Sofia Gantois

Developing New Modes of Playing for the Transverse Flute

An Acoustic Understanding of Already Existing Techniques

Sofia Gantois delved into both classical and experimental repertories while training in transverse flute at the Royal Conservatory of Liege. She regularly collaborated with Centre Henri Pousseur — a center for mixed and electronic media — before joining the Hopper Ensemble. Her career, marked by moments of musical experimentation, is now expanding to include her keen interest in how science and theory can enrich instrumental practice, in terms of knowledge sets and understanding various phenomena.

For her research on *Developing New Modes of Playing for the Transverse Flute*, Sofia Gantois called on acousticians, a flute manufacturer and composers. The research stages spent alongside acoustic theoreticians were aimed primarily at acquiring special expertise — notably in aerodynamics — to gain access to the complexities of the discipline. This essential theory-driven phase was supplemented by experiments in the flute's physicality. Sofia Gantois found herself learning how to disassemble and reassemble the flute in order to be autonomous in her modifications of it, and to carry out the transformations necessary for playing and producing modulations — inserting an element into the tube, opening a hole, removing a key, etc. These "preparations" for the instrument make it possible to expand the playing repertoire and propose even more sound possibilities to composers. With an eye to more easily transmitting the many modes of playing, the artist meticulously recorded and defined them so her discoveries and adjustments might be shared with the composers.

For a professional instrumentalist, this experimentation on and with an instrument, discovering modes of playing and pushing them even further, can reverse the set order of things. Sofia Gantois used these expanded modes of playing the flute as a springboard for composers to create new works for an evolving repertoire. Four new pieces were composed: *Face au monde*, by Denis Geerts in collaboration with Centre Henri Pousseur (mixed piece for solo flute); *Pattern Nostrum*, by François Couvreur (for flute, clarinet, violin, cello, guitar, piano, percussion); *Wind Rustling Through, (*for solo flute based entirely on alternative techniques), composed by Maija Hynninen; and *Aquifères* by Lukas Ligeti, (for flute, violin, cello, guitar, piano and electronics). Sofia Gantois is currently continuing her collaboration with Maija Hynninen.

The following interview was conducted in Brussels during the summer of 2023.

(A/R) For many instrumentalists, it can take an entire lifetime to fully understand their instrument, and this also holds true for those who perform classical repertory. When did you feel the need to branch out into the physicality and acoustics of the flute, and thereby embed your work within the experimental/contemporary music repertoire?

(S.G.) I discovered contemporary music at the Royal Conservatory of Liege in a very engaging composition class (lead by Michel Fourgon) that was quite open to experimentation. It was the perfect place to explore this universe.

While I was completing my bachelors in transverse flute, I had the chance to perform pieces written by my fellow composition students for their exams, as well as study contemporary pieces recommended by my flute professor, Toon Fret. During my studies, collaborating with Centre Henri Pousseur — a center for mixed and electronic music — also left a deep impression on me.

I really got a taste for it and I soon joined a student ensemble that was interested in pursuing performance in this kind of music. Ten years later, the Hopper Ensemble still exists and continues to perform works by today's composers with a lot of conviction and courage, which isn't always easy in the current political-cultural climate[1]. I still occasionally play with the ensemble, but now I'm above all their production manager!

It was together with this ensemble that I envisioned developing a specialized Master's project. I wanted to bring my scientific interest, which had been heavily prioritized during my secondary studies, together with the flute. I imagined giving a lecture on how alternative modes of playing might function on the flute, followed by a concert, surrounded by my colleagues from the Hopper Ensemble.

Alternative modes are contemporary techniques introduced in the second half of the 20th century which have now become part of the modern fluting *lexicon*. They include *multiphonics* (producing several pitches simultaneously on a wind instrument), *flatterzunge* ("flutter-tonguing" — producing vibrations with the tongue or the throat that adds an *rrrrrr* to the regular sound of the flute), *singing and playing* (producing sound with the vocal cords while playing the flute, which either acts to reinforce the sound, or to superimpose sung and played pitches), *whistle sound* (drastically reducing the air pressure, resulting in a very quiet and volatile sound), *bisbigliando* (timbral trill between two notes of similar or equal pitch), *glissandi* (by using the open key holes on the flute, one can "slide" between one pitch and another), etc.

I've always found it difficult to do something in a specific way just because someone told me to. I've always needed to understand the how and why.

Our way of learning music, especially these contemporary techniques, is often based on imitation or a sensorial approach: the teacher shows, the student imitates and the teacher explains how it feels to execute the technique and asks the student to do the same. We very rarely address the reasons why there is a specific position for the mouth or why we use a particular amount of air. I sensed this way of learning was hindering my autonomy and slowing down my progress. I was convinced that understanding the functioning behind these techniques would help me to improve how I execute them, and that this might offer me new leads.

Following this specialization, which focussed on studying existing contemporary techniques for the flute, there were still a lot of unanswered questions, and the FRArt grant seemed an excellent framework for diving a bit deeper. I decided to call it: "Developing new modes of playing for the transverse flute based on an acoustic knowledge of already existing techniques."

(A/R) Although a good portion of the research is spent on experimenting with and on the instrument, you also emphasize how the knowledge required to perform these experiments draws to a great extent on acoustic theory and scientific data, particularly in physics. How did you work with all this?

(S.G.) Physics can be used to explain how every instrument functions, and at the Conservatory we had a course in acoustics that covered the basics: waves, changes in air pressure, harmonics, etc. So in order to understand certain phenomena that hadn't

yet been covered, I had to start with the theory of acoustic/physics. The goal was to understand the physics of the instrument and existing techniques in order to push the extremes of what is possible, and thereby develop new modes of playing. But as I had only limited knowledge of physics, I planned from the start to collaborate with Michèle Castellegno and Benoît Fabre, who are both acousticians at LAM (Luthiers - Acoustique - Musiques) at the Sorbonne (Paris). Sometimes the theories discussed with Benoît Fabre were so difficult for me to understand that it got too complex to make them concrete or experience them first-hand. My sister, who is an engineer, lent me her aerodynamics syllabus and I spent many evenings poring over studies and articles that could help me develop my own theories and answers.

It's in large part thanks to acquiring this new knowledge that I was able to develop the "inside harmonic" technique, which was a key discovery in this research. It's a technique that uses the inside edge of the flute's embouchure (mouthpiece) to produce the sound, and not the outside edge as one would in the normal mode of playing.

It's a technique that was first used in compositions by Salvatore Sciarrino, "Opera per flauto". At the time he didn't name it, he simply described it in the instructions. As is often the case when something has no name, flutists who learned this technique began to call it "Sciarrino whistle" or simply "inside whistle sound". This name refers to another way of playing that already exists, called "whistle sound".

This technique has a strong connection to bevel sounds, for example the sounds you hear when you blow into a paper or when the wind blows. This happens due to a phenomenon called the "air jet-labium system": a stream of air meets an edge which produces a sound that gradually changes frequency as the air pressure changes. This will result in a *glissando* (sliding between pitches).

In both transverse flutes and recorders, this air jet-labium system acts as a stimulator (image air-column resonance). The air jet-labium system gives a first impulse, then a stationary wave will form inside the tube in reaction to this first impulse, and the wave will impose a pitch. In a regularly functioning flute, the pitch of the edgetones therefore has very little influence. On the other hand, in a "whistle sound", the air pressure is so low that the edgetones are precisely what will dominate. They are acoustically reinforced by the tube, but without any stationary waves taking over. We will not hear a *glissando* but only the pitches that are reinforced by the tube, which correspond to the tube's own modes.

This is the root of the *whistle sounds*' instability: as soon as there is the slightest change in air pressure, the sound will jump to another pitch. Since we're already dealing with a system of very low air pressure, the *whistle sounds* are difficult to control or stabilize.

To come back to our *Sciarrino whistle* (or *inside whistle sound*), this nickname seems to point toward a similar functioning as in a classic *whistle sound*, but by using the inside edge of the flute's embouchure. By studying the air pressure used to execute this technique and observing the clear stability of the pitches produced, I came to the conclusion that its function was not at all comparable to that of a classic *whistle sound*.

Once a technique has been freed from its label, a whole world of possibilities opens up. The biggest discovery has been that this mode of playing is very similar to the normal functioning of the flute, the sole difference being that we use the inner edge of the embouchure, so the flutist has to position the embouchure in their mouth and incline the hole to find the correct angle, which corresponds more or less to 45° from the palate.

I quickly baptized this mode of playing *inside harmonic* in order to distance it from the misleading name, *inside whistle sound*. When played in the classic way with an open-air embouchure (so, not placed in the mouth), the flute can allow for certain alternative techniques, particularly *multiphonics*, *bisbigliando* (timbral trill), *flutter-tonguing* and *glissandi*. So I tried to transpose these alternative techniques to the mode of playing with a closed embouchure (between the flutist's lips) and after a few days' work, five unprecedented sounds were born: the *inside multiphonic*, *inside bisbigliando*, *inside flutter-tonguing*, *inside glissandi*, and it's even possible to sing while playing in the closed embouchure mode.

I came to the conclusion that putting labels on things without understanding them in depth can limit our vision and how they're used.

(A/R) Could you give us more detail about the research you conducted on the sound of the flute, and how the different ways of channeling air through the instrument led to you transforming it through the addition of other elements?

(S.G.) While I was on my journey toward the *inside harmonic*, another avenue was being explored. It all stemmed from my desire to understand how the *jet whistle* functions, which is an existing contemporary technique where the flutist takes the embouchure in their mouth and blows a very powerful jet of air inside it. It's a rather explosive technique that demands that the flutist blow a lot of air in one go, so composers use it in moderation.

At the end of my specialization[2] I still had many questions about how the *jet whistle* functions, and this became the main subject of my first discussions with Benoît Fabre from LAM.

One hypothetical answer seemed to be hiding in the vortex phenomenon produced in corrugated or waved tubes. Think "old vacuum cleaner tube" or ventilation tubes: a tube that gains flexibility through the small wave forms on its surface. When you send air through these tubes with a certain amount of pressure, they start to whistle. This phenomenon is less practical for ventilation but is very interesting for my research!

The corrugation, or waves, will create inequalities in how certain air particles travel through, and the movement that this creates, because of this inequality, will produce vortices, like mini swirls. When they correspond to the pitch of one of the tube's modes, the tube will reinforce them and make them resonate.

The transverse flute has bumps along its holes which push outward on the tube. So it was possible to imagine, when blowing inside it in a *jet whistle* way, that they behave in the same way as corrugated tubes. This spurred the idea of making something that would facilitate the *jet whistle*: the *whirly tube*.

With the help of Robin Gantois, founder of 3D Planner, a 3D-printing company, I designed a little corrugated tube to be inserted into the flute. After trying to place it in many different ways, and other considerations, I opted for a corrugated tube that can only be used on the inside, inserted into the foot of the flute (furthest away from the embouchure), which also has holes corresponding to those on the transverse flute. The produced effect is similar to how wind blows, and the movement of pitches follows the air pressure used by the flutist.

Thanks to the three holes, one can adapt the fundamental note being used, but there are still limits to the technique in terms of its melodic or harmonic possibilities.

Aside from the *whirly tube*, I also wanted to create a mirliton effect that could be accessible to flutists. The mirliton effect has existed for centuries, it's the principle of covering a hole with a membrane that vibrates while playing, which adds a kind of buzz to the sound.

There are many traditional instruments that use this principle, for example the Dizi in China or the Shino-bue in Japan and even one you have certainly played yourself, the kazoo, which uses the same principle.

After trying several things, I found a transverse flute with an adapted head: the *Matsui flute* invented by Matthias Ziegler. Its head has an extra opening covered by a membrane. You can control how you activate the membrane with a string around your right thumb. I strongly encourage you to hear it, it's incredible[3].

To keep flutists from having to purchase a special flute head, I wanted to investigate whether it would be possible to add a membrane to a pre-existing hole on the flute to produce this same mirliton effect. After much trial and error, I came to the following solution: you can remove the key that closes the hole

on the *ti* of the transverse flute and affix a cigarette rolling paper with a small elastic (like a hair elastic) so that it covers the hole. At this spot on the flute, covering the hole with your thumb allows you to retain the most possibilities for playing in the classical mode. By using the hole at the far left of the flute, you also have practically all the notes that can be played with a mirliton effect.

These were the two more "handcrafted" avenues for my research. I admit that I was quite satisfied with the discovery of the *inside harmonic*, which does not require any additions for it to work. I simply expanded on the instrument's intrinsic possibilities.

(A/R) For this research project, you surrounded yourself with an acoustician, several composers and a flute manufacturer. Could you explain who you brought in to expand your understanding of the instrument, develop its physicality and create new pieces in this context?

(S.G.) As I was explaining, since the very beginning there was this collaboration with Benoît Fabre for all of my physics and acoustics related questions. He really guided me toward the right articles to read and validated my theoretical hypotheses. His lab was outfitted with all kinds of measuring tools that enabled me to collect some of the essential information for my research.

I also sought to work with Daniel Vandenbrande, a flute manufacturer and repairman, who taught me how to disassemble and reassemble the keys on a flute, which is, as you might have guessed, a very precise and delicate process! It can actually be quite scary the first time you see a flute without its keys. It allowed me to conduct experiments during my research and more comfortably measure the keyholes, and to retain some autonomy throughout all these steps.

Since my research was artistic in nature, I wanted to put my hypotheses to the test, that is, within a musical context. From the start, I contacted four composers who were eager to take on the challenge of integrating my results into some new compositions.

The dialogue between a musician and a composer while a piece is being written is always an incredibly enriching experience. It was no different for this research, on the contrary! Composers who are empowered to use the techniques they like best appropriate these modes of playing and make them come alive in ways I never could have imagined.

Not only did they integrate the sounds to their musical language and pieces, but by asking questions about the possibilities of certain techniques, they also pushed me to reconsider the limitations of my execution. Their desire to write certain things that seemed "impossible" to me forced me to try again and again, which in most cases led me to re-evaluate what I deemed was within the limits of the possible and realize that I too hastily determined I wouldn't be able to do it.

(A/R) Four new pieces were written by four composers. Could you describe them?

(S.G.) It was important to stay connected to the Royal Conservatory of Liege, which supported me during this research, so the first composer was a composition student: Denis Geerts. He has written a mixed piece for solo flute, which means that he uses electronics in addition to the flute.

Face au monde was created in collaboration with Centre Henri Pousseur, who not only hosted our work but also gave us advice on the right materials to use.

Denis used the *inside harmonic*s to create melody, all on its own and in combination with *flutter-tonguing* and *bisbigliandi*. The piece transforms the flute sounds through real-time electronics. So I have a microphone that can record the desired sounds and then there's a pedal connected to software that Denis has pre-programmed with all the required effects. The pedal sets off a series of transformations that change throughout the piece. In total, I had to push the pedal 138 times, and each number of pedaling corresponds to a very specific transformation.
For example, you can record a particular sound, and then have that recording play through the speakers while playing something else on the instrument. Or you could also transpose the pitches that I play in real time to create polyphony. And of course there were also the more familiar effects like *delay*, *reverb* and hundreds of other processes. So you can imagine that there were a lot of possibilities!

François Couvreur is the second Belgian composer that wrote a piece for this project, this time for the flute but within an ensemble. *Pattern Nostrum* for flute, clarinet, violi n, cello, guitar, piano, percussion and director, uses the *inside harmonic* for harmonic color rather than melody. It was certainly a challenge to integrate this mode of playing to an ensemble piece because the sound is very soft and can quickly get lost, but François made excellent choices about when to use this technique.

Wind Rustling Through is the third composition, it's a piece for solo flute written by Maija Hynninen, a Finnish composer. Maija opted for a piece made entirely of sounds produced through alternative techniques; there are practically no *classical* flute sounds. In the piece, you find the *inside harmonic* with its variations (particularly the *inside multiphonic* and with singing), as well as the *whirly tube*. What was really interesting about this collaboration with Maija was that she also decided to use the accidental results of the *whirly tube*. When you play the flute in a classical mode, with the *whirly tube* inserted in the foot of the instrument, some notes have a weird sound and aren't "usable". Maija decided to integrate these sounds to her piece. It was one example of an idea I never would have had if I'd only worked alone! The result is a piece that works with the inner world of the flute, and I'm excited to say that we are currently working on a version with electronics in collaboration with Centre Henri Pousseur.

The final piece written as part of this research is called *Aquifers*, by Lukas Ligeti, for flute, violin, cello, guitar, piano and electronics. Lukas decided to use all three options in one piece: the mirliton, the *whirly tube* and *inside harmonic*s. This yielded a piece with a very eclectic repertoire, with passages that are very different from one another.

(A/R) You also initiated discussions with other flutists, why did you find that necessary?

(S.G.) I conducted a few interviews at the very beginning of my research with several flutists (notably Toon Fret, Ine Vanoeveren and Caroline Peeters) which were extremely helpful!

I wanted to know how they saw certain alternative techniques so I could expand my vision of it all. These exchanges inspired a lot of ideas and I could also go deeper into what I knew about the *sciarrino whistle sound*, which I have never been asked to perform and which I still do not master at all!

(A/R) What kinds of concerns arise when it comes to sharing these experiments and the musical pieces that were created and performed as a result?

(S.G.) Well, it's not like it's a cure for severe illness or a discovery that will help us live in harmony with the Earth. So it's hard for me to speak in terms of concerns, but there are sounds that have never been heard before, and that's pretty cool!

That said, in our little microcosm of flutists or perhaps contemporary musicians, there might be small effects on the future: the *inside harmonic* and its variations could become standard techniques in contemporary repertoire, accepted as part of the fluting language, perhaps even taught to students in a few years, who knows? But now I'm just dreaming out loud.

(A/R) You've produced a few educational formats to present your "findings", is it one of your research goals for other musicians, particularly ones in training, to appropriate these findings?

(S.G.) If I want my results to spread to other conservatories, absolutely. I had the opportunity to give a few masterclasses in Liege, in the flute as well as composition classes. It's incredibly important for young composers to understand how the instruments work, so they don't wind up writing passages that are impossible for the instrumentalist to play.

(A/R) Between the beginning of the project and now, the project has inevitably encountered some detours. Could you elaborate on what kinds, and the reasons for them?

(S.G.) In the research I conducted specifically on the *jet whistle*, my hypotheses often turned

out wrong. Following my hunch about the corrugated tube led to fabricating the *whirly tube*, but the hypothesis that the flute acts as a corrugated tube when a flutist executes the jet whistle turned out to be incorrect.

So we developed other hypotheses which, after some experimentations in the LAM lab, showed that the *jet whistle* simply uses the inside edge of the embouchure to produce the sound. This observation contributed to the discovery of the *inside harmonic*, which uses the same inside edge.

(A/R) Does this period of research, which took a little longer than a year, represent a continuation in your practice, or a break from it? What does the future hold after this year?

(S.G.) The research phase that concentrated on developing these new modes of playing was a real change from my usual routine. On the other hand, the artistic phase that came after more closely resembles how I usually work; in collaboration with composers, through studying the pieces and rehearsals together, organizing a concert.

As we are currently re-working the piece by Maija Hynninen, I hope to organize another lecture-conference again, as I did when I concluded my research at the Théâtre de Liège.

Developing other projects has taken up a lot of my time so I haven't yet been able to look into the next steps for my research. I hope to find some time for it soon, because I truly want to share my experience with other flutists and musicians! It could inspire others to learn more about how their instrument works, or to embark on a search for new sounds.

And there are still some phenomena and questions that remain unresolved. One year is pretty short, so maybe I can launch another research project soon!

1. Contemporary music, and classical music in general, unfortunately relies on funding and grants. Its audience is not as large as for pop or rock, so it's often difficult to embark on ambitious projects without knowing whether it will be funded. Sometimes it's a real battle to defend contemporary music.
2. A project developed in the final stages of a Master's in Belgium, often presented as a performance or concert.
3. Zawinul by the Anders Hagberg Quartet: https://www.youtube.com/watch?v=flyUDhHiQYo

GLOSSARY

Normal/classical playing:
The sound of the transverse flute as one hears it in Debussy, for example. The flute is played with an open embouchure hole, with the edge of the latter in contact with the flutist's lower lip.

Alternative or contemporary technique:
Any mode of playing that goes beyond the normal use of a flute.

Whistle sound:
Also known as *whistle tone* or *whisper tone*. It is produced by drastically reducing the air pressure, compared to normal playing. It sounds a bit like wind blowing, very light and unstable.

Jet whistle:
A technique that involves blowing out a jet of air with a lot of pressure into the embouchure, which is nested completely between the flutist's lips. The result is a rather loud and energetic sound that naturally follows a *glissando* movement.

Multiphonic:
A sound that contains one or several pitches/notes simultaneously. The flute is usually a melodic instrument used for playing, in principle, only one note at a time, unlike the piano where one can play chords. Multiphonics are the flute's moment of harmonic glory! It is often produced with special fingering called "forked" fingering because in a suite of closed keys/holes, there is one hole left open in the middle.

Flatterzunge or *Flutter Tongue*:
A sound effect produced by rolling the tongue (*rrrrr*) or in the throat (with a kind of gargling motion) while playing a note in the normal way. This gives a special color to the sound, like an insect buzzing, and at the same time reinforces the volume.

Glissando:
Sound whose pitch slides uninterruptedly higher or lower. In this way, the note gradually becomes more high- or low-pitched.

Singing and playing:
We can blow air into the flute and hum/sing a note at the same time. The note played and the note sung do not necessarily have to be the same pitch.

Bisbigliando:
Timbral trill. A tremolo or rapid switching between two notes with the same pitch, but different timbres.

CAPTIONS

fig. 01 Talk "Out Of the Box, Into the Tube", June 2022, Liege Theatre.
fig. 02 Balibar, S., *L'Acoustique de la Flûte* [The flute's acoustics], 1981, La Recherche, pp. 36-44.
fig. 03 Drawing, Sofia Gantois.
fig. 04 Nakiboglu, G. (2012). *Aeroacoustics of corrugated pipes*, TUE: Eindhoven.
fig. 05 Portrait of Sofia Gantois. Photo credit: Nora Hansen
fig. 06 Whirly tubes. Photo credit: Sofia Gantois.