale을 가진 플루트에 대해서도 본인의 귀와 능력으로 잘 적응해서 음이 맞게 잘 연주할 수
있습니다. 소리 듣는 것에 재능이 없는 다른 연주자들은 엉터리 인토네이션으로 연주할 것이며 절대로 자신이 잘 못하고 있다는 것을
알지 못 할 것입니다. 다른 동료들이 알 수는 있습니다 그러나 좋은 말이 있는데 처음부터 뭐하러 다리 3개 달린 (병신)말로
달립니까? 잘 제작된 scale은 당신이 보다 테크닉적으로 훌륭하게, 보다 자유로운 음악적 표현을 가능하게 합니다.

*** 'There is no perfect scale; players just have to get used to and adjust to what they have'**

True, they can, depending on their skill, but why should they? This is the same as suggesting that a badly tuned violin can
be played in tune by an accomplished performer by 'getting used to what they have'. This is an excuse by uninformed flute
makers to justify their ignorance about flute scale design. A poorly designed scale will hamper the development of a performer.
Times are so competitive now that the sensible student must ensure his career has the fewest obstacles.

잘못 : 완벽한 scale은 없다 그래서 연주자들이 그들이 가지고 있는 (잘못된 scale의) 플루트에 익숙해져서 적응해야 한다.

사실입니다. 연주자들이 본인의 능력과 기술로 그렇게 할 수도 있습니다. 그런데 왜 그들이 그렇게 해야 합니까? 이런 이야기는
자신들이 가지고 있는 악기에 익숙해진 바이올리니스트들이 음정이 맞지 않는 바이올린으로 음정에 맞게 연주할 수 있다는 말과
같습니다. 이것은 플루트 제작관련 지식이 충분하지 않은 플루트제작사들이 scale에 대한 그들의 무지를 정당화하려는 변명입니다.
제대로 디자인되지(제작되지) 않은 scale은 연주자의 발전을 저해할 것입니다. 요즘 시대는 경쟁사회

로, 센스있는 학생이라면
본인의 전문 연주자로서 삶에서(전공과정)에서 (잘못된 scale의 플루트와 같은 ) 장애물을 되도록이면 만나지 않도록 해야 합니다.

* Can the listener tell whether the flute has a good scale?

Yes, and with experience, quite often. When a student is having problems with intonation, we can make a good guess as to
the probable scale and often the maker too. The characteristics of some flutes (flat Bb2s & B2s and a sharp C2 & C#2, etc.)
is a fingerprint as to its general derivation.

질문 : 소리를 듣고 플루트가 좋은 scale을 갖주었는지 안 갖추었는지 알 수 있나요?

알 수 있습니다. 경험으로는 꽤 자주 확인 할 수 있었습니다. 만일 학생이 인토네이션에 문제가 있을 때 우리는 학생이 가지고 있는
플루트의 scale이 어떤 scale일 것인지, 어떤 제작사에서 만든 것인지 잘 알아 맞출 수 있습니다. 어떤 악기의 특정 음,
특히 flat Bb2s & B2s and a sharp C2 & C#2 음에서 발견되는 특징은 그 플루트의 근원(제작사, 제작 scale)에 있어 지문과
같습니다.

* Correct the flatness in pitch by rolling the flute in/out with your hands (from a published booklet on ‘steps to acquiring good intonation’.

This booklet also contains: ‘slide your finger off one of the five open holes when flat..., and practice to become proficient at
that technique’). Moving the flute inwards or outwards with the hands should never be an option to remain in tune when
using dynamics. There is quite enough to do expressively -<wbr /> while keeping a careful control over the tone -<wbr />
without rolling the flute in and out. It is a ridiculous solution for pitch control and will lead to instability and poor performing
habits. It can be used of course, as a means of flattening a note when note-<wbr />bending, and it is used in contemporary
music. Sliding the fingers off too, will correct a temporarily flat note and is useful for special, or alternative fingerings, but is
useless as a long term solution to pitch control and expression.

잘못 : 손으로 플루트를 안쪽 바깥쪽으로 돌려가면서 피치가 낮은 것을 교정해라

(이 이야기는 실제 출판되어 나온 steps to acquiring good intonation' 라는 소책자에도 나온 말입니다)
이 소책자에는 "음이 낮을때 5개의 오픈키 중 하나를 손가락을 밀어서 열어라 " 그리고 이러한 테크닉에 능숙하도록 연습해라 하는
내용도 있습니다. dynamics(세게불고 약하게 부는 것을 반복하는 연주 기법???)을 사용할 때에 음맞도록 하기 위해 손으로
플루트를 안쪽 바깥쪽으로 움직이는 방법은 선택되어서는 안됩니다. 음을 세심하게 조절하면서 플루트를 안쪽 바깥쪽으로 돌리는
것 말고도 표현(연주할때)해야 할 것들이 꽤 많습니다. 이런 방법은 피치 조절하는데 있어 터무니없는 해결책이며 이것은 불안정을
야기시켜 나쁜 연주 습관이 생기게 될 것입니다. 물론 note-bending(음을 변형시킬때???) 음을 낮게 하는 방법으로 사용될 수도
있고 현대음악(contemporary music)에서 사용되고 있습니다. (키컵위에서?) 손가락을 미끄러 뜨려서 하는 연주법은 일시적으로
낮은 음을 교정할 수도 있고 특별한 또는 대안적인 운지법으로 일적으로 효과가 있을 수 는 있지만 피치 조절과 표현에 있어 오랬동안
할 수 있는 근본적인 해결책은 아닙니다.

* 'Correct sharpness by making more room inside your mouth and throat'.

Unless this action also affects covering the mouth hole, it is unlikely to affect the pitch of a note. It may however affect the
tone and harmonic balance, but as a device to be used by a performer for seriously controlling the pitch and for expressive
purposes, it is nonsense.

잘못 : 입안과 목구멍안의 공간을 더 넓혀서 sharpness(은의 날카로움, 높음???)을 교정해라

만일 입안과 목구멍안의 공간을 더 넓히는 것이 입구멍을 막는데 영향을 미치지 않는다면 음의 피치에 영향을 줄 것 같지는 않습니다.
이것이 음색과 harmonic balance(하모닉 발란스)에 영향을 줄 수도 있습니다. 그러나 피치를 엄격하게 조절해야하거나 음악적
표현(다양한 기법??? expressive purpose)을 주 목적으로 하는 연주자가 사용하기에는 의미가 없습니다.

* 'The 'Donut' improves top E'

True, but only a very little -<wbr /> but it also seriously lowers the quality of A1 & A2, and in most cases,

makes these notes
flat. The authors have collectively removed several donuts from flutes both to good effect and to the delight of the player. Some
makers have enlarged the A hole to make it sharper so as to insert a donut, but this has also spoiled the quality of the note.
More recently, a thin ring has been inserted into the 'spare' G# hole rather than a crescent and this is less obtrusive though
it seems it may make the top E thin in tone.

사실 : Donut 가 고음역 E 음을 개선시킵니다(New E-mechanism, Lower G insert ,High E facilitator 이야기 하는 듯)

사실입니다. 그렇지만 아주 조금 개선시킵니다. 반대로 A1, A2 음의 질을 심각하게 떨어뜨릴 수도 있는데 많은 경우에서 이러한
음들이 낮게 나옵니다. 저자는 여러 플루트들에서 이러한 donut를 제거해서 보다 좋은 효과를 내고 연주자에게 기쁨을 주었습니다.
어떤 제작사는 A 톤홀을 크게 해서 보다 음이 높게하면서 donut를 넣기 쉽게 했습니다. 그러나 이러한 조치는 음의 질을
망가뜨립니다. 최근에는 초승달모양보다는 얇은 링모양을 spare(크기가 조금 더 큰???) G# 톤홀에 넣습니다. 이것 역시
고음 E 음색이 약간 얇게 나오는 하지만 초승달 모양보다는 조금 덜 거슬리기는 합니다.

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http://www.trevorwye.com/cooper3.html

**Revised Scale 2012..continued**

**4. Is your Flute in Tune?**

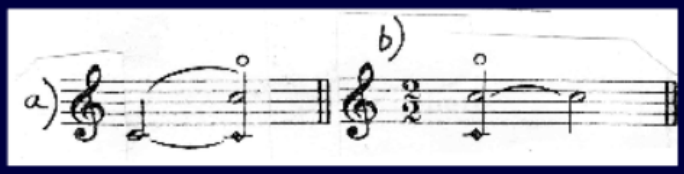
This checking process will take a little time and is best done where there is quiet. Allow at least 30 minutes to complete it and be *prepared to repeat it on successive days* as each day may produce slightly different results. We three are quite experienced in this technique after testing hundreds of flutes. You will need a lot longer.

4. 당신의 플루트는 음이 맞는가?

음이 맞는지 확인하는 작업은 약간의 시간이 소요되며, 조용한 공간에 할때 가장 잘 확인할 수 있습니다. 확인하는 작업은 적어도
30분정도 소요되고 연이어 다음날까지 확인하는 작업을 반복해서 진행해야 합니다. 작업을 진행한

날에 따라 결과가 약간 다른 수
있기 때문입니다. 우리 3명은 수백대의 플루트를 테스트했기때문에 이러한 작업에 매우 능숙합니다.
당신은 더 오랜 기간 더 많은
경험을 필요로 할 것입니다.

1) Warm the flute thoroughly for a few minutes and then play low C, hereafter called C1.
Move up to the second harmonic, C2, by over blowing, as illustrated at *a)*.




Now take your fingers off the keys to compare the second harmonic of C1 to the natural note an octave above - C2 - as at *b)*. If it is not exactly an octave, adjust the headjoint, moving it in or out until the two Cs - the second harmonic of C1 and the normal C2 - are as closely as possible at the same pitch. *Do not move your lips or make any alteration to the intonation with your lips.* Just accept what the flute is telling you.

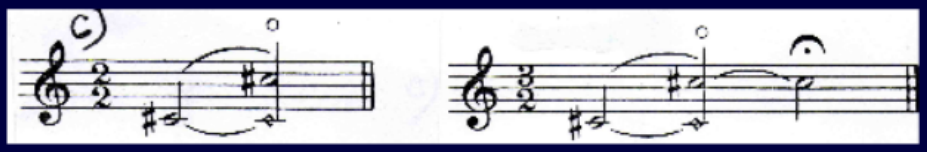
1) 수분에 걸쳐 플루트를 따뜻하게 하십시오. 그리고 나서 낮은 C, 즉 C1 음을 연주하십시오

연주하면서 overblowing 기법으로 그림 a) 에 있는 것 처럼 C1의 second hamonic인 C2으로 옮겨가십시오

(overblowing : 관악기에서 숨의 속도 · 압력과 입술 조정에 인해, 바탕음 대신 상부배음(上部倍音)을 내는 주법의 하나)

이제 당신의 손가락을 키에서 떼서 그림 b)에 있는 것 처럼 C1의 second hamonic으로서의
C2와 C2의 natural note
(원래 2음대 C음)를 비교해 보십시오. 만일 옥타브가 정확하지 않으면(음이 서로 똑같지 않으면???)
2개의 C, 즉 C1의 second
hamonic 음과 정상적인 C2 가 같은 피치에서 가능하면 근접한 소리가 날때까지 헤드조인트를 안쪽 또는 바깥쪽으로 움직여
보십시오. 입술을 움직이거나 입술을 통해 인네이션에 있어 변화를 주면 안됩니다. 단지 플루트가 당신에게 알려주는 것을
받아드리십시오(플루트가 나는 소리를 있는 그대로 들으십시오)

2) Repeat this for C#1 and compare it with the natural note an octave above as shown below at *c)*.




Typically, the two C#s are not in tune, even though the two C naturals are. This illustrates the problem we face: the maker may not have constructed the scale carefully enough. If the two Cs are in tune, the two C#s should also be in tune. It is a common problem and we will return to it later.

2) Repeat this process in the same way for C#1 sound. So, like Figure c), the second hamonic sound of C#1 and the natural C#2 sound
Compare.

In general, even if two C notes (C1's second hamonic note and natural C2) match each other, two C#1 (second hamonic notes) and
natural C#2) do not agree with each other. This is the problem we face. The manufacturer is not careful enough to make the scale
May be. If two C notes are correct, then two C# notes must also be correct. This is a common problem, but again later
I'll talk.

3) Now check the pitch of C1 and C2, this time with your tuning machine: probably the upper one is sharp and the lower one flat. If this difference is small, don't worry about it yet. The important step is to ensure the two Cs are as nearly as possible in tune using both the harmonics and the machine to check them. This ensures you have the correct octave-length.

Before the next step, read the following carefully:- you will be using 3rd harmonics (a twelfth above the fundamental) to check the pitch of the second octave of your flute. Unlike 2nd harmonics (octaves), the 3rd harmonics should be slightly sharper than the natural note*. What you have to do is determine the difference between the two notes or the *degree of sharpness*. You must train your ear to hear the *degree of difference.*

* This is the difference between natural 'just intonation' and man- made Equal Temperament.

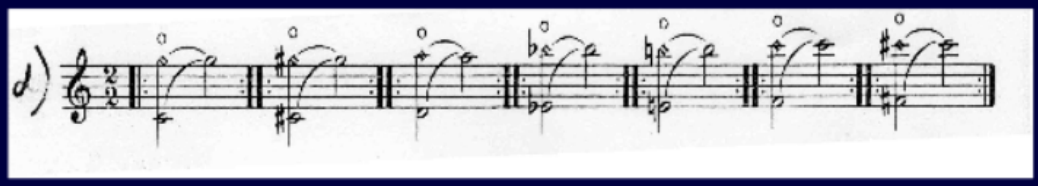
Continue to the next step:

Now check the pitch of C1 and C2. When doing this, use your tunning machin (tuning machine, tuning fork, tuning fork?)
Please use. Perhaps the upper one (C2?) is high and the lower one (C1) is low. If the pitch difference between these two notes is small, there is no need to worry
No (it shouldn't be a big deal). More importantly, these two. When checking C1, C2 by harmonics method and tunning
When using a machine, the two notes should be as close as possible (closer, accurate). This is your flute is the correct octave

It will confirm that you have length.

4) Play C1 again, this time over blowing it until it produces the 12th above, G2, as at *d)* below. Compare this harmonic with the natural G2. There should be a difference, but is the gap large or is it small as it should be? Though small, the difference should just be discernable. Make a note of the size of the difference or gap. *Do not make any alteration to the intonation with your lips or jaw.* It is tempting, driven by fear about what you may find, to 'adjust' the intervals so as to justify the money spent on your 18ct gold cherished flute.

c) Play C#1 and by over blowing to the 3rd harmonic, compare it to the natural G#2. Make a note of the degree of difference in pitch. Now play D1 and compare it with A2. Continue through Eb1 comparing it with Bb2; E1 comparing it with B2(3) and then F1 comparing it with C3. You can make a 'double check' here between the 4th harmonic of C1 (C3) and the 3rd harmonic of F1, also C3. Finally, check the C#s, using both 3rd and 4th harmonics.



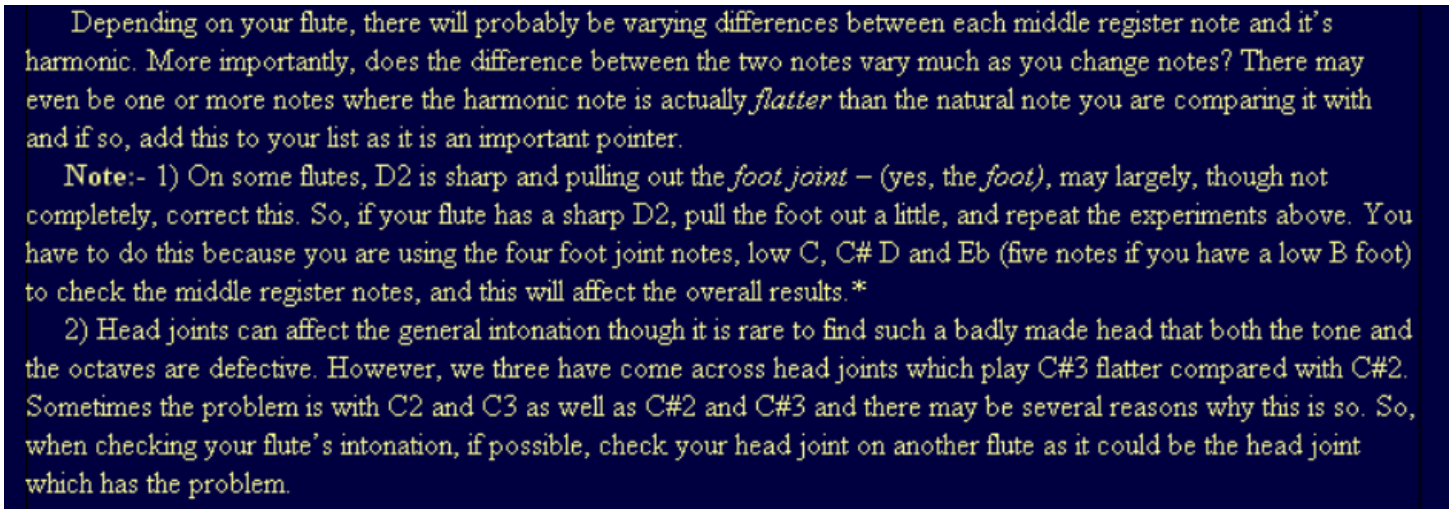

You will have to be patient, making a note of how large the gap is between the natural middle register note and the harmonic. There should be a small difference, the harmonic usually being sharper. It is the *degree of sharpness* you are noting. The amount of swing of your tuning machine indicator between the two notes, may also be helpful.

4) Try playing C1 again. d) Blow in the overblowing method to make the sound G2, the note above 12 levels, as shown in the picture. And this
Compare the hamonics to the original G2. There will be a difference, see if the difference is large or small. Even in small cases
Be able to identify (recognize, notice) differences. Write in your notebook about the magnitude (degree) of these differences. Lips or chin
Do not make any changes to intonation. To justify the cost of buying your fancy 18K flute
You might want to adjust the interval (change intonation to get the result that the flute scale is correct???), but this
The fear of what will happen if you find something in trouble is the thought of making a difference in intonation.

Play C#1 and overblowing to play the 3rd hamonic note, and compare it to the original C#2 note. Look. Write down information in your notebook of differences in pitch. Now play the D1 note and compare it to the A2 and D1 notes. Bb soundness
In the same way, compare Bb2, E1 to B2, and F1 to C3. You are the 4th hamonic of C1
You can do a double check with the C3 note and the C3 note, the 3rd hamonic note of F1. Finally in C#
Also check out the C3# sound with the 3rd hamonic and the 4th hamonic.

You need patience when writing down in your notebook how much difference is between the original

mid-range sounds and harmonics. There must be a small difference
However, the harmonic sound is usually slightly higher. You have to write down the amount of difference between how high this harmonic is. When playing two notes
The amount (how much) your tuning machine's instrument (indicator, needle) swings left and right between the two notes can help.



Depending on your flute, there will probably be varying differences between each middle register note and it's harmonic. More importantly, does the difference between the two notes vary much as you change notes? There may even be one or more notes where the harmonic note is actually *flatter* than the natural note you are comparing it with and if so, add this to your list as it is an important pointer.

**Note**:- 1) On some flutes, D2 is sharp and pulling out the *foot joint* – (yes, the *foot)*, may largely, though not completely, correct this. So, if your flute has a sharp D2, pull the foot out a little, and repeat the experiments above. You have to do this because you are using the four foot joint notes, low C, C# D and Eb (five notes if you have a low B foot) to check the middle register notes, and this will affect the overall results.*

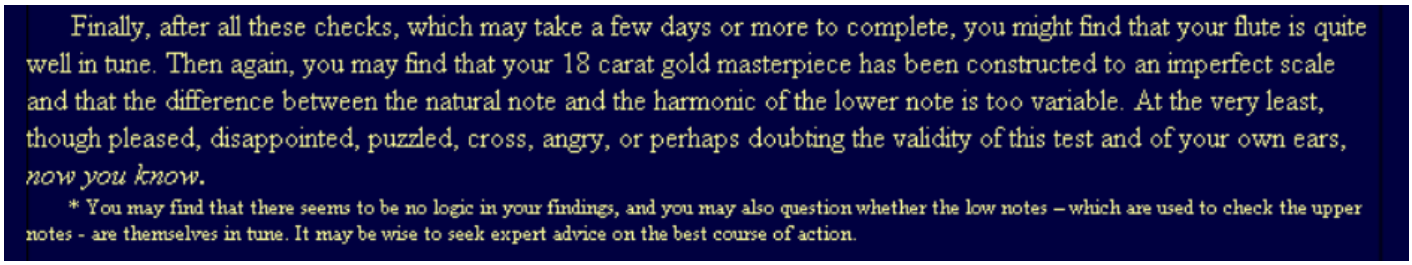
2) Head joints can affect the general intonation though it is rare to find such a badly made head that both the tone and the octaves are defective. However, we three have come across head joints which play C#3 flatter compared with C#2. Sometimes the problem is with C2 and C3 as well as C#2 and C#3 and there may be several reasons why this is so. So, when checking your flute's intonation, if possible, check your head joint on another flute as it could be the head joint which has the problem.

Depending on the condition (type) of the flute you have , there may be varying degrees of difference between the mid-range and the harmonic of that note.
Will. What's more important is whether the difference between the two notes changes more significantly as you move on to play another note. You
When performing a comparison demonstration, there may be one or more notes with a lower harmonic than the original. If so, then
Add important information (advice) to the Divine Handbook

note:

1) In the case of some flutes, D2 is high, so if the fan joint is pulled out, it is not perfectly corrected, but a lot of high D2 sounds can be corrected.
There is. So, if your flute's D2 sound is high, pull out the foot joint a little. Then, the test (experiment, demonstration) we did above
Try again. You have to do this. Because if you want to check your mid-range notes, the notes associated with the footjoint, i.e.
This is because low C, C#, D, Eb and B-footjoints have to be used up to low B notes. So whether you do this or not
That will affect the overall result.

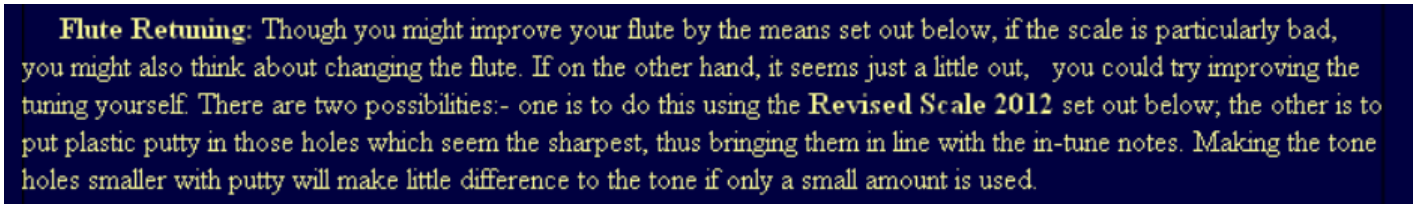
2) Although it is difficult to find a badly made head joint that has problems with both notes and octaves, head joints also affect the overall intonation
Can give. We have found headjoints where C#3 notes play lower when compared to C#2 notes. Not only C#2 and C#3 well
There is also an occasional problem with notes C2 and C3. There can be several reasons for these problems to occur. So that's your flute
When checking intonation, there may be a problem with the head joint, so if possible, try to insert your head joint into another flute.
See


Finally, after all these checks, which may take a few days or more to complete, you might find that your flute is quite well in tune. Then again, you may find that your 18 carat gold masterpiece has been constructed to an imperfect scale and that the difference between the natural note and the harmonic of the lower note is too variable. At the very least, though pleased, disappointed, puzzled, cross, angry, or perhaps doubting the validity of this test and of your own ears, *now you know.*

* You may find that there seems to be no logic in your findings, and you may also question whether the low notes – which are used to check the upper notes - are themselves in tune. It may be wise to seek expert advice on the best course of action.

Finally, after checking all of these things in a few days, no matter how many days, you will find that your flute is quite well tuned.
There is also. However, the 18K flute you bought expensive was made with an incomplete scale, so the difference between the original and harmonic notes is quite diverse.
You may find it makes a difference. At least happy, disappointed, bewildered, annoyed, angry, or at least your ears
Whether you doubt the legitimacy (suitability) of these tests (checks), you now know the truth.

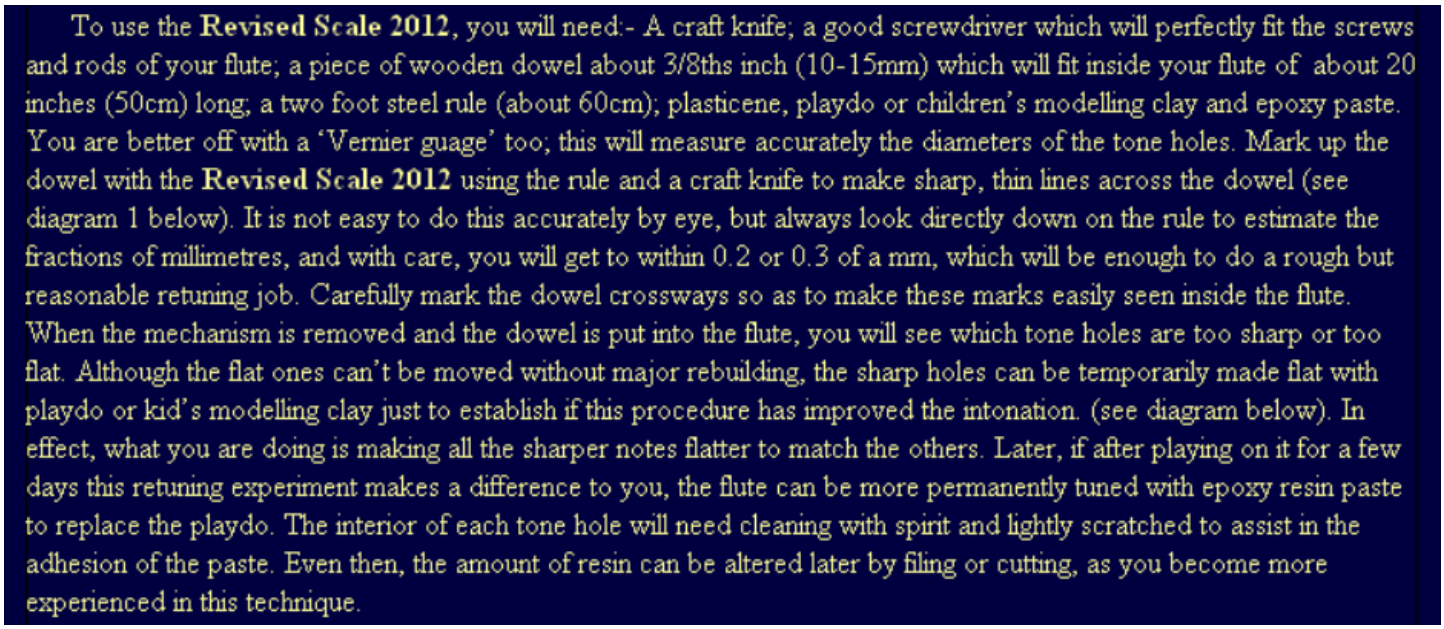
* You may be worried that what you've checked is not logical (if it doesn't make sense), and in checking the high-end notes
You may be wondering whether the bass notes at the reference point are properly pitched or not. In that case, the best way is
It is to consult with an expert who can do well on the test.


**Flute Retuning:** Though you might improve your flute by the means set out below, if the scale is particularly bad, you might also think about changing the flute. If on the other hand, it seems just a little out, you could try improving the tuning yourself. There are two possibilities:- one is to do this using the **Revised Scale 2012** set out below; the other is to put plastic putty in those holes which seem the sharpest, thus bringing them in line with the in-tune notes. Making the tone holes smaller with putty will make little difference to the tone if only a small amount is used.

flute retuning (flute retuning)

Even though you can also improve (improve) your flute by following the methods written below, if the scale is particularly bad, try using the flute.
You may also need to consider replacing (requiring a new purchase). On the other hand, if you say that the problem with scale is very little, you
You can solve the problem by trying to improve the tuning method. There are two ways to do this. One thing is
It is using the revised 2012 scale. Another way is to put a plastic putty ( putty: glass on the window frame) in the toneholes where the sound comes out higher than the original .

Add a bonding agent to be used when inserting, so that the tone hole sound that causes this problem is in a straight line with the sound
This is how to make the sound sound properly). To make the tone hole smaller using putty, if the putty is only a very small amount
If used, it will not affect the tone hole significantly. (That means it's okay if you don't use a lot)


To use the **Revised Scale 2012**, you will need:- A craft knife; a good screwdriver which will perfectly fit the screws and rods of your flute; a piece of wooden dowel about 3/8ths inch (10-15mm) which will fit inside your flute of about 20 inches (50cm) long; a two foot steel rule (about 60cm); plasticene, playdo or children's modelling clay and epoxy paste. You are better off with a 'Vernier guage' too; this will measure accurately the diameters of the tone holes. Mark up the dowel with the **Revised Scale 2012** using the rule and a craft knife to make sharp, thin lines across the dowel (see diagram 1 below). It is not easy to do this accurately by eye, but always look directly down on the rule to estimate the fractions of millimetres, and with care, you will get to within 0.2 or 0.3 of a mm, which will be enough to do a rough but reasonable retuning job. Carefully mark the dowel crossways so as to make these marks easily seen inside the flute. When the mechanism is removed and the dowel is put into the flute, you will see which tone holes are too sharp or too flat. Although the flat ones can't be moved without major rebuilding, the sharp holes can be temporarily made flat with playdo or kid's modelling clay just to establish if this procedure has improved the intonation. (see diagram below). In effect, what you are doing is making all the sharper notes flatter to match the others. Later, if after playing on it for a few days this retuning experiment makes a difference to you, the flute can be more permanently tuned with epoxy resin paste to replace the playdo. The interior of each tone hole will need cleaning with spirit and lightly scratched to assist in the adhesion of the paste. Even then, the amount of resin can be altered later by filing or cutting, as you become more experienced in this technique.

How to use the newly revised 2012 scale

You will need several items to use this. Carving knife (tool knife, utility knife), screwdriver suitable for your flute,
A wooden rod of about 3/8 inch (10-15 mm) that fits inside the flute of about 20 inches (50 cm) (dowel = dowel rod, just round
I think you can think of a stick. A wooden stick used to remove the cork), two iron feet ruler (foot rule: one marked with feet and inches ), plasticine
(plasticene = plastincine: synthetic material such as clay for children's work), playdo (play-doh: one

of plasticine's products), children's work
Clay, epoxy paste, etc. are required. Also, a vernier gauge:
길이 재는 디지털 길이 측정기)가 있으면 더 좋습니다. 이것은 톤홀의 직경을 아주 정확하게 측정해 줄 것입니다.

이제 아래 그림 1처럼 나무 봉막대(wooden dowel)위에 자와 다용도칼을 이용하여 예리하고 가는 선을 개정된 2012년도 scale을
표시합니다. 그냥 눈으로 보면서 이것을 정확히 하는 것이 쉬운 일은 아닙니다. 밀리미터의 몇분의 1을 측정하기 위해 항상 줄자 바로
아래를 정확히 보아야 합니다. 주의를 기우리면 0.2 내지 0.3mm의 오차범위내에서 이 작업을 해 낼 수 있습니다. 이것이 아주 정밀한
것은 아니지만(개략적인 작업이지만) 보다 좋은 scale을 얻기 위해 scale을 개조하는데 정도로는 충분합니다. 봉막대에 표기한
부분을 십자가 모양으로 표시해서 프루트내부에서 이 표기가 더 잘 보이도록 하십시오.

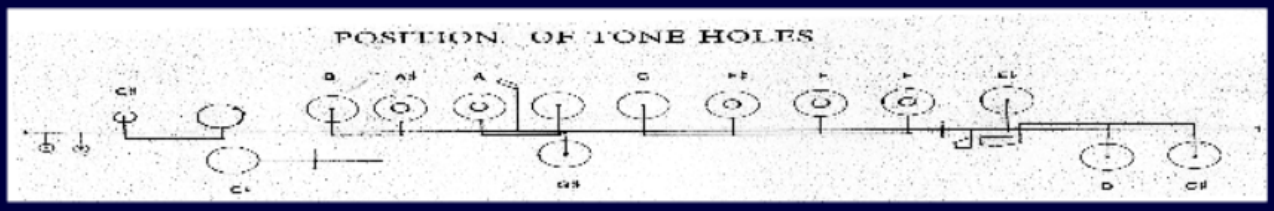
(스크류드라이버 및 다른 공구를 이용해서) 플루트에서 키와 메카니즘을 제거한후, 나무봉막대를 플루트 내부에 넣습니다. 당신은
위에서 했던 점검을 통해 당신의 플루트의 어떤 톤홀이 높은지, 아니면 낮은지를 이미 알고 있을 것입니다. 낮은 음은 이러한 작은
조작(처치)로 해결되지 않고 크게 개조(major rebuiding)해야 좋아질 수 있지만, 이러한 조치가 인토네이션을 개선시키는 지를
확인하는 목적이라면 높은 음의 경우 playdo나 어린이 공작용 점토를 이용해서 일시적으로 낮게 만들 수 있습니다.(아래 도표를
보십시오). 실제로 당신이 하는 것은 더 높음 음들을 낮게 해서 원래부터 맞았던 다른 음들과 음정을 맞추는 것입니다. 이러한 조작
If you blow it for a few days after (action) and you notice a difference (if you think it's better), you can remove the playdo or craft clay and
You will be able to permanently scale your flutes using epoxy adhesive. The inside of the tone hole prevents adhesive sticking
It must be cleaned neatly while lightly scraping the inside so as not to damage it.(Remove any sticky foreign matter inside the tube or tonehole tube.
Must be removed and smoothed). Even if it has been renovated like this, if you become more proficient in these operations (measures) later,
You may be able to adjust the amount of resin (synthetic resin, epoxy paste as talking about) by adding more filling or cutting it.

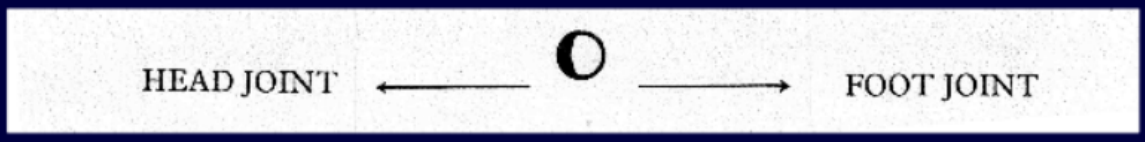
The other way is simply to flatten the notes which need altering according to your written notes first with playdo. Then play the flute for a few days and then recheck using harmonics once again. Using either playdo or more permanent epoxy putty will not damage your flute in any way.

If the scale is very defective though, it is better to change the flute.

Note that if you are used to a faulty scale, you can still play it reasonably well in tune in slow pieces with clever use of the embouchure and, like most people, you can also get used to the out-of-tuneness, perhaps even thinking it is other players who are wrong. It is extraordinary how many of our commercial CDs – by celebrated performers – have poor intonation and how common it is to hear a sharp C#2 & C#3, a flat D3 and sharp Eb3 and E3. The performer becomes used to hearing it like that.

The diagram below may help in understanding the geography of the tuning procedure and the lower diagram shows where the putty should be inserted




Another way is to simply use the playdo to lower the notes that need to be changed in the above check. And then for a few days

After demonstrating the modified flute, check it again using the harmonic sound as in the above check. playdo or other epoxy

If you use an adhesive putty, etc., your flute will not be damaged at all.

If there are too many problems with the scale (large), it is better to just buy a new flute rather than do this manipulation (measure).

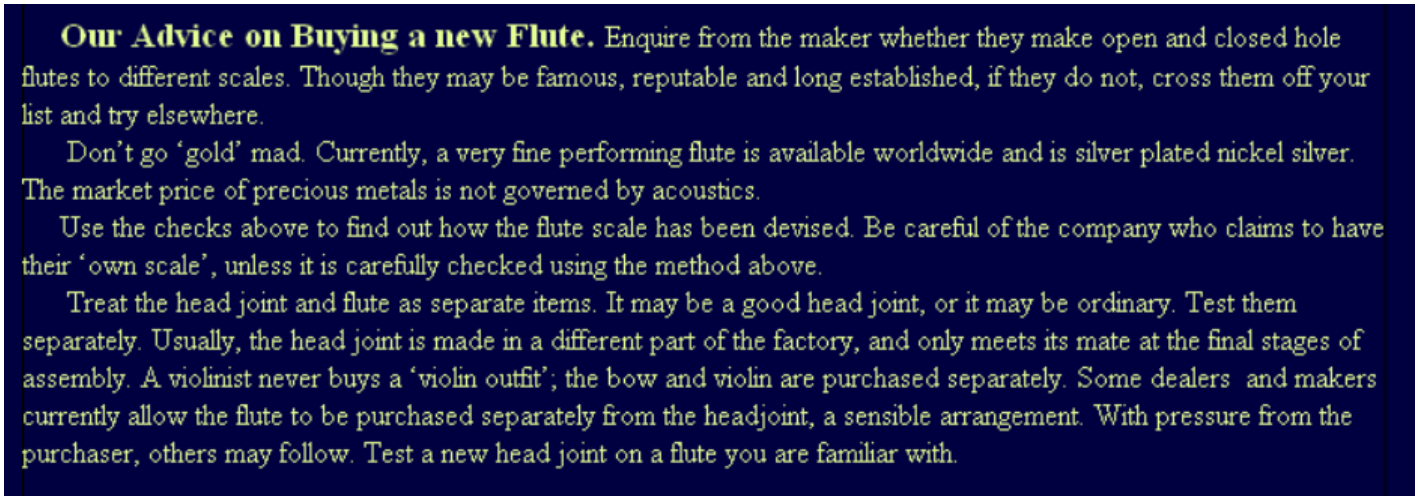
If you use a flute of the wrong scale, you may be able to adjust your ambush well so that when you play slow tunes, you can play the notes right.

There will be, but this way you will get used to the wrong pitch, like most players, and even the other players will play it properly.

Keep in mind that you may think you are playing something wrong. Even in numerous recordings performed by renowned performers

How many plays with poor intonation, C#2 played higher, C#3 played higher, and D3 played lower on these records,

And it's amazing how common you can hear the higher Eb3 and E3 notes.




Tips for buying a new flute

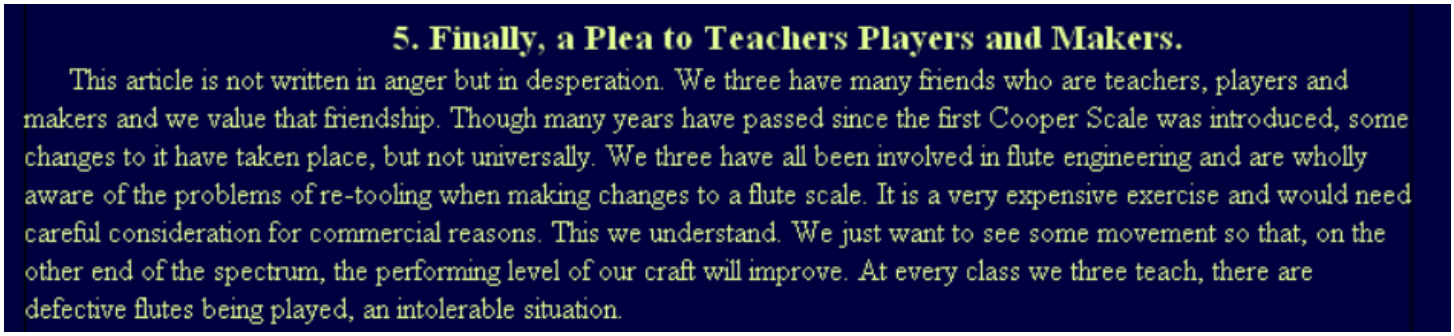
Ask the flute manufacturer to see if the manufacturer makes an open key flute and a closed key flute at different scales.
Please contact us. Even if the production company is famous, has a good reputation, and was founded long ago, the production company
If you're not making it, it's a good idea to set aside (don't take into account) the flute from that manufacturer and find out about the flute from another manufacturer.

Don't go crazy for gold (don't cling to expensive instruments). Recently, there is one of the best performing flutes in the world. Nickel Silver
It is a flute. The market price of flutes made of expensive metal is not acoustically determined. (It sounds better because it's expensive
Not)

To check how the flute's scale was created (if it was made), check the check method written above. These checks
Be careful in the case of a manufacturer's flute claiming to be made on their own scale, unless it has been verified by the method.

Consider headjoint and flute as different instruments. There might be a good head joint, just a normal head joint
There is. You should test the flute and head joint separately. In general, head joints are used in flute workshops.
It is made by the department that makes flute body foot joints and other departments. They are

made separately so they only join each other at the end.
Violinists never buy a set of violins and bows. Bows and violins are purchased separately. With any store
The manufacturer recently made it possible to purchase flutes and head joints separately, but I think it's a very sensible behavior.
Ask those who want to buy to do this, so other manufacturers and retailers will follow this method of sale. Flute familiar to you
Put a new head joint on (Body) and test it.




5. Appeal to the teachers and flute makers who teach students.

This article was written not because of anger, but because of desperate need. The three of us are teachers, performers and producers.
I have friends. And we take our relationship with them very seriously. Many years have passed since the first Cooper scale was introduced, but a little
There was only a change in the world, but it was not known worldwide. The three of us are all involved in making flutes.
We are well aware of the problem of having to re-equip (change) all production equipment when changing the scale during production. This is very
As it is expensive, it will be a big concern for economic reasons. We fully understand this. We are just on the scal
At the end of this debate about the flute, we look forward to seeing some movements that can further improve the production level of making flutes.
The three of us are faced with an unbearable situation where each lesson has to be heard playing on a flute with a problem.

**Teachers**: please teach young players how to control the pitch of a note to play correctly in tune. If you don't know, find out. This will lead to greater expression, more interesting concerts and will bring us in line with the rest of the woodwind and strings. You owe it to your students. In later life, let them look back at you as an enlightened teacher who gave them a head start in a competitive world. It is to your shame if you do not.

**Players**: Please check your flutes. The checking process requires patience. When in doubt, seek advice. Ask your flute maker about open and closed hole scales – if they know! You are the ones who can change the current state of flute making by demanding a better instrument. Read behind the wording in their brochures with their claims. Demand answers - whether in platinum, gold or nickel silver! You are the customer.

**Makers**: Please check out our **Revised Scale 2012**. It may not be completely perfect yet but it is better than the flute scales you are using. All guitar makers use the same fret positions because it is logical, and they wouldn't sell any if they didn't, so why not flute makers? Please use closed hole and open hole corrections; it makes life easier for us teachers and players.

We three believe that *there is a desperate need to have someone in your workshop who is a fine player, has an open mind, and possessed of very good ears and who is enthusiastic about engineering*. Such players are out there. You listen too much to performers whose intonation skills may not always match their fame.

To teachers

Teach young players how to adjust the pitch of notes to play the notes correctly. You do this way
If you don't know, find out and learn. This enables better expression, more interesting performance, and the rest of the woodwind and string instruments
We will be able to raise the level of our flute to the level. This is what your students should do. At the end of the year, the students
You will look back as a smart teacher who has helped you get started with a better advantage in a competitive society. If you do this
If you can't, it will be a shame.

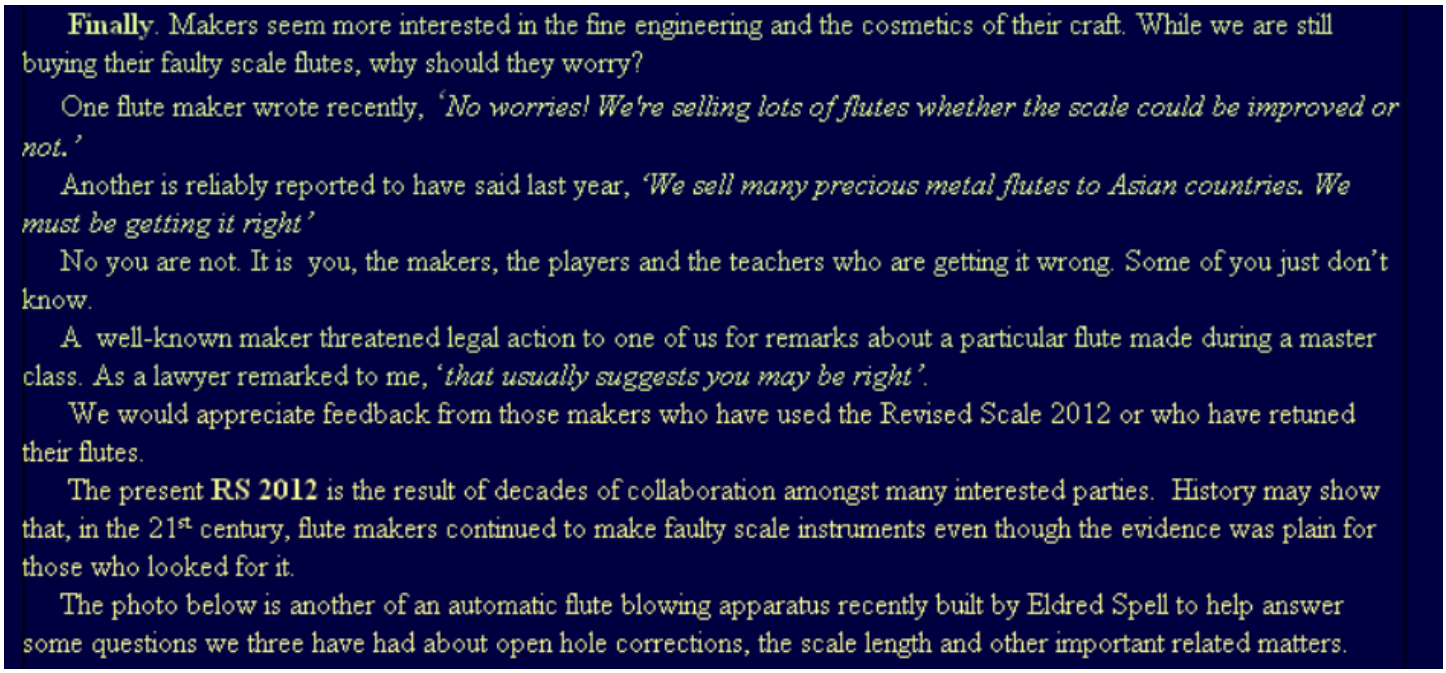
To the performers

Check your flute. The process of checking takes patience. If you're worried about doing well, get advice. Your flute
If you know the scales of open key flute and closed flute from the manufacturer, please ask about these scales. You have a better flute
He is the one who can change the current misplaced situation of the flute maker by asking him to make it. In their advertisements that the manufacturers claim
Read the truth behind the written phrase (check), and ask the question whether the instrument you purchased was platinum, gold or nickel silver.
do it. You are the customer.

To the makers

Check out our new revised 2012 scale. This may not be completely perfect yet, but you
It will be better than the scale you are using. All other manufacturers use the same fret position.
Because the pratt
Because the location is the most logical. They won't sell guitars that don't use the most logical pratwitches. Then why
Can't we do this for a flute maker? Use a scale suitable for closed key flute and open key flute. This is with the teachers
It will make the life of the performers more comfortable.

The three of us are great performers, passionate, good-eared, and open minded musicians.
I absolutely hope that the performers will be with your production workshop. Usually such performers are not with the production workshop. You
Too much advice from players with bad intonations that don't match their reputation.



**Finally**. Makers seem more interested in the fine engineering and the cosmetics of their craft. While we are still buying their faulty scale flutes, why should they worry?

One flute maker wrote recently, *'No worries! We're selling lots of flutes whether the scale could be improved or not.'*

Another is reliably reported to have said last year, *'We sell many precious metal flutes to Asian countries. We must be getting it right'*

No you are not. It is you, the makers, the players and the teachers who are getting it wrong. Some of you just don't know.

A well-known maker threatened legal action to one of us for remarks about a particular flute made during a master class. As a lawyer remarked to me, *'that usually suggests you may be right'*.

We would appreciate feedback from those makers who have used the Revised Scale 2012 or who have retuned their flutes.

The present **RS 2012** is the result of decades of collaboration amongst many interested parties. History may show that, in the 21st century, flute makers continued to make faulty scale instruments even though the evidence was plain for those who looked for it.

The photo below is another of an automatic flute blowing apparatus recently built by Eldred Spell to help answer some questions we three have had about open hole corrections, the scale length and other important related matters.

Finally

Manufacturers seem to be more interested in elaborate crafting techniques and flute appearance. If you are on the wrong scale flute
Why would they worry about scale if they keep buying and writing without pointing out about it?

Recently, some creators said: "I don't worry. Whether the scale is improved or not, we still have a lot of flutes
Sells well"

Another flute maker actually said this last year. “We have many very expensive metal flutes in Asian countries.
Sold to performers. It is certain that we are going right (and doing it right)"

no. You are not doing it right. You, the producer, the performer, and the teacher who are not doing it right
All.

A well-known flute maker told one of us that it would sue for a reference to a specific flute spoken in the masterclass.
I threatened. The lawyer gave me the following opinion: "It's usually the case that the producers do this
Means that"

We would highly appreciate manufacturers using the revised 2012 scale, or modifying their flutes.

The current revised 2012 scale is the result of the cooperation of many research groups that have studied with interest. about the scale
The evidence is so obvious to those who have recognized it, but even in the 21st century, flute makers still produce flutes of the wrong scale.
You may still see it in history.

Pictured below is an automatic fluting device that Eldred Spell recently created to help answer questions three of us had about the open key flute's scale position, scale lengh, and other related important issues.

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# scale data

Now it's time to open minded and see the material available to all flutists and creators. I'm going to look at the two materials.

One is http://www.trevorwye.com/cooper4%20figures.html which corresponds to the 4th post of the

post above , mainly talking about this post,
The other is the article eldredspellflutes.com/scales/index.htm, which was mentioned at the beginning of this cafe article .

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First of all, I would like to talk about the article at eldredspellflutes.com/scales/index.htm . Another advantage of this article is
In addition to the revised 2012 scale, there are several versions of the Cooper scale, as well as the scales of WIBB, Louis Lot, and Powell.
It is a very good data to compare the difference between the old and new scales.

eldredspellflutes.com/scales/index.htm

Below is the scale for 2012 and 2011 made by WIBB, Wye, and Spell.

Before viewing the contents of the revised 2012 scale, first, a post about the revised 2012 scale linked below

http://eldredspellflutes.com/scales/PDF/February-2012.pdf Let 'sfirst readEldred Spell's words at the beginning of the article.

Do it. What is the main purpose of this revised 2012 scale, and what difference is there with the 2011 scale version?

You can tell if it is.

About this revision:
“The scale” was and remains a work in progress. At issue here is the open-hole correction – the amount a tonehole must
be moved down the flute to compensate for the sharpening effect of perforating the key. Albert Cooper initially used 1mm
and WIBB slightly more - 1.2mm.

Both figures were intelligent guesses. “Automatic Trevor 4.1” was in a primitive state as the previous version (March 2011)
was being finalized, but yielded numbers around 1.25, which were incorporated. At present, Trevor 5.3 is yielding better
numbers – and a typographical error was discovered in the correction for E-natural! The new data suggests an average
correction of 1.3mm, with slightly less for F# (1.2mm) and more for A (1.5mm).

The change for A is significant. We have long had issues with G and B appearing to be flat, but the

culprit may be, in part,
a sharp A. Lowering this slightly should help bring all these notes into better alignment --and slightly improve the always
sharp high E-natural.

About this revised 2012 scale

The scale problem is still going on. The point of this revised 2012 scale is the calibration of the scale for the open key flute.
In conclusion, since the key cup as an open key has the effect of increasing the sound, the location of the tone hole is
It should go down below the tone hole position of the closed key flute. Alber Cooper was initially 1mm, WIBB (Bennett) was initially
I moved it about 1.2mm .

Both corrections were a good idea. The Automatic used in the experiment when the previous scale version released in March 2011 was finally released.
The Trevor 4.1, although it was an early model (a less complete machine), has a correction value around 1,25. And this figure is formally
It was added to the 2011 scale. Currently, the Trevor 5.3 model is used to figure out a better number, and it is also used to correct E-natural notes.
A typographical error has been detected. In the new data, the correction value of 1.3mm for most toneholes, 1.2mm for F# toneholes, and A toneholes
A 1.5mm correction was presented.

There is a huge change in the A sound. We were very interested in the problem of low G and B notes, but the main cause of the problem was
Partly because of the high A sound. By slightly lowering the A note, the other notes were more evenly matched,
It brought the effect of slightly improving the high-frequency E-natural sound.

## The Scale (WIBB, Wye, Spell)

2012 http://eldredspellflutes.com/scales/PDF/February-2012.pdf

2011 http://eldredspellflutes.com/scales/PDF/March_2011.pdf

**Earlier versions**

**Cooper**

1980 http://eldredspellflutes.com/scales/PDF/Cooper-1980.pdf

1978 http://eldredspellflutes.com/scales/PDF/Cooper-1978.pdf

Early “orchestral” version http://eldredspellflutes.com/scales/PDF/Cooper-early_orchestral_vrersion_for_Kate_Lukas.pdf

**WIBB**

1997 http : //eldredspellflutes.com/scales/PDF/WIBB-1997.pdf

1993 http://eldredspellflutes.com/scales/PDF/WIBB-1993.pdf

1987 http://eldredspellflutes.com/scales/PDF/WIBB-1987.pdf

1984 http://eldredspellflutes.com/scales/PDF/WIBB-1984_Comparison_with_finished_Almeida.pdf

1982 http://eldredspellflutes.com/scales/PDF/WIBB-1982.pdf

1978 http://eldredspellflutes.com/scales/PDF/Cooper-1978.pdf

## “Classic scales”

Lot #814 http://eldredspellflutes.com/scales/PDF/Lot-814.pdf

Powell #1745 http://eldredspellflutes.com/scales/PDF/GG_Powell_1745=442.pdf

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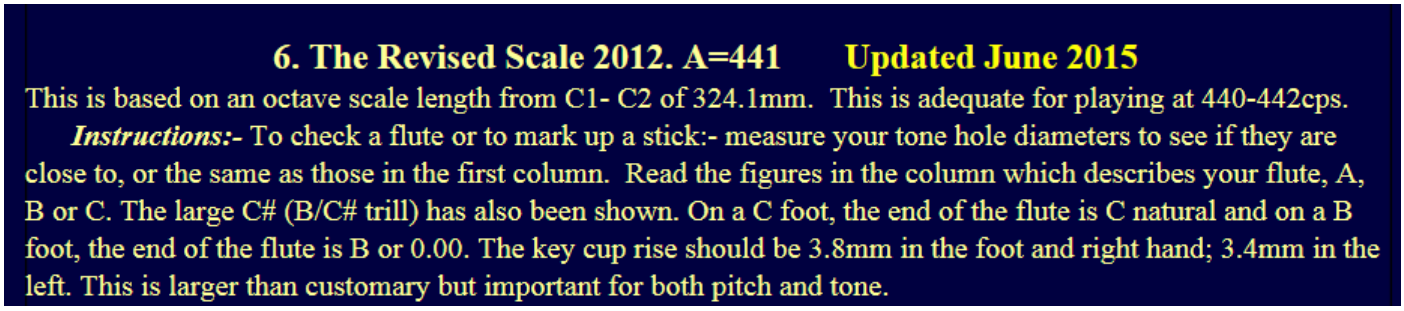
Now it's time to look at the long-awaited "revised 2012 scale".

In fact, there is only one thing that is right in the world.

It's the same story as all other makers use only one fret position.

http://www.trevorwye.com/cooper4%20figures.html




6. The revised 2012 scale. A=441. Updated June 2015

This is based on an octave scale lengh of 324.1mm length from C1 to C2. This is when playing 440-442 Hz (cps = Hz)
Suitable.

Notice

Check and mark the flute: In the first vertical line of the revised 2012 scale text (the contents of the vertical line under the tonehole diameter)
Measure the tone hole diameter of your flute to see if it is equal to or close to the one. And the revised 2012 scale text
Read the number A, B, or C for your flute. C# large trill(B/C# trill() is also shown in the article.
It starts with footjoint). So, in foot C, the end of the flute is usually natural C (Low C), and in foot B, the end of the flute is B or
Displayed as 0.00. The gap between the key cup and the tone hole is 3.8mm from the foot joint and the right hand side. It should be 3.4mm on the left hand side. this is
It is larger than the customary specification, but it is important for both pitch and note.

Since the calculation of this scale, we have corrected some notes slightly after performing trials. These notes are now incorporated into the figures set out below. A recent correction to Csharp2 is shown in red.

After arranging the revised 2012 scale, several notes were recalibrated through an experiment (verification demonstration). These things now
It has been added, and has recently been revised for C#2 and is marked in red. (C# normal red: This tone hole
should be deeper than others by 0.5mm http://eldredspellflutes.com/scales/PDF/February-2012.pdf )

***The Figures***

| | *Tone hole Diameter* | **A** C Foot (Closed hole) | **B** C Foot Open hole) | **C** Low B foot (Open hole) |
|---|---|---|---|---|
| **Low B** | ***15.6*** | --- | --- | 0.00 |
| **Low C** | | 0.00 | 0.00 | 45.5 |
| **C#** | | 43.35 | 43.35 | 81.85 |
| **D** | | 77.7 | 77.7 | 116.2 |
| **Eb** | | 110.1 | 110.1 | 148.6 |
| **E** | ***14.2*** | 141.8 | 140.1 | 178.6 |
| **F** | | 169.3 | 168.05 | 206.55 |
| **F#** | | 197.7 | 196.45 | 234.95 |
| **G** | | 224.3 | 224.3 | 262.8 |

| | | | | |
|---|---|---|---|---|
| **G#** | ***13.5*** | 248.2 (if **12.8** then 248.65) | 248.2 (if **12.8,** then 248.65) | 286.7 (If **12.8**: 287.15) |
| **A** | | 270.6 | 269. 45 | 307.95 |
| **Bb** | | 293.15 | 292.15 | 330.75 |
| **B** | | 314.0 | 314.0 | 352.5 |
| **C** | | 333.15 (if 12.8, then 333.55) | 333.15 (if 12.8, then 333.6) | 371.65 (if 12.8, then 372.05) |

Please note: After a good deal of testing, we are now of the opinion that C2 would be better if placed 0.3mm flatter than shown above. June 2015.

| | | | | |
|---|---|---|---|---|
| **C# large trill** | | 352.4 (if **12.8** then 352.85) | 352.4 (if **12.8,** then 352.85) | 390.9 (**12.8**: 391.35) |
| **C#** normal | ***6.7*** | 364.3 | 364.3 | 402.8 |

(This hole position has been revised (sharpened by 0.5mm) after a lot of testing and experiments, to address the slightly flat octave. The new figures are in red. The tone hole should also be undercut all round, but the diameter of the top of the hole should remain at 6.7mm)
(This tone hole should be deeper than the others by 0.5mm and the key opened to 3.5mm above the tone hole) This is important.

| | | | | |
|---|---|---|---|---|
| **D (trill)** | ***7.5*** | 382.8 | 382.8 | 421.3 |
| **D#** | | 398.7 | 398.7 | 437.2 |

The 'End Correction' (the distance from the end of the flute to the centre of the low C# hole): 7mm. This figure has already been added to the final figures.
The open hole corrections (Eldred Spell, March 2011) E: 1.7; F: 1.25; F#: 1.25; A: 1.12; A#: 1.1.

Last calibration (distance between end of flute and center of low C# tonehole): 7mm. This number has already been added.

Scale correction for open key holes (Eldred Spell, Mark 2011) E: 1.7; F: 1.25; F#: 1.25; A: 1.12; A#: 1.1

**To check your flute against the figures above:** Use large size Vernier calipers and sharpen, by filing, the fixed inside edge so as to make a sharp edge for an accurate reading against the inside face of each tone hole. Measure the diameter of each tone hole north to south and east to west (this is to check if they are identical). If the tone hole diameters differ from those given above, a correction should be made, though most flutes will correspond. (A tiny difference is not important). Now measure each tone hole from the end of the foot to the inside (south) edge of each hole. Add the radius (half the diameter) to this figure. This gives the distance from the end of the foot to the centre of each hole. Compare with the figures above.

***William Bennett, Eldred Spell and Trevor Wye . January 2014***

To check your flute against the number written above (data)

Use a large-sized vernier caliper (vernier measuring instrument), sharpen the inner blade of the caliper with a file and make it sharp (pointed?)
When measuring the inner diameter of the tone hole, make sure that the value is accurately read.
The diameter of each tone hole is two times in the north-south direction and in the east-west direction.
Measure. This is how you check if the flute's tone hole diameter and the above figure are the same.
If the diameter of the tonhole is written above
If it is different from the numbers, it will require correction. However, most flutes will fit. Minor differences don't mean much. Foot
Measure the distance from the end to the inner (south) boundary of each tonehole. Add to this number the radius (half of the diameter) of the tonehole you measured earlier.
This is the distance from the end of the foot to the center of each tonehole. Then the measured figures and the revised 2012 scale text appear
Compare the figures you have

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In the last article, I will write about retuning. It would be nice if the flute you have is the right scale, but it might not
I think there will be.

If you read the above, you will find the patching method and the swaging method. In trevor wye writing, using clay or epoxy adhesive
How to calibrate comes out, but I'm going to find out how to retuning.

I want to see two articles.

http://www.justin-young.net/wiki/var/upload/anon_moving_flute_tone_holes.pdf MOVING FLUTE TONE HOLES

http://www.garylewisflutes.com/index.php?main_page=index&cPath=4 Flute Retuning

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Below, I brought it as it seemed to explain the traditional methods of moving toneholes, the swaging and patching techniques.

If you go to the site linked below, there are many articles related to the repair and production of all wind instruments. If you look at it when you have time
It seems to help a lot. http://www.justin-young.net

http://www.justin-young.net/wiki/var/upload/anon_moving_flute_tone_holes.pdf MOVING FLUTE TONE HOLES

# MOVING FLUTE TONE HOLES

How to move the position of the flute tonehole.

It is important to stress that this is not a job to be undertaken lightly. While holes can be re-positioned it is expensive and all
the possible tuning side effects of moving the hole should be considered before starting. Depending on the method used the
re-positioning will be visibly detectable and could possibly reduce the value of the flute.

It should be emphasized that this is not something to be done lightly. When the tone hole is repositioned and is about to be moved, this is very
It is costly and other tonal side effects caused by relocating the tonehole must be fully considered before starting work.
Depending on the method you use, the displaced trace may be noticeable and the flute may be less valuable.

None of the various methods used are cheap enough to be used on low quality flutes unless the owner is sentimental about
the instrument and has loads of brass to indulge their whims.

None of the methods are low enough to be used for poor quality flutes. If the owner of the instrument is emotional
(Feelings) I don't know if you have enough wind instruments to make a whim on an instrument at any time.

The method used to move the hole on a flute is decided by two factors.

1) The distance hole is to be moved
2) The thickness of flute body

The way to move the tone hole is largely determined by two factors.

1) Distance to which the tonehole should move
2) The thickness of the flute body tube

Older flutes tend to have soldered on tone holes and thicker bodies than modern instruments. Modern expensive semi-mass
-produced instruments could have either soldered or drawn tone holes on a thin or extra thin wall depending on player's
preference.

Older flutes are usually welded with toneholes and tend to have a thicker body (tube) compared to modern instruments. Modern expensive
Semi-hand made instruments have soldered tone and drawn tonehole, but the body tube is thin, depending on the taste of the player.
It is often made thin.

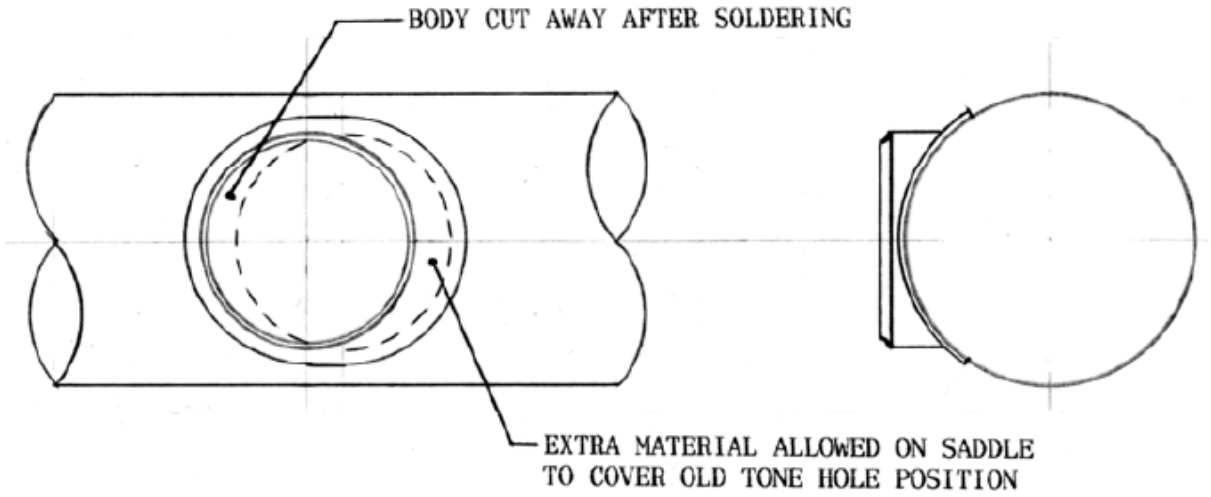
For moving holes a small distance (0-1.5mm) on thick wall flutes with soldered tone holes the hole can be move without
leaving any visible sign.

In a flute with a thick tube wall with soldered tonehole, if the tonehole is moved as small as 0-1.5mm, the tonehole is external
It may be transferred without any signs of modification.

The strap is removed first. This is usually only soft soldered on. Next the tone hole is unsoldered, these are usually hard
soldered on and the area around the tone hole is annealed at the same time.
With a good fitting mandrel down the bore of the flute it is possible with a large burnisher to stretch the metal around the hole
in the direction the hole is going to be moved.

First, remove the strap (not the mechanism rib??? strap, not the strip???). It is usually soldered together.
Next, the tone hole is removed again by soldering. It is usually brazed and heat-treated around the

tone hole (
It has been heated and then cooled).




Insert a mandrel that fits well inside the flute tube (hole) (a mandrel that fits into the hole (tube) when processing a work (tube) with a hole in the center).
When inserted, it is possible to increase the tube metal around the tone hole with a large burnisher (polishing machine????) in the direction the tone hole should move.
Wouldn't the thickness become thinner???) (This technique is actually called the swaging technique)

Depending on the material of the body and the distance the hole is to move, a second annealing may be necessary, followed
by further burnishing. The hole should now appear off round due to the extra material from thinning the wall.

Depending on the material of the body tube and the distance the tone hole needs to move, a second heat treatment process may be required after further burnishing (polishing) work.
There is. The tone hole is not round because of the additional (pushed) metal material by thinning the tube wall.

The new tone hole is turned and filed to fit the curve of the body. It should be positioned in its new place and hard soldered.
After soldering any excess body can be trimmed from inside the new tone hole. The strap should be re-soldered. The
keywork will also need modifying to suit the re-positioned tone hole. Depending on which hole is involved this part could be

more complicated than moving the hole.

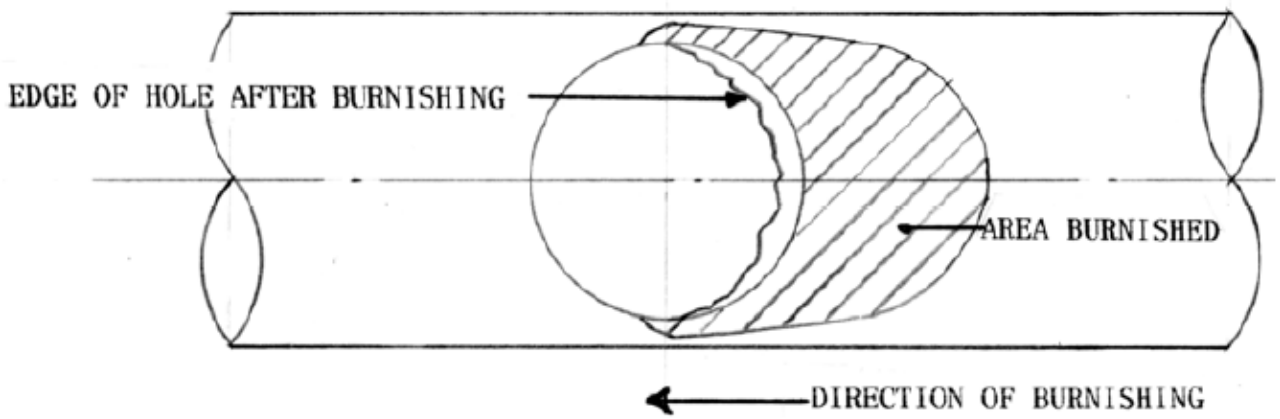
The new tonehole is fixed in its new position and must be filed to fit the curved surface of the body.
New tonehole in a new location
It must be located and brazed and attached. After attaching the tone hole by brazing, the extra metal materials that protrude inside the new tone hole
It needs to be trimmed. The strap (mechanism rib? strip???) must be re-attached through soldering.
Key operation is performed according to the newly attached tone hole
You need to re-adjust your seat. Depending on which part of the tone hole is moved, keying can be more complicated than moving the tone hole.

This method of stretching the body to moves holes was first attributed to Albert Cooper. This technique has been used to
re-scale complete flutes made in different pitches. Quite a few fine Louis Lot flutes have been butchered in an attempt to
convert to modern pitch.

This way to stretch the tube on the body to move the tonehole was developed by Albert Cooper. (I think this is a swaging technique). this
Technology has been used to convert flutes made with different pitches into flutes of completely different scales. Quite a few great Louis
Lot flutes were broken in the process of converting them to modern pitches (A=440, 442, 444).

Holes on flutes with thin walls or a where moving a large distance requires different technique. The walls are usually not
thick enough to gain the extra material required for the new tone hole position by burnishing. The existing tone hole is filed
away to leave a hole in the body. A new tone hole is turned and silver soldered to a curved saddle. The saddle must be
large enough to cover the old hole and provide a 1-2mm solder area around the new tone hole. The saddle is soft soldered in
new position and any part of the body projecting into the new hole is cut away. It is possible to move tone holes with this
technique without unsoldering straps and fittings from the body, but care will have to be taken in order that they are not
detached accidentally. The keywork would also require modifying to suit the new hole position. This method of moving holes
will always be noticeable

A different technique is required for the tone hole of a flute with a thin tube thickness or the tone hole that needs to be moved a long distance. burnishig (to increase by polishing)
By the way, it wasn't thick enough to be stretched further to create a new tonehole location. You can change the existing tone hole with a string
Widens in the direction. So, when a hole for a new tone hole is made, a curved saddle-shaped structure (fit to the curved surface of the body tube)
Glue it through silver soldering. This saddle-shaped structure completely covers the old (original before moving) tonehole, while simultaneously surrounding the new tonehole.
It should be large enough to have a part to be soldered to about 1-2mm (see picture below). The saddle-shaped structure is soldered to the new tonehole location.
If there is any part of the body that needs to be pasted and extends into the new tonehole, it must be cut (trimmed). This method is new to the body
It is possible to move the position of the tone hole without having to remove the strap (rib? Strip?) through soldering to insert the tone hole. But
Care must be taken not to accidentally remove the strap (rib? strip?). The key work is also transformed to match the new tonehole position (new
According to the location). This method of moving the tone hole will always leave a trace after treatment. (This is the patching method used by WIBB
It seems to be a technique)

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I went to our cafe before "3 piece flute No. 2 piece flute Yes!!!" I have written an article. This is the article linked below.

http://cafe.naver.com/withflute/374

It was related to Gary Lewis flute, and there is a retuning related article on this flute related website.
Traditional patching,
Unlike the swaging technique, it is similar to the scale calibration method provided by Trevor Wye.

http://www.garylewisflutes.com/index.php?main_page=index&cPath=4

## Flute Retuning

**Many flutists find themselves attracted to the tone and response of a great vintage flute but are put off by the scale of the instrument.** Fortunately, there is a very easy and economical solution.

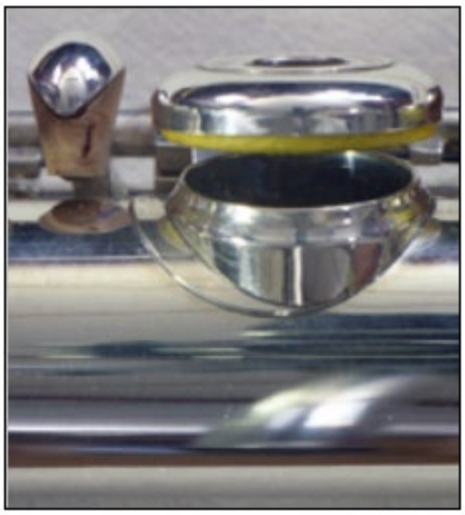
While many flutists are interested in the tone and responsiveness of vintage flutes, these instruments (different from the scales currently used)
The scale eventually loses interest. Fortunately, there is an easy and economical solution to this scale problem.

Louis Lot built flutes at two pitches: high pitch (c. A=446) and low pitch (A=435). Neither is comfortable for performance at
A=440 or 442. Verne Powell built flutes at A=440 with a somewhat longer scale than is common today. The result is a flute
which is not comfortable to play at pitches of A=442 and above. Many players will often have to sacrifice tone quality to play
in tune.

Flute maker Louis Lot made flutes with two pitches A=446 and A=435. These instruments are (mostly used now)
It is very inconvenient to play with A=440 or 442 pitch. Flute maker Verne Powell made a flute with an A=440 pitch.
There are some inconveniences in playing with a pitch of A=442 or higher. So, many flutists try to match the sound quality
There are cases where you have to make a lot of sacrifice (see the damage).

The traditional technique to retuning a flute is to completely unsolder the instrument, move (and in

some cases replace) tone
holes, patch the areas of the tube where holes are shifted significantly, rework the mechanism to match the new hole
positions, shorten the body and/or foot to bring up the foot position, and overhaul the completed flute. This work is very
expensive (c. $5,000) and involves significant and permanent alterations that can actually degrade the resale value of
collectible instruments.



The traditional way to retune the notes of a flute is by tinkering in the flute.
And then remove the pasted tone hole again, relocate the tone hole, and
A new tone hole that fills up the empty space in the tube left by moving a lot
Reattach the key cup and mechanism according to the position, and attach the changed scael.
To adjust the position of the foot joint accordingly, the foot joint or body
Shorten it, and proceed with the process of replacing the entire pad. These actions
Very expensive (about 5000 US dollars) and actually
It reduces the value of the product when reselling. (Of the traditional method
It seems to explain the patching method )

( In the photo on the left, you can see the patch to the left of
the tonehole. Toneholes on this flute were moved towards the
headjoint to increase the pitch. This technique for retuning a
flute is permanent and irreversible. For many collectors of
vintage flutes, this type of work degrades the value of the

flute. )

(If you look at the picture on the left, you can see that the left side of the tone hole was soldered (filled). The tone hole of this flute moved toward the head joint to raise the pitch. Matching the note of the flute in this way is Permanent and irreversible. For those who import vintage instruments, this type of work devalues the product.)

Gary Lewis, however, developed another accurate and effective retuning method that does not permanently alter the
instrument. The result is a flute with an excellent scale that will still be considered an authentic original instrument.

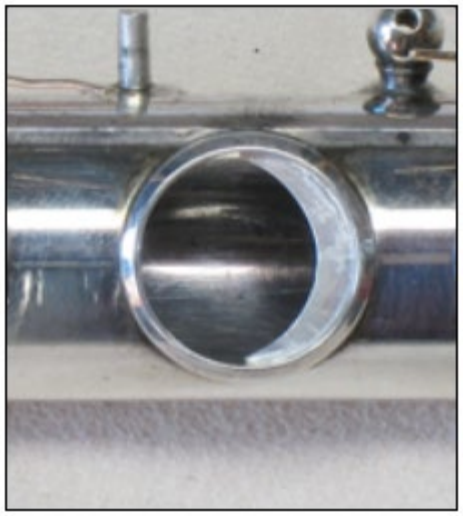
Gary Lewis is not a method of permanently altering (damaging) an instrument, but rather accurate and effective retuning.
Work, scale calibration work) method was developed. As a result, it has a great (newest) scale, while
It turns into a flute that produces a sound (no deterioration in sound quality).

First he calibrates the lowest note of the body (typically low D or Eb) to A=440, A=442 or A=444. This often means pushing
the headjoint in further than normal. At this position, notes in the left hand are very sharp, while the notes in the right hand
and lower registers are closer to the desired pitch. He then measures all aspects of the flute and use computer models to
accurately and reliably calculate the required alterations to bring the entire flute to the desired scale.

Initially, the lowest note among the notes in the body (usually low D or Eb notes) is selected at the desired pitch (A=440, A=442 or A=444).
Fit. This sometimes means pushing the headjoint more inward than it would normally be. With the pitch aligned
If you check, the left-handed notes are very high, while the right-handed and low-pitched notes are close to the desired pitch. Then the
Measure all parts of the flute, and use a computer model to determine how to change the whole flute's notes to the desired scale.
Calculate more accurate and more reliable.

Once the results are determined, Gary prepares silver wedges in the proper sizes and shapes and set them in place with

cyanoacrylate adhesive. These wedges bring down the pitch of the upper notes, shortening the scale and adjusting all
toneholes to agree with the lowest note of the original scale at A=440 (or the desired pitch).



When the calculation results come out, the appropriate size and shape of silver
After making a wedge shape (crescent shape), cyanoacrylate adhesive
( Cyanoacrylate adhesive: strong instantaneous adhesive for medical use, etc.) Attach to the necessary tone hole. Attached wedge
Lower the high notes on the left hand side , and adjust the scale interval (between toneholes).
Reduce the spacing) and make sure that all tonehole notes match the lowest note matched to the desired pitch .

The results are both precise and economical ($950). The
changes are also reversible, which preserves the value of the
vintage flute.

As a result, it is an accurate and economical method (the price is 950
In the US dollar, it is about a fifth of the traditional method.)
You can get it back. Therefore, the original vintage flute
It retains its value.

( In the adjacent photo, you can see the silver we dge that Gary created specifically for this tonehole.Each tonehole has its own custom silver wedge.If the owner decides to bring the flute back to its original pitch, the process is completely reversible. More importantly, the value of the flute is preserved. )

If you look at the picture above, you'll see a silver wedge that Garyr made specifically for this flute.
Each tone hole has a wedge suitable for each tone hole

The shape is attached. If the flute owner wants to return to the original pitch of the vintage flute, it can be restored to the original. More important
The thing is, because there is no damage, the value of the flute is preserved.

Gary has retuned Louis Lot, Rive, and Bonneville instruments to A=440 and vintage Powell flutes to A=442 and A=444 scales,
using non-permanent silver wedges. These instruments have been used professionally by a number of players with
excellent results. Time at the workshop: 2 weeks. Fee: $950 for all models.

Gary set vintage instruments such as Louis Lot, Rive, and Bonneville to the A=440 scale. Vintage powell instruments A=442 and A=444
It has been remodeled using a non-permanent silver wedge to scale. Modified instruments have good results and are still professional
It is used for performance. It takes about two weeks to complete, and any model costs around US$950.

Want to learn more about the retuning process? Read Gary's article,

To learn more about how to do these modifications, see the article linked below.

http://www.garylewisflutes.com/index.php?main_page=page&id=10 How to modify using silver wedge

http://www.garylewisflutes.com/index.php?main_page=page&id=9 How to convert using traditional methods

---

This is the end of this article. I am also happy personally. Too long

In any case, the method described by Trevor Wye without using a professional method (using co-acting clay or epoxy adhesive to make tone holes and scales)
Even if you use the method of making changes), you must first accurately measure the location of the tone hole.

Trevor Wye's article told you to use a wooden dowel with a length of about 50 cm and a diameter of 10-15 mm.
Applicable items are officially sold.

It is sold by JL Smith, which we previously tooled for flue juice. There is an article related to the scale story stick on the JL Smith site.
There is an explanation on how to use this item in the article, but it is a method of measuring the diameter and location of the tone hole.
I saw it.

http://www.jlsmitheurope.eu/wp-content/manuals_w/242053_Flute-Scale-Story-Stick.pdf scale story stick

# JLS Flute Scale Story Stick (#242053)

Subtle differences in the position of keyholes have a great effect on intonation, responsiveness and overall performance of
an instrument. The Flute Scale Story Stick is a simple two-piece tool that allows technicians to accurately locate, measure
and analyze the exact positioning of tone holes along the entire length of the flute body.

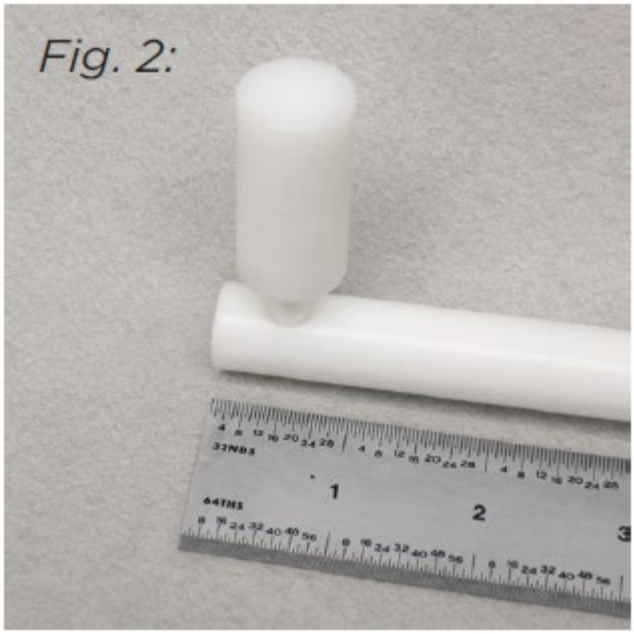
Even the slightest difference in tone hole position has a major impact on intonation, flute responsiveness and overall operation. Flute Scale Story Stick has 2
It is composed of parts and helps to measure and analyze the exact position of the tonehole located along the entire length of the flute body.


**Instructions:**

Notice

The Flute Scale Story Stick consists of two essential parts: the Story Stick Rod and the Tone Hole Center Finder.

Flute Scale Story Stick is divided into two components: Story Stick Rod (a part like a bar) and Tone Hole Center Finder.




1.Detach the Tone Hole Center Finder from the Story Stick Rod. Note that Tone Hole Center Finder is convex and fits into the
concave thread hole located .5 inches from the end of the Story Stick Rod (Fig. 2).

1. Remove (pull out) the Tone Hole Center Finder (hereinafter referred to as the finder) from the Story Stick Rod (hereinafter referred to as the rod). In Figure 2, the finder is convex
It is a (convex protruding) shape that is fixed (inserted) in a concaver thread hole located 0.5 inches from one end of the rod.
Can be checked.


2.Before inserting the Story Stick Rod into the flute body you can align it to the tone hole you intend to measure using your
thumb as a depth guide (Fig 3-4).

2. Before putting the rod into the flute tube, use your thumb to help measure the depth,
You can put them side by side. (Figure 3-4)

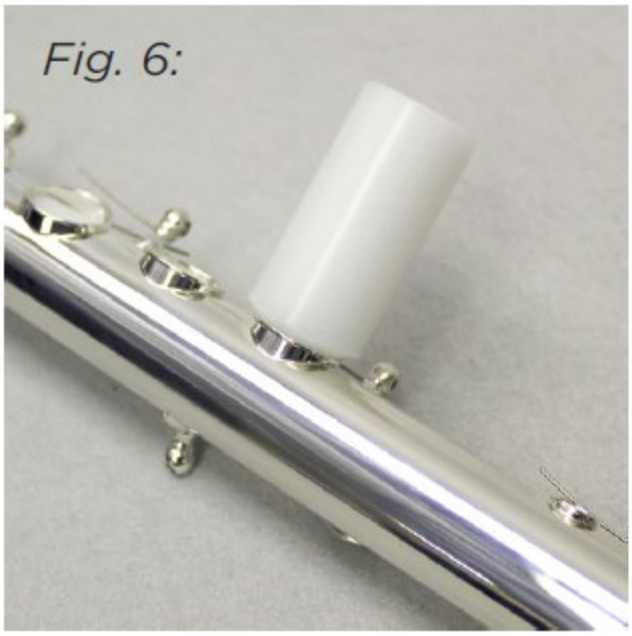


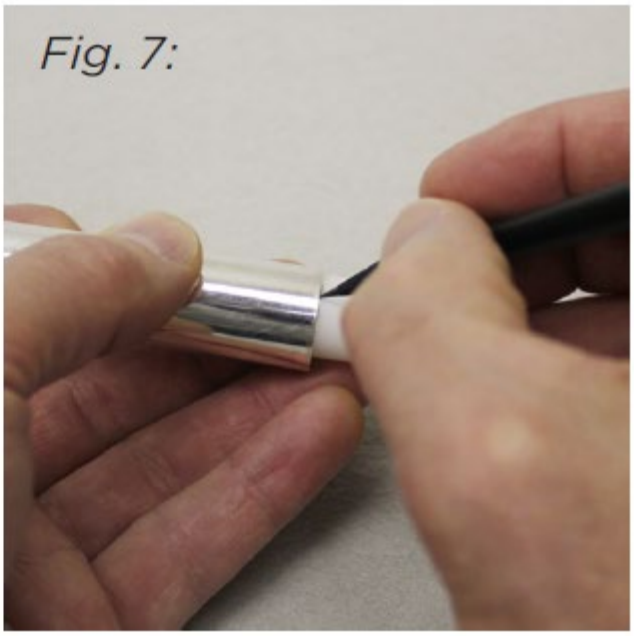
3. Gently insert the Story Stick Rod into the flute body from the footjoint end.

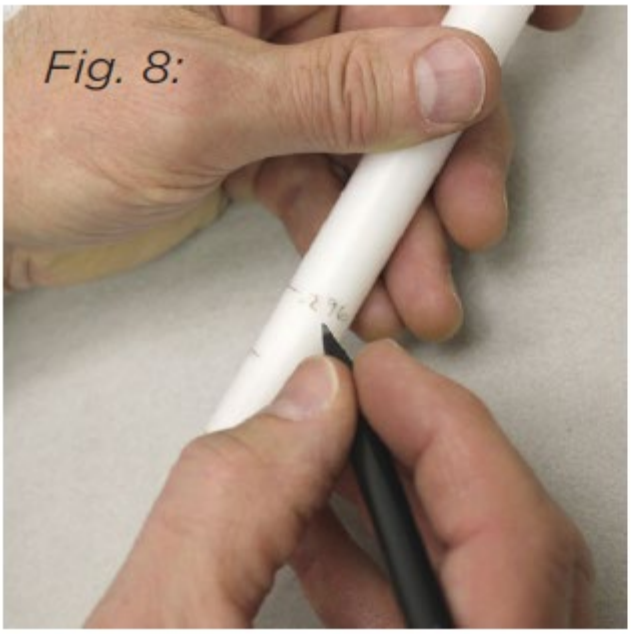
3. Now carefully push the rod into the tube from the end of the flute foot joint toward the body.

4.Match the concave thread hole to the center of the tone hole being measured (Fig. 5).

4. Align the concave thread hole at the end of the rod to the center of the tone hole to be measured as shown in Figure 5.



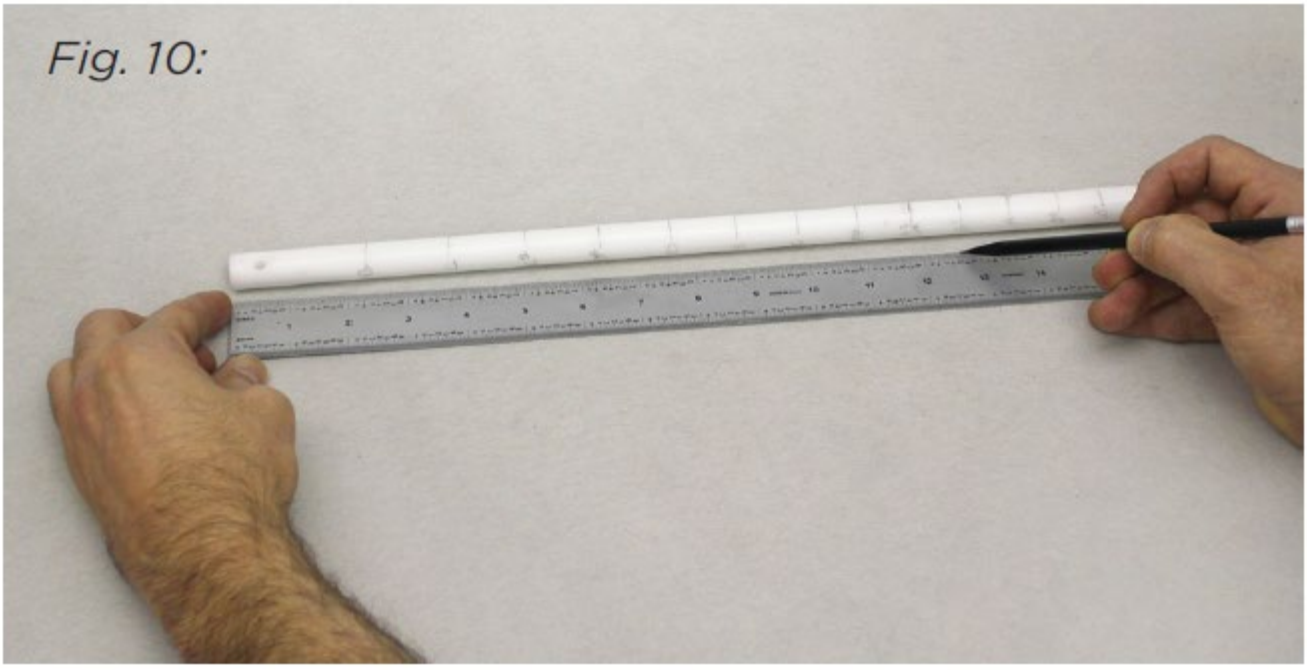


5.Gently thread the Tone Hole Center Finder into the Story Stick Rod until it fits snugly against the tone hole (Fig. 6).
(Do not overtighten.)

5. After that, insert the finder into the concave thread hole of the rod as shown in Figure 6.
Comfortably in the tone hole (comfortable, not too tight???)
Screw in (like a screw) until it is fixed.

6.Use a fine pencil to mark the distance on the Story Stick Rod at the end of the footjoint (Fig. 7-8). You may also want to
record the name of the key and inside diameter of the tone hole on the Story Stick. Use a dial caliper to measure the id of
the tone hole (Fig 9). (Pencil marks are easily cleaned off afterward using a mild citrus-based cleaner.)

6. Mark the distance from the rod to the tip of the foot joint on the rod using a thin pencil as shown in Figure 7-8. You can tell the rod the inner diameter of the tone hole and
You may want to write the name of the key. Then, if you measure the inner diameter of the tone hole using an electronic (digital) caliper as shown in Figure 9,
It's possible. (Pencil marks were later diluted with a citrus cleaner (citrus cleaner, citrus-based cleaner.
It will be erased cleanly)




7.Once tone hole positions are marked, a mechanical ruler can be used to measure the exact distances from the precise
end of the Story Stick and calculated by subtracting .5" (Fig. 10). (.5" represents the distance from

the end of the rod to the
center of the threaded hole.)

7. When all the tone hole locations are marked on the rod, you can measure the exact distance from the end of the rod using a metal ruler as shown in Figure 10.
Since the center of the concaver thread hole, which became the reference point, was located at a distance of 0.5 inches from one end of the rod, 0.5 inches from the measured distance
Should be subtracted.

8.You can measure and record the distances or put them in a spreadsheet file for safekeeping.

8. To completely keep your measurements, record them or save them in a spreadsheet file (a program such as Excel) as shown below.
Put

| | A | B | C |
|---|---|---|---|
| 1 | Flute Scale Analysis: | | |
| 2 | | | |
| 3 | | | *Model Y* |
| 4 | Location | Hole diam. (in) | Location (mm) |
| 5 | trill 1 | 0.295 | 17.23 |
| 6 | trill 2 | 0.295 | 16.64 |
| 7 | LH C | 0.295 | 15.85 |
| 8 | Thumb | 0.532 | 14.67 |
| 9 | Bb | 0.532 | 13.90 |
| 10 | A | 0.532 | 13.01 |
| 11 | G1 | 0.532 | 12.15 |
| 12 | G2 | 0.532 | 11.30 |
| 13 | G# | 0.532 | 11.30 |
| 14 | F# | 0.558 | 10.34 |
| 15 | F | 0.558 | 9.25 |
| 16 | E | 0.558 | 8.21 |
| 17 | D | 0.558 | 7.06 |
| 18 | D# | 0.615 | 5.84 |
| 19 | C# | 0.615 | 4.52 |
| 20 | C | 0.615 | 3.24 |
| 21 | B | 0.615 | 1.80 |
| 22 | | | |

---

Did you think the above was the last one? no.

I want to end with one more comment.

This article is the story of the size and location of the tonehole, and ultimately the scale, and furthermore, it is related to the sound of the flute.

So why do you need acoustics to do fundamental research, what is the content of the acoustics of flute, and
As a basis, you need to know how to determine the size and location of the tone hole.

Cafe members who want this information, I think the three articles linked below will be helpful.

(Because of lack of ability, it is difficult to translate these articles ^^;;;)

http://muse.jhu.edu/journals/lmj/summary/v022/22.dick.html Why flutists should know about acoustics

http://newt.phys.unsw.edu.au/jw/fluteacoustics.html#toneholes flute acoustics

http://www.chrysalis-foundation.org/flute_tone_holes.htm Tonhole Size Location Data Paper Complex Numerical Quantification

---

# references

http://www.flutebuilder.com/2013/02/flute-scales.html Flute Scales

http://www.justflutes.com/blog/scales-an-incomplete-look-at-what-every-flutist-should-know-2/

http://www.trevorwye.com/cooper1.html

http://www.trevorwye.com/cooper2.html

http://www.trevorwye.com/cooper3.html

http://www.larrykrantz.com/wyept2.htm Scroll down to "intonation of the modern flute." You can see it.

https://prezi.com/npex4fz8bkft/the-evolution-of-flute-intonation/ The Evolution of Flute Intonation Summary

http://www.fluteworx.co.za/articles/Flute%20Options.pdf

http://www.trevorwye.com/cooper4%20figures.html

http://www.eldredspellflutes.com/scales/PDF/February-2012.pdf The Scale – February, 2012 (A=441)

http://www.justin-young.net/wiki/var/upload/anon_moving_flute_tone_holes.pdf MOVING FLUTE TONE HOLES

http://www.garylewisflutes.com/index.php?main_page=index&cPath=4 Flute Retuning

http://www.jlsmitheurope.eu/wp-content/manuals_w/242053_Flute-Scale-Story-Stick.pdf scale story stick

http://www.chrysalis-foundation.org/flute_tone_holes.htm Tonhole Size Location Data Paper Complex Numerical Quantification

http://muse.jhu.edu/journals/lmj/summary/v022/22.dick.html Why flutists should know about acoustics

http://newt.phys.unsw.edu.au/jw/fluteacoustics.html#toneholes flute acoustics

## Other references

https://www.fluteland.com/board/viewtopic.php?t=5930 Barrel length and tonehone placement

http://homepages.bw.edu/~phoekje/acoustics/p101L06FluteDesign.pdf To find useable finger hole locations for a flute;
to learn more about the length corrections for tone holes and how to study the scale. Like a regular flute

http://feldmus.com/tools.php Leveling tone holes

http://forum.saxontheweb.net/archive/index.php/t-10654.html Rolled Tone Holes-Are They Better? rolled tone hole

http://www.theburnfieldcastle.com/yahoo_site_admin/assets/docs/The_Physics_of_Flutes.335191129.pdf Flute Design

http://www.markshep.com/flute/Holes.html Where to Put the Holes for a Flute

Placing and Tuning Finger Holes in Flute Making

https://books.google.co.kr/books?hl=en&lr=&id=_uWIcK_Gl-8C&oi=fnd&pg=PR7&dq=Flute+intonation:+A+comparison+of+modern+and+Theobald+Boehm+flutes+scales.&ots=zf9VnV__As&sig=DR1na-hGNT3j9sPEtNs56D76vKo#v=onepage&q=Flute%20intonation%3A%20A%20comparison%20of%20modern%20and%20Theobald%20Boehm%20flutes%20scales.&f=false

https://books.google.co.kr/books?hl=en&lr=&id=kHFxAwAAQBAJ&oi=fnd&pg=PP1&dq=Flute+intonation:+A+comparison+of+modern+and+Theobald+Boehm+flutes+scales.&ots =wRrsozxagS&sig=_H0sgjlmy5_YSutQSxOBeJpocyA#v=onepage&q&f=false

http://www.nfaonline.org/The-Organization/Achievement-Award.aspx?Award=1 Bickford Brannen

VOLUME XXXVII, NO. 3 SPRING 2012

# THE FLUTIST QUARTERLY

## Scales: An Incomplete Look at What Every Flutist Should Know

### Developing an Online Presence

### Michel Debost: Teaching Artistry

### Remembering Jack Wellbaum

THE OFFICIAL MAGAZINE OF THE NATIONAL FLUTE ASSOCIATION, INC

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**THE NATIONAL FLUTE ASSOCIATION**
26951 RUETHER AVENUE, SUITE H
SANTA CLARITA, CA 91351
*FOUNDED NOVEMBER 18, 1972, IN ELKHART, INDIANA*

This magazine is published quarterly by the National Flute Association, Inc., a nonprofit organization. The statements of writers and advertisers are not necessarily those of the National Flute Association, Inc., which reserves the right to refuse to print any advertisement.

ISSN 8756-8667

Holes, the crux of the matter. Top to bottom: Figures 1A, 1B, 1C, and 1D.

# Scales: An Incomplete Look at What Every Flutist Should Know

**What's in a scale? More to the point, what's in "the Cooper scale"? This short primer on scale—and why every flutist needs to understand its importance—includes a heartfelt appeal for the open information-sharing that defined the character of the late Albert Cooper.**

**by Eldred Spell**

The crucial concept of "scale" in the lives of flutists began, more or less, with Theobald Böhm—and, sadly, its technical understanding largely ended with his death in 1881. But throughout much of the 20th century, a gang of mostly British flutist-technicians (along with myself as a token American), searched for ways to improve the tuning (and with it the sound quality) of the modern flute.

Following the death in 2011 of the group's key member, Albert Cooper, the man whose name will be forever linked with the flutemaker's Holy Grail—the Cooper Scale—there has come a renewed interest in explaining, disseminating, and perfecting the details of this approach, so that future flutists can continue the work that Cooper and his friends began.

## In the Beginning

"Scale," for our purposes, means a set of proportions that can be seen in the different placement of frets on a guitar fingerboard and the curve of a rank of organ pipes or piano strings. In equal temperament, these follow a simple mathematical formula. Multiplying by 1.06 (or 1.0594630948 or 12,-2. ) increases the overall length proportionately to eventually reach the octave—exactly.

Stringed instruments are well behaved and follow this rule closely. Sadly, flutes are not well behaved. Because we move our lips, intonation is a moving target.

Before Theobald Böhm, the concept of "scale" was lost on flutists. Figures 1A and 1B in the photo on the preceding page show two one-key flutes pitched at A=427 and 442, with nearly identical hole placement. While flutemakers were not concerned with mathematical abstractions, they were not ignorant. With the finger position decided on, tuning could be dealt with by changing the size of the holes. A larger hole raises the pitch and a smaller hole lowers it. Makers sometimes also undercut the tonehole, making it larger and raising the pitch without changing what you see on the outside. Remember this principle, as there will be a quiz later.

The larger holes of our modern flute absolutely require an accurate "scale." The photo's figure 1C shows a Nicholson model flute, with the usual placement and wildly enlarged finger holes. Figure 1D shows an 1832 Böhm model flute as made by Rudall & Rose. This is Böhm's direct response to the Nicholson instrument. Notice the absolute regularity of tonehole size and placement. Böhm's understanding of "scales" must have been extraordinary, but the knowledge largely died with him. Flutemakers were left to copy existing instruments and make the occasional tweak.

## A New Era

In the United States, we can easily imagine what happened with scales in the early 20th century. As the French style of playing became fashionable, so did French-style flutes—namely those made by Louis Lot. Most of these were intended for *diapason normale*, or A=435. These can be played at A=440 by shortening the headjoint, but this leaves the holes too far apart. If A is in tune, C-sharp will be sharp and the low notes will be flat. This is what the famous flutists played, so customers wanted a copy, and makers did their best to provide. A flutemaker might tweak something here or there, but they would have been crazy to deviate significantly from the "ideal." Players learned to adjust for the errant notes (with mixed success), creating a paradox: a theoretically perfect flute would have been unacceptable, because established players would find the low notes sharp and the C-sharp flat! And this is exactly what happened.

In 1974, Bickford Brannen visited Albert Cooper in London, brought the scale back to Powell Flutes, and so contributed to an historic decision. Powell, at the height of prestige and with no need to innovate, introduced not just a new scale but an entirely new instrument and approach to flutemaking. It is difficult today to appreciate the controversy this created. This pivotal moment in our history deserves a separate article, if not a book. Suffice it to say that we are all deeply indebted to Bick Brannen for taking the first step on this groundbreaking journey.

## Across the Pond

One does wonder why this new scale came from London and not some American corporation or university. The answer seems to be found in our different histories and attitudes. In the US, flutes were (and are) considered art objects.

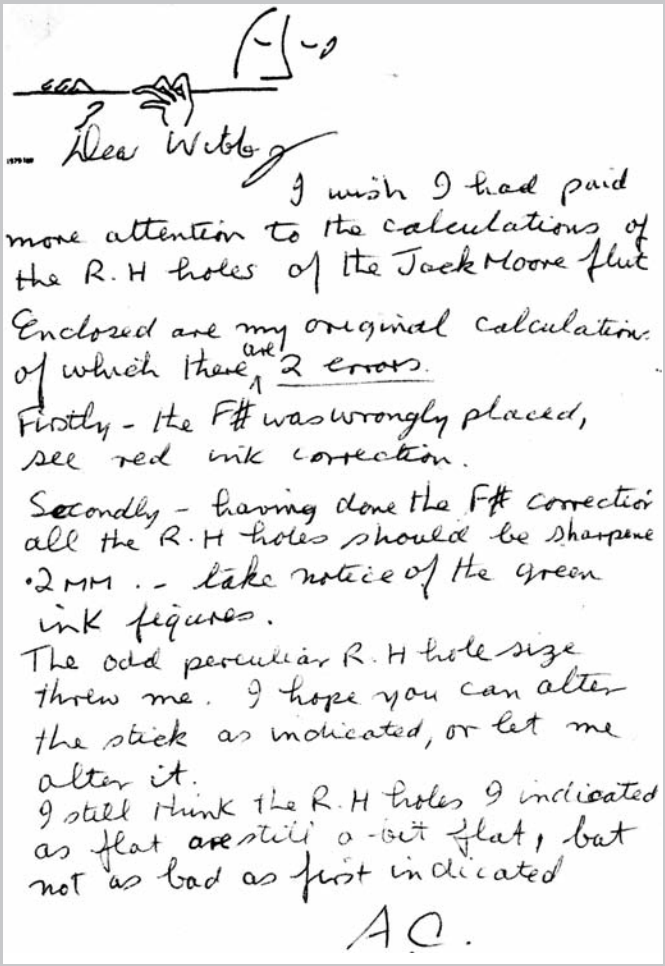
Albert Cooper in the doorway of his shop.

Left: Young Cooper in the Navy. Right: Cooper's favorite tool.

Tampering was strictly forbidden and so experimentation was discouraged. Verne Powell left us with many colorful quotes, one of which nicely sums up the American attitude toward innovation: "I made it, it's right, go play it!"

The situation in England could not have been more different. Like the Powell scale in the U.S., the Rudall & Carte "schema" was presumed perfect. However, Rudall & Carte made quite a few "HP" (high pitch) flutes, and with the establishment of A=440 as the international standard (1939), these became obsolete. R&C could have sold many new flutes but instead transplanted the old mechanism to a new tube at the new pitch. This in itself was not "experimentation"; the concept of repurposing flutes was well established. Further, London flute players are arguably (pun intended) more critical of flutes and flutemakers. Everyone seems to have strong opinions and "agreeing to disagree" is an absolute tradition.

By the 1950s, R&C had gone into decline and then folded. This removed the sort of central authority the U.S. had in Boston and also left a number of highly skilled craftsmen to fend for themselves, most notably Albert Cooper.


Dear Wibb

I wish I had paid more attention to the calculations of the R.H holes of the Jack Moore flut

Enclosed are my original calculations of which there are 2 errors.

Firstly - the F# was wrongly placed, see red ink correction.

Secondly - having done the F# correction all the R.H holes should be sharpened .2 MM - take notice of the green ink figures.

The odd peculiar R.H hole size threw me. I hope you can alter the stick as indicated, or let me alter it.

I still think the R.H holes I indicated as flat are still a-bit flat, but not as bad as first indicated

A C.

A letter to William Bennett from Albert Cooper.

## The Cooper Scale "Brand"

When Powell (and later Brannen Brothers) invested in the Cooper scale, it became a brand—and should have. The companies took risks, and Cooper certainly deserved financial reward and every bit of credit. That said, Albert Cooper did not invent the scale out of whole cloth. What became "the Cooper scale" evolved as a group effort, with input from many different players. What in the United States became an industrial property remained "Cooper's scale" to those who had played a part in its development.

The best known of these is William Bennett (aka WIBB), author of the William Bennett scale. Cooper and WIBB agreed to disagree on some details but were long-time friends who shared information and opinions freely. It was WIBB who first said, "If the hole is in the wrong place, move it!"

And he did, beginning in 1954. In 1956 he invented the technique of "patching" toneholes. This allowed an incremental approach to tuning flutes rather than building an entirely new instrument to test every possibility. The process has always been one of trial and error, and without this expediency, progress would have been slow indeed.

Cooper left R&C and began making his own flutes around 1958. Both he and WIBB experimented with fixing the worst notes, but a systematic approach was needed.

The person who most deserves recognition here is Elmer Cole, principal flutist with the English National Opera Orchestra for nearly 35 years. (Cole also invented the convertible footjoint, an improved system of trill keys, and who knows what else.) Cole had ordered a flute from Cooper around this time, and as it was being made, Alex Murray (inventor of the Murray-system flute) suggested Cole look into Böhm's book. He did, but unfortunately, the flute was finished too soon to incorporate the new ideas.

## The Cole Factor

Regardless, Elmer Cole set the entire effort on a straight course by insisting that, whatever else, *the scale must have an underlying mathematical basis.* He coined the term "octave length" and laid the groundwork for everything that followed. And octave length continues to be a subject of discussion. It determines the overall pitch of a scale (A=440, 442, or whatever)—and small uncertainties still continue about the best starting measurement and how, exactly, to proportion the tonehole placement.

Obviously, Albert Cooper made the largest contributions to the effort. Among many things, he developed a "displacement graph" that enabled makers to substitute different-sized toneholes in a predictable way. Just one example of Cooper's quiet genius: When the strict "Böhm schema" was tried, the left-hand notes were found to be flat—a very serious problem. Instead of belaboring theory, Cooper simply (but rationally) jumped to a workable solution. In essence, he grafted two different scales together—what we now call the "Cooper stretch."

This was a major breakthrough, and one that Cooper could well have kept to himself. Instead, all developments were shared, discussed, and incorporated into the general effort. This attitude of sharing both effort and credit seems difficult for Americans to understand, i.e.: "My scale is better than your scale!"

This is not to say there was agreement on every item. Everyone was working toward a common goal—better flutes—but not necessarily a common solution. There are myriad compromises, and everyone had slightly different opinions. Quite remarkably, there was a common understanding of what the compromises were and why certain choices were made.

As an example, the octave between low and middle D tends to be wide. If you make the low D "in tune," the middle D will be sharp. Conversely, if the middle D is "in tune," low D will be flat. What to do? Cooper reasoned that since third-space C-sharp also tends to be sharp, putting two sharp notes together might lead players astray. WIBB reasoned that if the player is already adjusting the C-sharp, why not humor the D as well?

They were both right.

To be clear: despite superficial differences, both Cooper and Bennett scales were always based on these same underlying concepts and measurements. I last saw Albert Cooper at the 1998 NFA Phoenix convention (at which, along with Charles DeLaney, he received the NFA's Lifetime Achievement Award). He was his usual cheerful self, but a bit contemplative. He said quite clearly that he thought "the scale" was essentially complete, yet there were still details to be worked out, and that WIBB would likely run those to ground. There was nothing about "his scale"—it would have been out of character.

## Keeping the Scale Alive

More than a decade ago, WIBB voiced concern that as the principal characters age and die, the process leading to "the scale" would be lost. This started me on a mission to document as much as possible. Sadly, this was about the time that Albert stepped in front of an oncoming car. He never really recovered, and WIBB's fears were partially realized.

Fortunately, WIBB kept detailed notes from the start. In reviewing five decades of his research, I noted a pattern of uncertainty about the tonehole displacement graph and the adjustments needed for open holes. Trevor Wye (another significant contributor and the engine behind our present effort) had built a mechanical flute player in the early days and got it working well enough to prove that things were actually headed in the right direction. It seemed a simple project to build another, take a few measurements, and settle matters.

Right. Wye's students called his machine an "Automated Trevor." Borrowing computer technology, I dubbed mine "Trevor 3.0." Years and sleepless nights later, "Trevor 5.3" is beginning to behave predictably, and the open-hole corrections are taking shape. The displacement graph just might come together in the next year.

## Everybody Else

As the initial controversy subsided, other makers were left to make tough choices. A few companies really did try to develop their own scales from scratch, with mixed success, but a simpler approach was to copy a "Cooper scale" flute and use it without giving credit.

Or they could get the William Bennett scale for asking.

Or they could copy either and announce their new "Brand XXX" scale.

Or they could tweak something (usually for the worse) and claim to have invented the thing entirely.

In any case, these came after the fact. It was the initial concept that mattered, and once the idea of improved tuning was accepted, anything seemed possible.

Sadly, in the past few years WIBB, Trevor Wye, and I have become increasingly concerned (annoyed/frustrated) at having students with expensive flutes that are obviously (in our opinion) out of tune. We don't mean to appoint ourselves the "pitch police," but it's been a long road, and the desire to make everyone's lives easier remains.

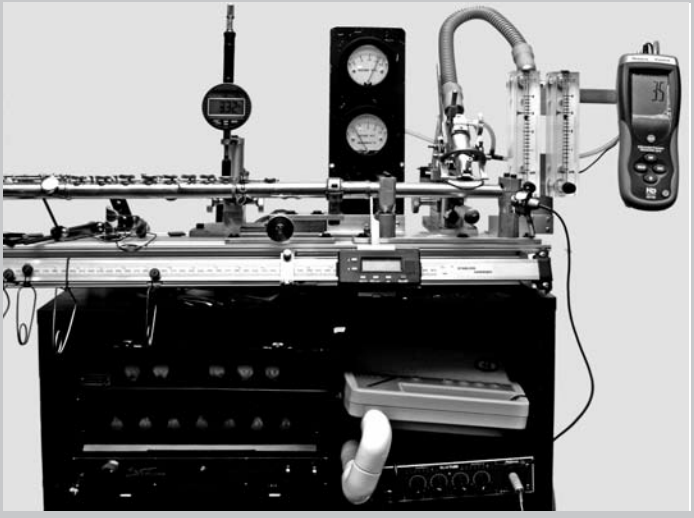
We hoped that if we published the actual numbers, flutemakers could use them directly or at least compare their numbers to ours and note the differences.

Thus, we offer—in a gesture of the openness and sharing that was a hallmark Albert Cooper's character—our most recent numbers for all to view and use. You can find them (and much more useful information from Wye, a 2011 Lifetime Achievement Award recipient) at trevorwye.com. They also are available in one easy-to-find location at eldredspellflutes.com/scales/index.htm ❋

***Eldred Spell is professor of flute at Western Carolina University.***

Edred Spell, left, Jack Moore, and William Bennett in 1978.

Judith Gilbert with a version of Wye's flute player, dubbed "Trevor 3.2."



A later version of Wye's mechanical flute player, "Trevor 5."