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Author(s): Chiara Percivati and Andrés Gutiérrez Martínez
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Abstract

We understand *speculative synthesis* as emerging through an ongoing exploration of a sonic space shared by a performer, her instrument, and a composer. Our approach is shaped by performance contingencies, the acoustic affordances and limitations of the instrument, the use of computational tools for timbre analysis, and compositional strategies that bridge the symbolic and the actual. These complementary modes of documentation and representation enable ongoing (re)mapping of the sonic space—one that unfolds through the interaction of embodied practice and symbolic systems.

Keywords: bass clarinet multiphonics, speculative synthesis, performer-composer collaboration, mapping, timbre maps

Introduction

The incorporation of complex sonorities beyond ordinary pitches in contemporary music practices, whether notated or improvised, has expanded the repertoire of sounds created by acoustic instruments.[1] Such is the case with bass clarinet multiphonics, which "involve oscillations of the reed based on two inharmonic downstream air column resonance frequencies and their intermodulation components" (Scavone 2008). On closer inspection, and as a premise for what follows, it is important to note that all sounds produced by acoustic instruments—including what we often call, for the sake of brevity, "ordinary pitches"—are already structurally complex, the result of an inner

[1] "Ordinary pitches" refers here to sounds produced by acoustic instruments using conventional techniques, as found in the traditional Western repertoire.

process of instrumental micro-synthesis (Grisey 2008). From the outset, therefore, the acoustic instrument—the bass clarinet, in our case—functions as a site of acoustic synthesis. While in monophonic sonorities the constituent frequencies belong to a single harmonic series, in clarinet multiphonic sonorities the spectrum is "composed of two main components plus two sidebands" (Backus 1977).

Clarinet multiphonics result not only from specific configurations of the instrument—often produced through unorthodox fingerings that distort its resonance spectrum—but also from the performer's use of particular techniques. As composer Scott McLaughlin notes, "each fingering configuration offers a different resonant landscape to be explored through a flexible range of embodied techniques, such as overblowing and underblowing, that may afford results across a spectrum of monophonic and multiphonic sound behaviours" (McLaughlin 2022). From the performer's perspective, multiphonic production requires precise control of embouchure—primarily tongue position and lower lip placement—and breath support, enabling simultaneous sound production across different registers. The vocal tract plays a crucial role by creating an upstream windway resonance that is strong enough to override the downstream system in controlling reed vibrations, primarily modulated through tongue position (Scavone 2008).[2]

Explored both individually and through co-creative practice by performers and composers, multiphonics have become part of the common technical expertise thanks to the dissemination of multiphonic charts (Rehfeldt 1993; Bok 1989; Sparnaay 2011).[3] These typically include a fingering diagram and a proposed notation of the multiphonic's pitch components, with varying levels of detail—ranging from simplified

[2] This same mechanism, as demonstrated by Scavone and collaborators, enables techniques such as "altissimo" register, pitch bending, bugling, and timbral variations.

[3] These charts, compiled by specialised performers, have been incorporated into instrumental treatises on so-called "extended techniques," aiming to provide performers and composers with immediate and efficient access to information.

dyads[4] to more thorough analyses of frequencies. Depending on the method, additional descriptors may specify embouchure tension, dynamic range, stability, articulation, poetic descriptions of sound quality, and other remarks (Figure 1). While some texts acknowledge certain performative "ranges" (mainly in dynamics), nearly all present a single mode of resonance per fingering.

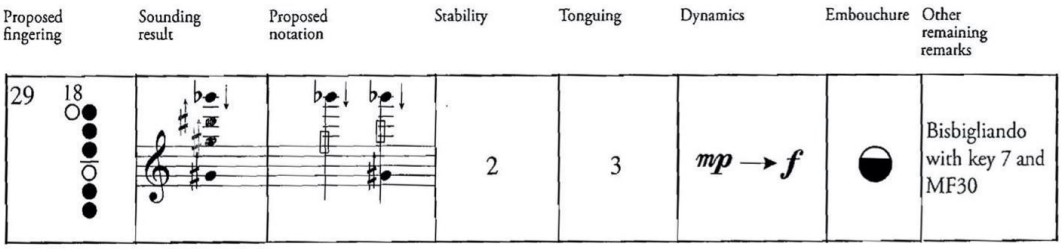

Figure 1. Multiphonic chart for Sparnaay's multiphonic no. 29, reproduced from *The Bass Clarinet: A Personal History* by Harry Sparnaay. © 2011 Periferia Sheet Music.

With few exceptions—such as Sparnaay's inclusion of alternative resonance modes for a couple of multiphonics—these resources therefore provide little to no framework for imagining a vertical[5] exploration of this resonant space. While we acknowledge the immense value of these groundbreaking texts—our first point of entry into this field and a foundation for further exploration—we must also recognise, following cellist and researcher Ellen Fallowfield, the inherent risk that notation reproduces itself, merely documenting what is already established and mastered, rather than fostering an understanding of both the instrument and the technique as dynamic fields for exploration (Fallowfield 2011).

[4] Many complex multiphonics are often notated as dyads, showing only the lowest tone of the multiphonic together with a higher, predominant harmonic—often the one that speaks most easily. This synthetic form of notation is functional and primarily aimed at the performer, indicating the pitches to target in order to efficiently initiate a multiphonic sonority on a given fingering.

[5] We use the abstract concept of verticality to refer to sounds or partials that occur at higher frequencies than those indicated in the given notation.

Some Technical Considerations

One approach that significantly influenced our work is presented by McLaughlin in *The Material Clarinet* (McLaughlin 2022) in which the author conceptualises the instrument as a "dynamic manifold of fingerings and registral resonance spaces." In this fascinating work, McLaughlin presents an original compositional practice that engages both "the player and the composer with the embodied materiality of the player-instrument assemblage"—an approach that resonated strongly with our previous experiences working with these sonorities and with the anticipated direction of our collaboration. Yet, given this conceptual framing, how can one practically, systematically, and even strategically approach the resonant space offered by each fingering configuration?

To begin our shared exploration of the bass clarinet's resonant space, we decided to employ a technique called *bugling*. Bugling involves articulating the notes of a harmonic series while maintaining a fixed low-note fingering, achieved through subtle modifications of tongue position and airflow. This allows for the isolation of individual partials within a given fundamental and enables free movement between them through vocal tract control and airflow adjustments.[6]

https://vimeo.com/1128491502?share=copy&fl=sv&fe=ci Bugling on low D

By combining this selective approach—focusing on specific regions or individual pitches—with the additive approach required for multiphonic production, where multiple performance techniques must be balanced to sustain simultaneous sonorities, it becomes possible to *bugle on multiphonics*. This technique allows for a refined exploration of the vertical modes within each multiphonic found in standard charts and,

[6] This technique was first introduced to Chiara during her studies by clarinettists Stefano Cardo and Ernesto Molinari, with the aim of producing a practical and embodied knowledge of the clarinet's harmonic series, increasing aural sensitivity to its sound components, and developing control and flexibility over the vocal tract.

more broadly, for any given fingering configuration.[7] But by what logic—or harmonic framework—do these multiphonics "open" into their successive modes of resonance? How might we speculate on this process and, possibly, manipulate performance parameters to shape or direct these resonance spectra?

https://vimeo.com/1128492431?share=copy&fl=sv&fe=ci Bugling on multiphonics, Sparnaay 16

At the core of our exploration was therefore a dual approach: a vertical investigation of each fingering configuration, not only eliciting its fundamental mode of vibration but also probing the full spectrum of available and reachable modes, up to the limits of both material and performer; and a lateral[8] exploration that sought to weave these multiphonics into larger, connected phrases, considering the inherent musicality that emerges from their transitions. Recognising that multiphonics which are a single finger apart may, from a performer's perspective, feel vastly different, we also aimed to develop tools that would complement existing notation with timbre space visualisations, to highlight the timbral relationships between different modes. Finally, by bringing together our distinct perspectives, experiences, and embodied knowledge—combining analytical and performative insights—we sought to contribute to a more nuanced and multifaceted discourse around clarinet multiphonics, bridging the gap between experimental exploration and practical implementation.

[7] By choosing bugling among the various technical and artistic approaches for navigating the bass clarinet multiphonic space—which prioritise, for instance, dynamism and flow (McLaughlin 2022) or immediate application in musical situations (Snekkestad 2019)—we opted for a systematic, step-by-step exploration of the resonant space offered by each fingering configuration.

[8] The concept of laterality is related to the neighbouring multiphonics in terms of fingering proximity.

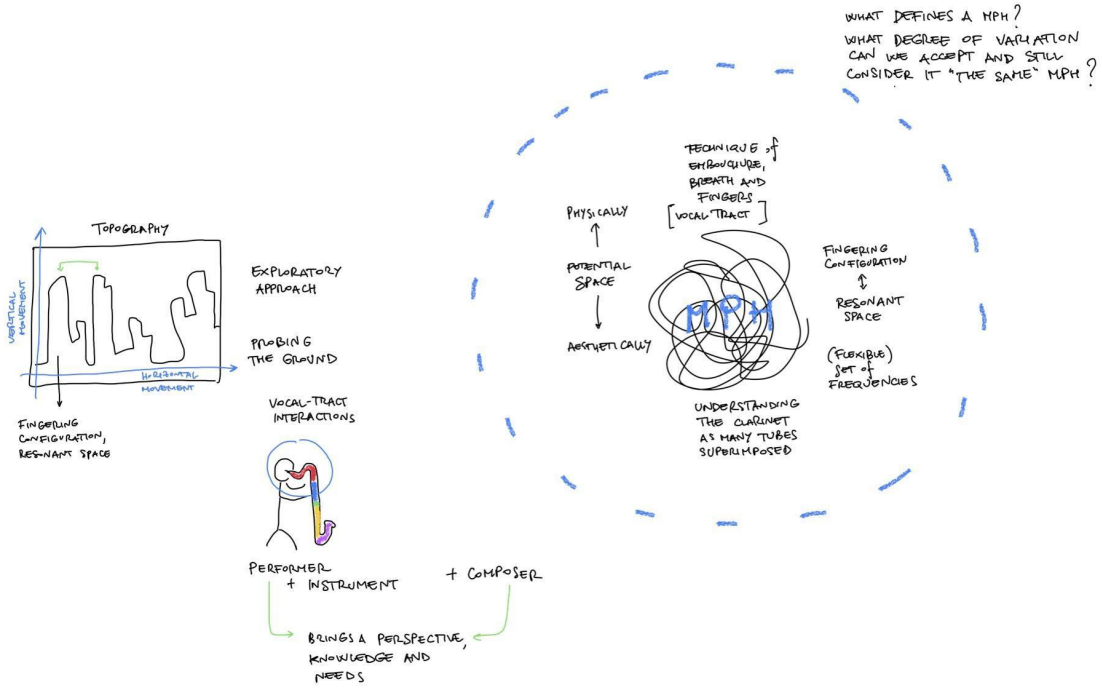

Figure 2. Preliminary sketch, mapping different aspects of our understanding of bass clarinet multiphonic sonorities and strategies to be employed to explore this potential space.

Preliminary Maps

Our point of departure was a selection of multiphonic fingering charts from existing bass clarinet methods (Rehfeldt 1993; Bok 1989; Sparnaay 2011), independent works (Roberts & Moroz 2021), and treatises (McLaughlin 2022), covering a variety of multiple sonorities and spanning forty-five years. Our own experience performing, composing, and improvising with these sonorities was naturally brought into the work.

In a preliminary and preparatory stage, Andrés surveyed the three bass clarinet methods looking for overlaps or similarities among them. This resulted in a first attempt at

organisation based on fingering proximity between different multiphonics, allowing for the creation of sequential arrangements that differed by only one or two fingerings.[9]

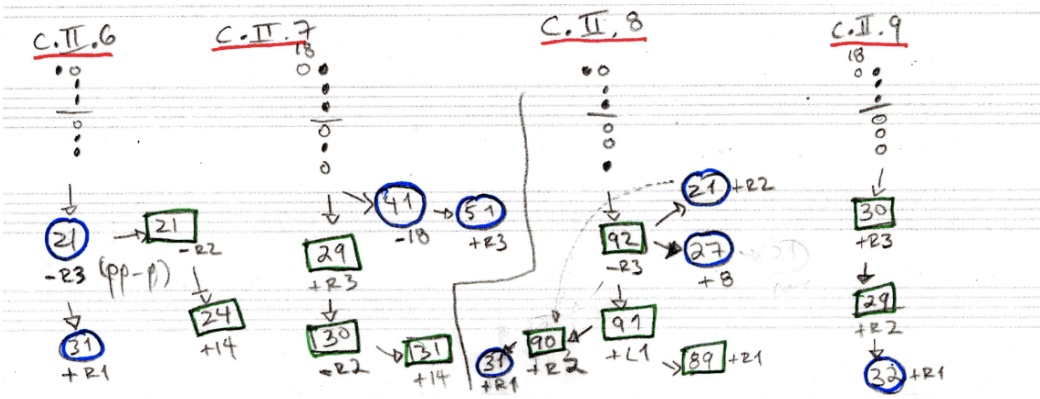

Figure 3. Example of sequential arrangement of multiphonics from Rehfeldt (underlined in red), Bok (circled numbers), and Sparnaay (green squares). The numbers were taken from the methods for the sake of clarity. The initial sonority was taken from Rehfeldt (C.II.6) and as we can see, the first "relative" sonority was found in Bok, which differs only by removing the ring finger of the right hand (-R3). From there one could then add the right index finger (+R1) to arrive at 31 from Bok or remove the right middle finger (-R2) to arrive at 21 from Sparnaay. As we can see, some of them create more than one path of exploration.

This led to the idea of a kind of topographic understanding—a sort of map of exploration of the sonic space in terms of "fingering distance." At this stage, we did not consider the actual sounds, nor the musical result of these sequences. The arrangements provided a speculative approach to concatenation of sonorities based solely on fingering, and an initial conceptualisation of the musical syntax we seek to develop.

[9] A similar work—of which we were unaware at the start of our project—was developed by Scott McLaughlin and collaborators as part of *The Garden of Forking Paths*. Their *Daisy Chains WebApp* is an online resource that maps an interactive network of clarinet multiphonics, advancing step by step between fingerings that differ by only one finger. The project also includes fingering diagrams and performance videos (https://lutins.co.uk/daisychains/).

Exploring the Territory

For the data-collection phase of the project, we were hosted by CIRMMT in Montreal, where we worked in a semi-anechoic chamber over a six-day residency (Figure 4). To fully capture the nuances of each of the multiphonics, and given that the bass clarinet projects sound from different areas of the instrument—depending on which tone holes are open in a given configuration—we decided to record the sound of the instrument from multiple perspectives, using different kinds of microphones. The recording setup included:

- One Cardioid MKH 8040
- One Omni MKH 8020
- One condenser Neumann TLM 170
- One Schertler dynamic contact
- One Viga intraMic internal microphone
- MOTU Stage-B16 as a mic-preamp

As seen in Figure 4, the cardioid and omni microphones were placed close to the upper end of the instrument. The Neumann TLM condenser microphone was placed below the middle of the instrument to capture the sounds coming from the bell and the centre of the tube. The Viga intraMic internal microphone was inserted into the mouthpiece to capture the sound inside of the instrument and the Schertler dynamic contact microphone was placed almost at the bottom of the tube to capture the vibrations of the wood.

Figure 4. The semi-anechoic chamber at CIRMMT, with part of our recording equipment.

We ultimately decided on a mix in which the reference microphone was the MKH 8020 Omni microphone, while the other microphones reinforced the sound projected from the tone holes in the middle of the tube.[10] We used REAPER to record the sounds and kept a recording log with take numbers, including additional information deemed appropriate.

In our recording sessions, we first explored the vertical space offered by each fingering configuration—not limiting ourselves to the primary mode of vibration but eliciting all stable, reachable modes, until the limits of the material and of the performer. In parallel, another focus of our exploration was speculating about the component sounds of the multiphonics based on their fingering configuration, following the reasoning introduced

[10] The overhead microphones provided a good capture of the instrument's sound; however, it was the addition of the TLM 170 and the VIGA intraMic microphones that contributed with further detail, enriching the mid register of the spectrum. Mixing the different microphones into mono in preparation for analysis didn't impact the final mix in terms of phase cancellation.

by McLaughlin in *The Material Clarinet*.[11] For each analysed multiphonic, we sought to understand how its fingering structure impacted the production of its specific resonant space, as revealed by the emerging harmonic series. By combining empirical listening with theoretical reasoning, we aimed to work toward a clearer understanding of the multiphonic space—integrating what we heard with our prior knowledge of bass clarinet harmonics.

Our shared exploration of the bass clarinet's vertical potential involved both systematic and intuitive approaches. The systematic method involved recording the multiphonics sequentially, beginning with the resonance mode presented by the original notation and then "probing the ground" vertically.[12] At the same time, some of the most compelling sounds emerged during moments of more exploratory, improvisational inquiry. The performative strategy we employed tried to balance control and intentionality (aiming for specific frequencies or sonic outcomes) with an openness to the emergent qualities of the system—tuning in to its natural tendencies rather than imposing strict expectations.

In examining the ninety-five multiphonics from the Sparnaay collection, we identified through this process at least three—and up to eight—additional stable modes for each multiphonic, demonstrating the viability of vertically expanding these sonorities beyond their standard notation and spectral content. We then recorded additional multiphonics from *New Directions for Clarinet* (Rehfeldt 1993), the Explore Ensemble's publication (Roberts & Moroz 2021), and a chart developed by Andrés over years of collaborative work, finding at least two—and up to five—additional modes for each.

The following examples from our selection of multiphonics present some of these sonorities alongside their original notations from the consulted sources (Figure 5). As

[11] For a detailed discussion of this process, please refer to the sections "Loading and venting" and "Multiphonics" in *The Material Clarinet* by Scott McLaughlin, accessible at https://www.lutins.co.uk/writing/The-Material-Clarinet-McLaughlin.pdf.

[12] Chiara achieved this by subtly adjusting her tongue position and tuning her upstream windway resonance, progressively layering upper partials onto the multiphonic's lowest pitch.

previously discussed, these notations represent only the first mode of resonance for each multiphonic, whereas our recordings explore the full range of resonance modes available to us.

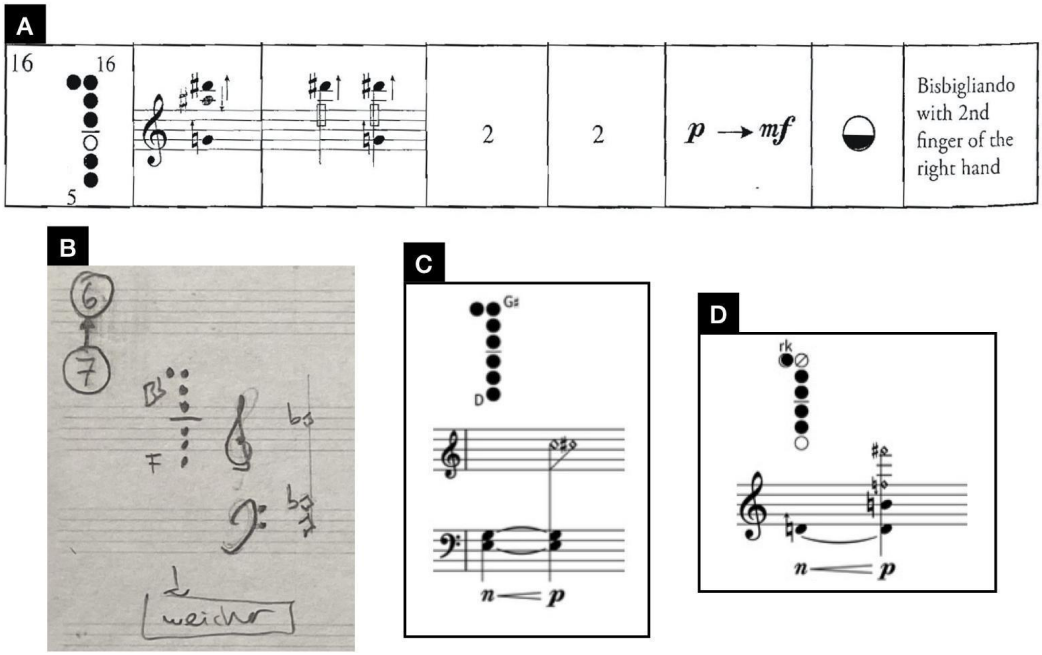

Figure 5. Original notation of the selected multiphonics from: A) Sparnaay, no. 16; B) Andrés's own chart, no. 7; and C-D), the Explore Ensemble's chart, nos. 10 and 31. Reproduction of multiphonic no. 16 from *The Bass Clarinet: A Personal History* by Harry Sparnaay. © 2011 Periferia Sheet Music. Reproductions of multiphonics no. 10 and 31 from *Bass Clarinet Multiphonics* by Alex Roberts and Nicholas Moroz. © 2021 Explore Ensemble.

Timbre Maps

We proceeded then to analyse the collection of multiphonics using FluCoMa (Tremblay 2019), which combines advanced timbre analysis on large collections of sounds to

obtain a visual representation of the sounds according to their timbral characteristics.[13]

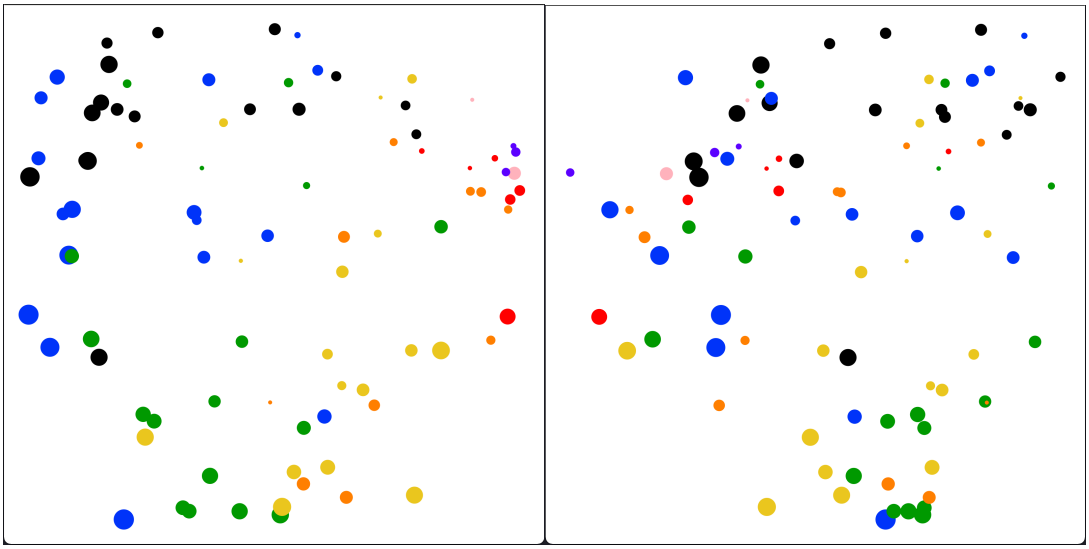

Figure 6. Visualisation of a preselected collection of bass clarinet multiphonics using timbre-sensitive analysis. Colour scheme (black, initial position [first partial]; blue, second partial; green, third partial; yellow, fourth partial; orange, fifth partial; red, sixth partial; purple, seventh partial; pink, eighth partial). The 3D data were visualised using two 2D representations. In both images, dimension 2 remains on the Y-axis. The first image plots dimension 1 on the X-axis, and the second image plots dimension 3 on the X-axis, effectively swapping dimensions 1 and 3 while keeping the Y-axis constant.

Figure 6 presents the visual representation of a preselected collection of sounds from our corpus. The spatial arrangement and clustering of the points is made according to timbral characteristics that have been scaled down through statistical processes. The point size maps the relative loudness from soft (small) to loud (big).

[13] Advanced computational timbre analysis is performed using Mel-Frequency Cepstral Coefficients or MFCCs, which represent the spectral envelope of the analysed sound through a reduced number of coefficients (Tremblay et al. 2022). Preliminary work applying this method to analyse a multiphonic collection as part of the compositional process was done by Andrés in preparation for his composition *Ebb and Flow* for saxophone quartet, written in collaboration with the Quatuor Quasar of Montreal (Gutierrez Martínez 2025).

The colour scheme reflects the harmonic progression of each multiphonic, starting with the first partial in black and moving through higher partials in the following sequence: blue, green, yellow, orange, red, purple, and pink. The spatial distribution reveals some clustering of sounds from the Sparnaay collection, as shown in the plot on the left, where points of the same colour are positioned in close proximity. The clustering doesn't necessarily arrange similar sounding multiphonics exclusively in terms of pitch similarity. In some cases, other perceptual attributes play a role in the arrangement of sounds, such as harmonicity (or "peakyness" of the spectrum), spectral flatness (or noisiness), granularity, and so on.

As the arrangements of colours on the left plot shows, spectrally rich and timbrally "thick" multiphonics (larger black dots) cluster on the upper left side, while the right side is populated with more "frail" sonorities. This suggests that spectral richness and harmonicity contribute to the arrangement of the multiphonics and account for the spatial distribution in the plots of Figure 6.

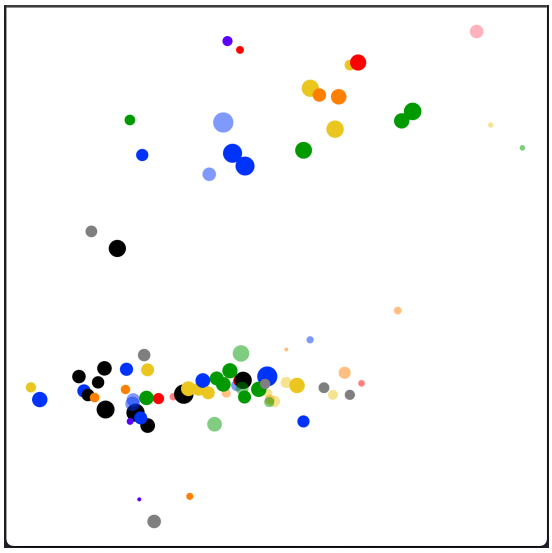

Figure 7. Plot containing estimated frequency of lowest component (y-axis) and spectral brightness (x-axis). Colour scheme (black, initial position; blue, second partial; green, third partial; yellow, fourth partial; orange, fifth partial; red, sixth partial; purple, seventh partial; pink, eighth partial).

Further visualisations were produced using different descriptors. Figure 7 presents two further arrangements of sounds in terms of calculated spectral centroid (x-axis) and estimated pitch (y-axis). Figure 8 presents spectral centroid (x-axis) and spectral flatness, which gives an estimate of the "noisiness" of the spectrum (y-axis).

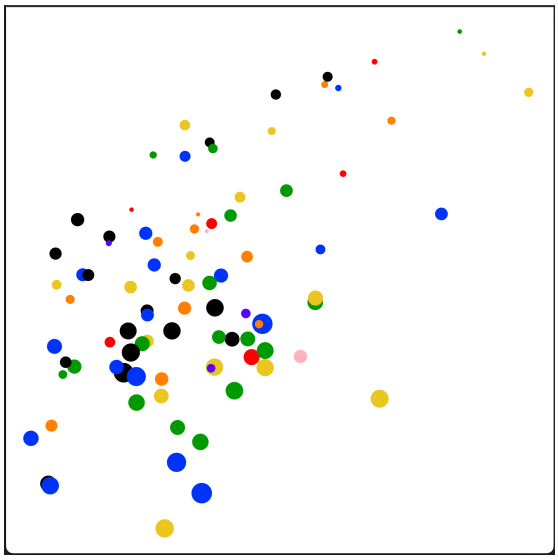

Figure 8. Plot of collection using spectral centroid (x-axis) and spectral flatness (y-axis) as descriptors.

An important consideration is that these visualisations don't provide—yet—any information regarding the "performative" proximity or the performance effort needed to produce these sounds. This is an important nuance that comes into play in performance, and is often overlooked by composers working only with fingering charts or "fixed" impressions of these sonorities extracted from the musical context where they are placed.[14]

[14] While several multiphonics might be in close fingering proximity to each other, some neighbouring multiphonics require somewhat different performance modes. This makes their concatenation difficult in cases where very different embouchure position or air pressure is warranted.

Sharing our Findings

We believe that this resource can serve as a useful reference for both performers and composers who wish to work with these sounds.[15] By visualising—and sounding—the multiphonic collection as points within a two-dimensional space, the user gains a bird's-eye perspective of the presented collection,[16] arranged according to timbral characteristics. This, in turn, enables a relational hearing of the sounds reinforced by the visual arrangement[17] —a process that would otherwise be more time-consuming to realise by playing sound files and attempting to do it "by ear."

https://vimeo.com/1129479591?fl=pl&fe=ti Interface Demo

The Map as Metaphor: A Path to Representation

The fingering charts from our initial mapping, together with the spatial distribution of multiphonics revealed by the timbre-space visualiser, not only shaped our understanding of the instrument's sonic landscape, but also contributed to the articulation of the space we were exploring—an articulation that was as much conceptual and poetic as it was grounded in the actual findings. This topographic metaphor became explicit in our work and subsequently informed the generation of an operational score.

During our initial exploration of the resonant space, we kept a recording log—a simple paper notebook without staves—in which we outlined a series of descriptors for each

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[15] The package includes the datasets of the calculated timbral descriptors, the sound collection, and the SuperCollider file, and is available for download from github: https://github.com/gutmandres/MF_TSVisualizer

[16] Presenting the full collection extends beyond the scope of this publication. For the sake of demonstration, we have only included representative examples for each multiphonic category that we found.

[17] The fingering diagrams were created using the web application *Fingering Diagram Builder* https://fingering.bretpimentel.com/

recorded sonority (Figure 9).[18] The upper harmonics were initially noted using Anglo-Saxon alphabetical notation and bass clarinet–transposed pitches.[19] For our initial exploration—layering the resonance modes and moving freely vertically among the different modes *within* each multiphonic—this intuitive, personal form of notation proved sufficient for us.

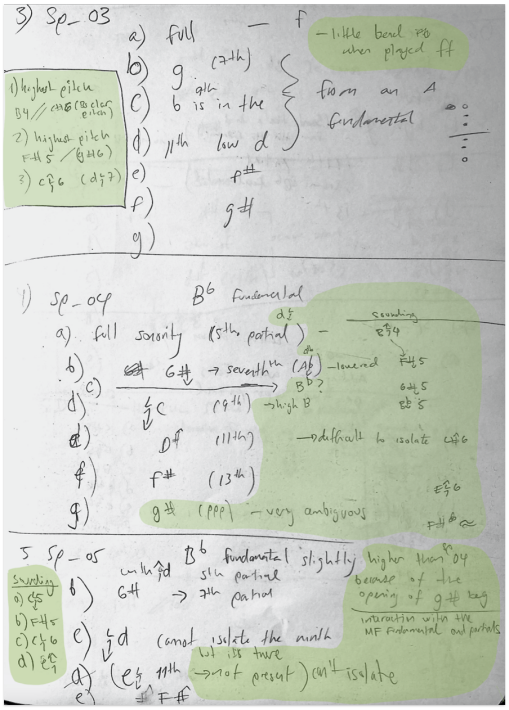

Figure 9. Photograph of the recording log showing annotations from the recording session and additional notes added during the analysis phase (highlighted in green).

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[18] These included the take number from our recording session, the source from which it was drawn, the "anchor fingering" diagram, the sequence of high resonance peaks (corresponding to the different modes of the multiphonic) that emerged through Chiara's articulation of the resonant space, and additional relevant observations.

[19] This choice reflected the fact that, while exploring the resonant space of each multiphonic, we were simultaneously speculating about the two interacting columns of air that generated the harmonic series we were encountering. Such speculation required constant shifts of attention between the fingering configuration and its sonic output. All this embodied and emergent information—haptic, structural, acoustic, and aural—is inscribed in Chiara's embodied memory as a clarinettist in the form of clarinet tones and transposed note names—not sounding pitches. As previously discussed, our speculations followed the "loading" and "venting" conceptualisation proposed by McLaughlin in *The material clarinet* (McLaughlin 2022).

As we progressed and began to move around multiphonics *laterally* (modifying the fingering while trying to maintain the multiphonic register) and *diagonally* (modifying the fingering while shifting between the multiphonics' resonant modes), a more conventional linear form of notation on the musical stave was introduced. The elements we considered necessary for the accurate and reliable production of each of the encountered resonant modes were the fingering diagram and a simplified dyadic notation, indicating the lowest tone of the multiphonic together with the predominant upper harmonic characteristic of that resonant mode—the tones the performer needs to target in order to efficiently initiate the sonority. In some cases, additional internal partials were included in the notation, when focusing on them—or on their surrounding region—proved useful for supporting the emission of a specific resonant mode. This simplified notation proved effective in connecting multiple sonorities into longer linear phrases, as shown in Figure 10 in one of Andrés's operative sketches.

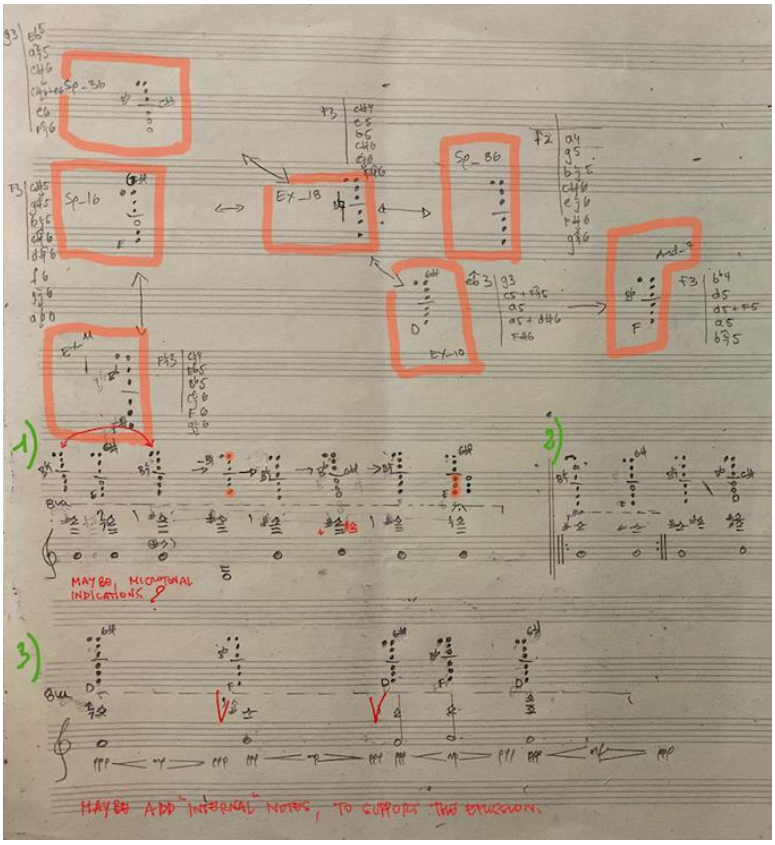

Figure 10. One of Andrés's initial sketches, annotated by Chiara with notes on performance-related issues.

While this dyadic form of notation—traditional and immediate[20]—proved effective in guiding the performer to reproduce predetermined concatenations of multiphonic modes, it still failed to capture the full composite resonant landscape expressed by each fingering configuration, since it excluded all other resonance modes associated with that fingering. At this stage, we verified the recorded partials in Sonic Visualiser and Spear, making necessary microtonal adjustments and generating two arrays for the interface (Figure 11).

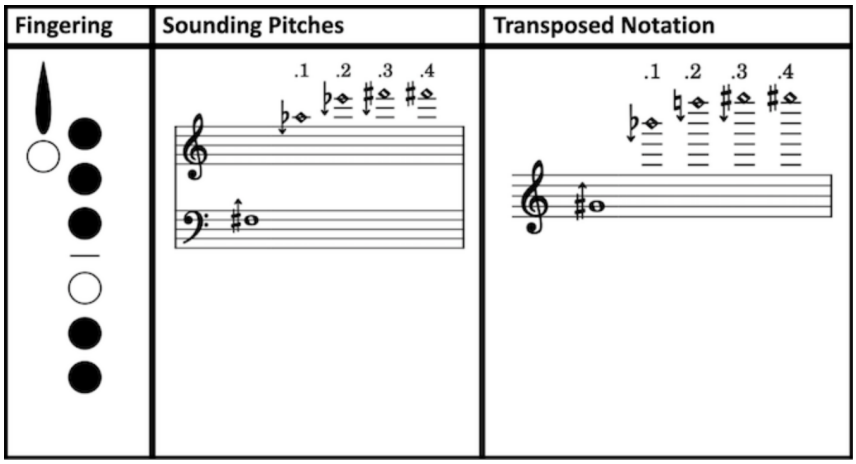

Figure 11. Multiphonic arrays from the second window of the interface, in sounding pitches and in clarinet Bb notation.

We decided on a form of notation that lists the partials linearly rather than as a stacked chord, reflecting the process by which we became familiar with these modes—by progressively probing the available resonant space. At the same time, by avoiding a chord-like representation of multiphonics, we aimed not to suggest the misleading idea that, as one moves vertically through the modes, the resonance peaks simply layer on top of one another, stacking on those previously reached. In reality, the way the analysed multiphonics "open" into successive resonant modes is extremely varied and often difficult to predict.

[20] As mentioned above, this dyadic form of notation is commonly used among composers (for example, in the works of Rebecca Saunders and Pierluigi Billone, among others) and discussed in several treatises on contemporary clarinet technique (such as those by Harry Sparnaay and Phillip Rehfeldt).

For every multiphonic we discussed, each subsequent resonant mode stacks on top of the lowest tone of said multiphonic—hence our proposal to notate them as an array of sounds with an initial pedal tone. Some multiphonics allow one or more higher harmonics to be embedded organically into the sonority without losing the initial main components, while others immediately drop one or more low partials as higher harmonics emerge. In some cases, lower frequencies that disappear in the early modes reappear in later ones. Generally, we found that attempting to reach higher partials produces an almost pure tone, which—as Benade explains—is "based on the tallest resonance peak" (Benade 1990, 1712), and that most of these extreme modes are accessible only at the quietest dynamics.[21]

To document our exploration of the sonic landscape of bass clarinet multiphonics, we have used a range of notational approaches and produced a variety of operational maps. These maps are operational and progressive: they work until they work. When new questions arose, when greater detail in description was required, or when a different perspective became necessary, we shifted to new maps. In this sense, each of these maps functioned as a springboard for the development of the next. Some of them—such as the notes in the recording log—were modified or integrated multiple times by our individual contributions, reflecting the different observations and needs of composer and performer, and now offer a stratification of remarks and reflections, like the traces on a well-used paper map. We consider them *operational maps*: frameworks that allow us to organise our thinking around multiple sonorities from complementary perspectives. Like all maps, they are also subjective, partial, and temporary—sketching a tracing that does not claim to fix the terrain, but to make it navigable from different perspectives.

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[21] A more detailed description of how each multiphonic develops—going beyond the emergence of resonance peaks to examine how partials interact and combine across modes—would require further analysis of each configuration and lies beyond the current scope of this project. Moreover, we observed that the possibility of vertically superimposing different partials depends partly on the specific properties of each resonant space we analysed and partly on the performer's ability to activate their *multiphonicking* technique—a technique that evolves in parallel with the exploration.

Going to the Territory: An Operational Map

Once we arrived at an agreed-upon form of representing the elemental information that was needed to reproduce a particular sonority and conceptually orienting our work in relation to the topographic nature of our conceptual framing, we decided to continue to use the map metaphor in the development of the collaborative composition.

The map allowed us to experiment with the proposed form of array notation and raised questions about the plausibility of the connections with regard to the performative constraints, while working on a small selection of nine multiphonics. How easy is it to move from one fingering to another? How seamless can these transitions be? Does our notational strategy provide all the necessary information for the performance? Is it easy to switch partials as one switches fingerings?

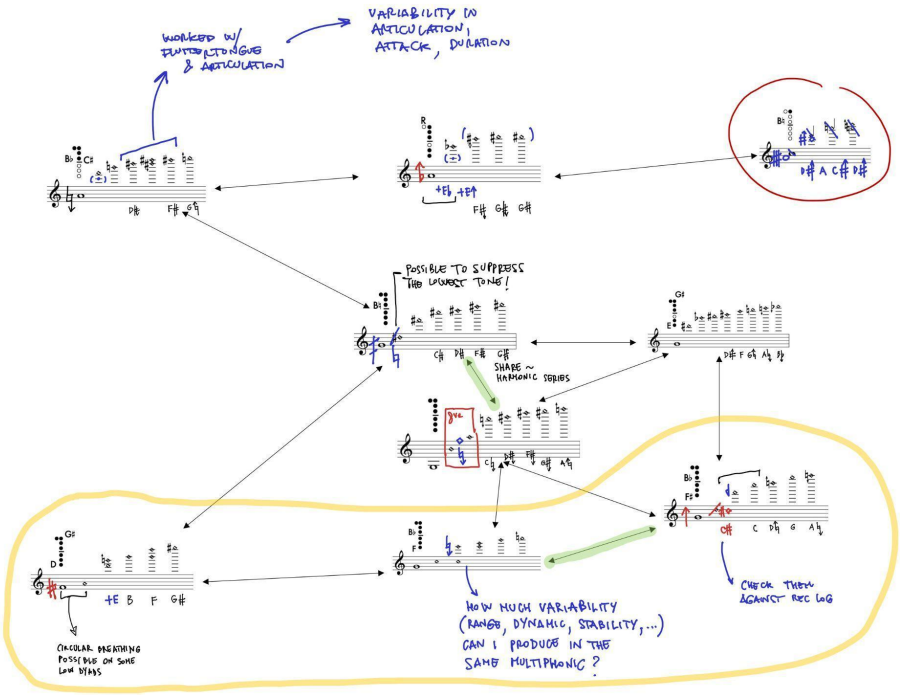

Figure 12. Sketch of road map for the performer to explore, designed by Andrés and commented by Chiara. The performer can decide whether to stay within a particular register or to switch registers as she changes fingerings.

By clearly presenting the available modes of each chosen multiphonic—that is, their similarities and differences in peak progressions, shared partials, or the melodic movements possible between different modes—the map supports the performer in creatively building on top of this preliminary information. The movement paths suggested by the arrows were tested by moving back and forth between the multiphonics and their modes.

This operational map served as an important step in trying to bridge technical execution and artistic use. For instance, it allowed us to imagine, discuss, and subsequently experiment with the superimposition of additional techniques onto those required to produce these sonorities. We tested different forms of articulation (staccato, fluttertongue, slap tongue), dynamic variation, circular breathing, and degrees of inner stability. In future iterations, the map will be complemented with "lateral neighbours"—that is, fingerings of adjacent multiphonics not included in our corpus—to create "local regions of exploration" tying together vertical and lateral explorations according to our topographic understanding of this exploratory practice.

Future Paths

Our aim has been to contribute to the growth of an artistic practice that fully embraces the dynamic sonic space of clarinet multiphonics. Further technical and creative efforts will be necessary to integrate these sonorities into our repertoire of usable materials, including testing the technique and the proposed notation with other instrumentalists.

Having performed extensive recordings, we have at our disposal a vast collection of sounds that create a corpus for electroacoustic treatment. The corpus forms the basis of a "timbre-follower" concatenative sampler that reacts to sound input. By performing real-time analysis of the incoming signal, the sampler searches within the existing collection triggering the sound with the closest timbral attributes. This system can be used both as stand-alone or in an interactive performance setting with the acoustic instrument.

While our approach takes into consideration the underlying fingerings that produce the complex sounds, these are not encoded within the data itself, but rather included as *metadata* for each data point. In the future, a more robust encoding of each sound—encompassing fingerings, lateral neighbours, performance effort, etc.—similar to that used in projects such as *OboeJS* (Döbereiner 2018) would certainly enhance the generative potential of our approach.

Probing the Ground (and the Sky, and the Sides)

During a week of dedicated work on bass clarinet multiphonics, we encountered sounds that evoked in us a sense of mystery and awe, dire impressions of inevitable failure, fleeting dreams of omnipotence followed by sudden returns to earth, and ongoing negotiations with the materiality of the instrument and the performer's body.

We acknowledge the oftentimes precarious nature of these sounds and techniques. Produced in a controlled environment and often emerging only after multiple fine-tuning iterations, these sounds, in our experience, rely on a precise coupling between the performer’s vocal tract control and the specific modes of resonance offered by each fingering configuration. Vertical, horizontal, and diagonal movements that connect partials of different multiphonics as part of longer musical phrases demand both immediate fine-tuning of the performer’s perception (imagining the correct sound) and action (adjusting technique accordingly). If, as saxophonist and researcher Torben Snekkestad suggests, “the energy of trying to control an unstable music material feels fruitful” for the improvising performer (Snekkestad 2019), the situation might change when such techniques are employed in contexts that demand stability, precision, and the reproducibility of predetermined trajectories. In these cases, frustration may arise from a diminished sense of familiarity with the full vertical extension of the multiphonic sonorities, and from the insecurity that moving within this multidimensional space entails.

While full control over these sonorities is probably achievable—given sufficient time and training—we must also ask ourselves, echoing Snekkestad, "to what extent one should strive to have control? When does that possible or impossible perfect command over the technique close the possibility of the unforeseen, the unheard, the gratifying surprise?" (Snekkestad 2019). Indeed, some of the most compelling sonic encounters of our exploration did not emerge from systematic mapping, moving safely along a fixed path from A to B, but rather from moments of suspension—pausing to playfully test the ground immediately around us. Slight variations in fingering, subtle adjustments of air, or moments of failure and instability opened up a spectrum of sounds we would not have found otherwise. Our practice unfolded, therefore, as an oscillating dialogue: a constant, imperfect, and contradictory attempt at balancing control and openness. To fully inhabit this landscape—not merely navigate it—what is required may be not only technical skill, but also a virtuosity of listening, fragility, and openness, welcoming the unforeseen as an integral part of the journey.

We call these sonorities *fragile* not only because they are technically demanding (requiring extensive study) but also because the technique itself is inherently delicate—as it arises from the performer's manipulation of the instrument's natural (built-in) resonances. Working with multiphonics means accepting the paradox of engaging with the materiality of the instrument while simultaneously seeking to override the system. Performers are part of the system, yet by interacting with and manipulating it to access these extreme sounds, they inevitably introduce elements of their own individuality—specific bodies, oral cavity dimensions, performance abilities, and instrument makes. Instrumental techniques are learnt in and through our bodies, and the knowledge we can produce and share about them is necessarily situated and partial, emerging from our limited but engaged standpoint. Embracing a situated form of knowledge, as proposed by philosopher Donna Haraway (1988), seemed unavoidable in our analysis—for instance, when attempting to notate the frequencies of each multiphonic down to the

Hertz level. These sounds would simply not exist without the interaction of physical—and therefore inherently individualised and transient—bodies.[22]

Multiphonic sonorities are the landmarks of the landscape we have sought to explore. At the same time, these sounds are traces—echoes generated through canyons, casts of an inner geography that is transversal to both performer and instrument. As we mapped the sonic landscape of bass clarinet multiphonics available to us, we simultaneously mapped—that is, reflected upon—our own specific interactions with the physical and theoretical space of these sounds. We repeatedly moved from the feeling of the space to its mapping, and then back into the territory, simultaneously testing the maps we produced and the different forms of awareness they generated.

Contemplating the Landscape

We are exploring this potential sonic space through the exchange of our individual expertise. We believe that what we have dug out from the soil could not have emerged from a soliloquy between the performer and her instrument, but only from the convergence of two different approaches, perspectives, and modes of listening. While the performer physically articulated the multiphonic space—like a flashlight revealing a hidden landscape or a probe testing the ground or the ceiling—the composer sought to connect and weave, pushing technique through sheer speculation. Different and complementary forms of mapping have accompanied and continue to shape our exploration of bass clarinet multiphonics. Some of them have guided, others prescribed, hidden, revealed, or arranged elements. At the same time, we have come to realise that this approach places the performer and the composer *within* the map, not only to account for a landscape but also to contribute to re-generate it. Anyone familiar with topographic maps knows that points appearing close on paper may, in reality, be separated by vast distances due to variations in terrain—valleys, ridges, and troughs. As

[22] This reminds us of Schrodinger's cat paradox—remaining on its methodological and procedural rather than quantum mechanics implications (Schrödinger 1935). By examining the system, by interrogating it, we are inevitably introducing elements of disturbance and subjectivity.

we account for our own journey of exploration, we embrace the precarity and fallibility inherent in this technical and compositional approach, and we stand in awe of the soundscapes that, even if only for a fraction of a second, we became a part of.

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References

Backus, John. 1978. "Multiphonic Tones in the Woodwind Instruments." *Journal of the Acoustical Society of America*, 63 (2): 591–599. https://doi.org/10.1121/1.381758

Benade, Arthur H. 1990. *Fundamentals of musical acoustics*. 2nd, rev. ed. New York: Dover Publications. EPUB.

Bok, Henri, and Eugen Wendel. 1989. New Techniques for the Bass Clarinet. Paris: Edition Salabert.

Döbereiner, Luc. 2018. "OboeJS: A Constraint-Based Approach to Instrument-Specific Algorithmic Composition," In *Proceedings of the International Computer Music Conference*, 235–237. https://quod.lib.umich.edu/i/i...

Fallowfield, Ellen. 2011. "Actions and Sounds: An Introduction to *Cello Map*." *dissonance*, 115: 51–59. Schweizerischer Tonkünstlerverein. https://doi.org/10.5169/seals-927560

Grey, John M., and John W. Gordon. 1978. "Perceptual effects of spectral modifications on musical timbres." *Journal of the Acoustical Society of America*, 63 (5): 1493–1500. https://doi.org/10.1121/1.381843

Grisey, Gérard. 2008. "À propos de la synthèse instrumentale." In *Écrits, ou l'invention de la musique spectrale*, edited by Guy Lelong and Anne-Marie Réby, 35–7. Paris: L'Harmattan.

Gutiérrez Martínez, Andrés. 2025. "Instances of proximity in ebb and flow for saxophone quartet." *Timbre and Orchestration Resource.* https://doi.org/10.5281/zenodo.16541473.

Haraway, Donna. 1988. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective." *Feminist Studies*, 14 (3): 575–599. https://doi.org/10.2307/317806...

Learn FLUCOMA. n.d.. https://learn.flucoma.org/reference/umap/. Accessed 15 September 2025.

McLaughlin, Scott. 2022. "The Material Clarinet." In *Rethinking the Musical Instrument*, edited by Mine Doğantan-Dack, 70–96. Newcastle upon Tyne: Cambridge Scholars Publishing. https://www.lutins.co.uk/writi...

Pimentel, Brett. 2010–25. Fingering Diagram Builder: https://fingering.bretpimentel.com/. Accessed 18 February 2025.

Rehfeldt, Phillip. 1994. *New Directions for Clarinet*, rev. ed. Berkeley: University of California Press.

Roberts, Alex, and Nicholas Moroz. 2021. *Bass Clarinet Multiphonics. Explore Ensemble*. Accessed 25 February 2025. https://explore-ensemble.bandcamp.com/album/bass-clarinet-multiphonics

Scavone, Gary P., Antoine Lefebvre, and Andrey R. Da Silva. 2008. "Measurement of Vocal-Tract Influence during Saxophone Performance." *Journal of the Acoustical Society of America*, 123 (4): 2391–2400. https://doi.org/10.1121/1.2839900

Schrödinger, Erwin. 1935. "Die gegenwärtige Situation in der Quantenmechanik." *Naturwissenschaften*, 23: 807–812. https://doi.org/10.1007/BF0149...

Snekkestad, Torben. 2019. "The Poetics Of A Multiphonic Landscape," *Research Catalogue*. Accessed 20 September 2025. https://doi.org/10.22501/rc.518792

Sparnaay, Harry. 2011. The Bass Clarinet: A Personal History. Barcelona: Periferia Sheet Music.

Tremblay, Pierre Alexandre. 2019. *The Fluid Corpus Manipulation*, https://www.flucoma.org/. Accessed 26 February 2025.

Tremblay, Pierre Alexandre, Gerard Roma, and Owen Green. 2021. "Enabling Programmatic Data Mining as Musicking: The Fluid Corpus Manipulation Toolkit." *Computer Music Journal*, 45 (2): 9–23. https://doi.org/10.1162/comj_a_00600

About the authors

Chiara Percivati is a clarinettist, performer, and researcher. Her artistic work and research focus on exploring, questioning, and expanding the symbiotic relationship between performer and instrument. She conducts research in the field of instrument preparation and augmentation as a PhD candidate at the Orpheus Institute and the University of Antwerp, and as a researcher at the Royal Conservatoire Antwerp.

chiara.percivati@ap.be

Andrés Gutiérrez Martínez is a composer and electronic music performer whose recent work is informed by the perceptual study of timbre and its role in contemporary music. He has a PhD in music composition from the University of California San Diego and has recently accepted a position as Professor for Electroacoustic Composition at the Gustav Mahler Privatuniversität für Musik in Klagefurt, Austria. The writing of this article began during his postdoctoral fellowship in the Music Perception and Cognition Lab led by Stephen McAdams at the Schulich School of Music of McGill University.

andres.gutierrez-martinez@gmpu.ac.at