Souffle

Air and breath as a composition material

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Abstract

This project explores the construction of a musical language based on air and breath, expanded in their understanding through the concept of *souffle*. The research explores the 'souffle' paradigm, working on the timbre and texture of air and breath and on the role these multifaceted elements can play in the articulation of the musical form.

While post-war and recent works have concerned themselves with the incorporation of air and breath as part of a wider range of technical possibilities and timbre-based sound vocabulary, the development of air as a full, independent sound state, perspective, overarching and self-sufficient composition system remains to be properly addressed. The concept of souffle 'dissolves' (or more exactly merges) the air and breath dichotomy, the duality between human (breath related) and instrumental (non-breath related) modes of sound production, allowing for the ability to focus on the fruits of their hybridization. By 'diluting' the breath/air (instrument/human) differences, new borders emerge and become materials for form, sounds and articulations.

The souffle continuum (air, breath, friction) develops through several compositional directions. Nine works create a corpus to explore interrelated research foci and developments. Chamber forces explore timbre complexity and sound malleability. Large ensembles use the instrumental mass to work on energy. Electronic expansions, new or unconventional instrumentations investigate the 'porosity' and fragility of air – air as an omnipresent element in the instruments' workings and inherent (possibly unavoidable) part of the sound of both traditional and contemporary techniques, re-evaluated and 'revitalised' through the lens of souffle.

Focusing both on the details and transversality of these complex elements, air emerges as a metamaterial investigated through three interrelated research axes: the air 'tactility' (air as a form of contact), the air 'resonance' (the complex human-instrumental intertwinement and ambiguity) and the air 'multiplicity and energy' (the extended developments through large forces). If the investigations are primarily compositional, they extend to broader reflections, perhaps inevitable in this context: perception and ambiguity, illusions and new temporalities, fragilities and instabilities, and air and sound porosities. Hybrid applications and extensions – i.e. the fusion (or confusion) of souffle with other sound phenomena or parameters – are key research axes. They develop compositional perspectives with other phenomena, parameters and (contemporary and traditional-classical) paradigms and approaches.

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Introduction. Souffle: protean tool - polymorphic (sound) material

This project explores the construction of a musical language based on air and breath, expanded in their understanding through the musical idea of *souffle*. While post-war and recent works have concerned themselves with the incorporation of air and breath as part of a wider range of technical possibilities and timbre-based sound vocabulary, the approach to and development of air as a full, independent sound state, perspective, overarching and self-sufficient composition system remains to be properly addressed. Focusing both on the details and transversality of these complex elements, the souffle paradigm develops air as a multifaceted metamaterial through interrelated research and compositional axes and foci. The souffle continuum (air, breath, friction) develops through several compositional directions, starting from the in-depth exploration of the air 'tactility' (air as a form of contact, chapter 1), the dual 'resonance' of air and breath (the complex human-instrumental intertwinement and ambiguity, chapter 2) and the 'multiplicity and energy' of air (extended developments in large instrumental forces, chapter 3).

Various approaches and instrumental mediums develop through the nine works of this project. Chamber forces explore timbre complexity and sound malleability. Large ensembles use the instrumental mass to work on energy. Electronic expansions, new or unconventional instrumentations investigate the 'porosity' and fragility of air – air as an omnipresent element in the instruments' workings and inherent (possibly unavoidable) part of the sound of both traditional and contemporary techniques, re-evaluated and 'revitalised' through the lens of souffle. Far from being an agglomeration of timbre 'residues' devoid of pitch, colour or function, or the mere manifestation of bodily, phonetic or instrumental actions, souffle is a complete compositional time and sound organisation principle with its sound states and harmonic, spectral, temporal, gestural and structural forms, whose physical and acoustic energies create complex timbres and resonances. If the investigations are primarily compositional, they extend to broader reflections, perhaps inevitable in this context: perception and ambiguity, illusions and new temporalities, fragilities and instabilities, and air and sound porosities. Hybrid applications and extensions – i.e. the fusion (or confusion) of souffle with other sound phenomena or parameters – are key research axes. They develop compositional perspectives with other phenomena, parameters and (contemporary and traditional-classical) paradigms and approaches.

This project is the fruit of an investigation into three compositional axes subdivided into three sub-axes (see form and methodology). Crucially, the research starting point by investigating air with no physical utilisation – air as a form of contact – is by itself an illustration of the research aim and souffle approach: under this approach, air (as souffle) is an overarching element, a musical state and writing system – a 'whole' expanding through and beyond air sounds (here in their multiplicity). While 'milestone' composers are abundantly discussed (explorations and compositional paths open by Sciarrino, Lachenmann, Holliger), other composers and approaches (spectral music, saturation aesthetics and techniques of composers such as Bedrossian, works of Boulez on resonance, and more generally other contemporary approaches to timbre and techniques) build fruitful pathways nourishing the souffle paradigm.

Emergence of souffle

To some extent, this project stems from an inspiring linguistic impossibility. There is no equivalent to the word 'souffle' in English. This allows me to approach this word (part of my mother tongue) from a new angle, envisaging it under its conceptual form as a frame for my research ideas, and propose a compositional (re)definition. Souffle emerges as a concept and expands beyond words as a complex category *of* timbre(s) and *within* the timbre – a hybrid between the human-instrumental worlds and within the sound, including in terms of intensity, energy and proportion, and in constant dialogue and interaction with the other 'granulated', 'saturated', 'inharmonic' or 'noise-based' sound states and compositional paradigms; a polymorphous, unifying *whole* that can deploy through and fragment into various sound states that are themselves multifaceted.

Through its expansions within and beyond air, souffle, as a musical idea, also represents an illustration – and a possible outcome – of a broader (historical and contemporary) phenomenon, the dissolution of traditional musical parameters (such as pitch or harmony) towards the construction of new sound paradigms around broader notions (granularity, timbre, gesture, saturation, to name only a few). The need for a lens on these emerging or existing paradigms – encompassing imaginary, poetical, functional or analytical perspectives – is illustrated by numerous publications attempting to explore the fruits of the post-war and 21st-century extensions and (r)evolutions – the possibly overwhelming 'unity-splintering' of the sound material,[1] the result of the 'refocusing on the level of the material, which takes precedence over the other two levels, language and form'.[2] In this context of material proliferation, souffle represents a tool that can cut through the parameters and create a possible perspective on today's evolving soundworlds – in which unpitched elements or timbre complexity are often the very basis for composition. The research postulates that air and breath, approached as a protean tool, material and perspective (souffle), can contribute to this trajectory by providing an angle of approach that is both *overarching* and specific.

As a consequence, this PhD does not attempt to define *souffle* (the usual equivalent is 'breath' – but it is only a near equivalent, see below), souffle being a reifying term encompassing multiple meanings and interpretations, literal and more conceptual (there are other words in the music vocabulary with such complex understandings and linguistic variations: timbre, texture, noise, etc.).[3] Rather, the research takes the multiple meanings of souffle as a fruitful compositional lens and more generally as a compositional mindset through which the multifaceted aspect of air and breath can develop compositionally limitlessly – as a cluster of interrelated parameters building a sonic state and composition system that can communicate with the other systems, and, more generally, represent a possible *lens* and *approach* to sound and composition as part of the gradual, yet constant dissolution of traditional parameters towards the construction of new sound approaches and paradigms, among which the one of souffle emerges as a possible reading grid.[4] Therefore, works of composers and musicologists such as Chion and Solomos, whose theories pertain to the definition and broader emergence of 'sound' (*le son*, another reifying, perhaps indefinable and linguistically changing word and concept), are incorporated and create fruitful perspectives in the three chapters/axes of the research.

[1] Cohen-Levinas, D., (2006) La *voix au-delà du chant : une fenêtre aux ombres,* Paris, Vrin, p.35.
[2] Solomos, M. (2020). *From Music to Sound. The Emergence of Sound in 20th- and 21st-Century Music,* London: Routledge
[3] See Solomos' discussion of the word 'timbre' in *ibid.*, its multiple meanings and linguistic variations (e.g. klanfarben, sound colour), Chion's reflection on the word 'sound' (see below) or the multiple understandings of the word 'noise' (e.g. bruit, geraush) in music.
[4] As seen below, souffle can both refer to and 'blur' the physical and sonic (causes and consequences) aspects and sources within a single term and concept, a fruitful perspective the research develops. Examples of applications and 'readings' under the souffle lens include timbral expansions (e.g. in the works of Sciarrino, see p.18-20), electronic and acousmatic applications (e.g. Henry *Le Voyage* (1962), see p.36) as well as corporeal-instrumental developments (e.g. Levinas *Arsis et Thesis ou la chanson du souffle* (1971), see p.116).

Towards 'Souffle': the air dichotomy

Thanks to the multiple ambiguities that the vague meaning of the word "sound" sustains, there can be no agreed-upon overview of all that has been written on the topic. (Chion) [5] *Air is the medium to generate beautiful sounds in traditional music, but one that is not meant to draw attention on itself, by, for example, escaping from a mouthpiece. (Lachenmann)*[6]

Air is the fundamental medium of sound. Sound is created through the vibration of air, and while other elements are possible transmitters of sound,[7] the absence of air means no possible 'life' of sound.[8] One could also say that air is omnipresent within musical developments. Air creates the sound of winds instruments; the movements of the musicians take place in the air; 'whipping' the air can even become a mode of sound production.[9]

Beyond a mode of sound production and a medium for sound transmission, air is also a complex sound by itself, and a result *within* the sound. Air can be both the physical movement (and mode of sound production) and the sound result – a cause and consequence – but also the sound result (and consequence) only. Its multiple natural, physical and sonic manifestations illustrate this duality: winds, tempests, breathings; air can be heard in whispering voices, howling winds, but also in white-noise and mechanical sounds. As a sound material, air can therefore develop as its own cause (both producing the sound and heard in the/as a sound) and a consequence only, untied to the cause (a 'resulting' element heard in the/as a sound, e.g. built or heard through other modes of sound production or phenomena).

For Chion, this duality between the cause and the consequence is the proper of sound as a wide/multifaceted phenomenon and leads to perception ambiguities – but also to multiple attempts to grasp 'what is sound' from its deepest causes to its deepest effects.[10]

In music, this dichotomy reflects in the modes of sound production. Air is the physical medium to create the sound of wind instruments – 'human' (breath) or 'mechanical' (for instruments such as organ or accordion) – and is a part of their sound (carefully hidden yet present in classical music, part of the expression in non-western traditions and element per se in contemporary explorations). If air is not the medium to create the sound of (non-wind) instruments such as strings or percussion,[11] it is, however, in many cases, a part of their array of sound (equally carefully hidden in classical contexts and full element of expression in other contexts, e.g. the result of hand movements on a fingerboard or friction of a bow on a string).

Several languages (including English) make a clear distinction between these two aspects, distinguishing the mode of sound production and the result in sound (*air* and *air-like* sounds). However, this distinction is far from universal. Latin languages (such as French) tend to encompass both physical and sonic (causes and

[5] Chion, M. (2016). *Sound: An Acoulogical Treatise*. Durham, London: Duke University Press. (Preface)
[6] *Hören ist wehrlos – ohne Hören in* Lachenmann, H., (1996) *Musik als existentielle Erfahrung: Schriften 1966–1995*, edited by Josef Häusler. Mainz: Breitkopf & Härtel, Insel Verlag.
[7] E.g. water, materials such as glass, marble.
[8] Throughout the discussion, quotation marks have been adopted to emphasise the poetical utilisation of a term as opposed to its literal understanding.
[9] E.g. 'bow-whipping' techniques (chapter 1.1).
[10] Chion, *Sound* (see footnote 5).
[11] With the exception of wind-stimulated instruments, e.g. aeolian harp, wind chimes.

consequences) aspects within a single term: souffle. If an 'air-like' *sound* is by definition not the physically result of air (but may be produced, for example, by a machine or instrumental friction) a *souffle* may indifferently be produced by air or by any other means.[12]

As a starting definition, souffle means air and movement. Souffle commonly serves to translate breath. Depending on the context, the term souffle finds possible equivalent(s) in words or combinations of words related to the ideas of air and movement - e.g. blow, wind, blast, breath - and, as seen previously the sound of (or resembling) air, be it related to the body, the instrument, or any source (e.g. electroacoustic). There is thus in the essence of souffle a *sense of the multiple*, for it can refer (in most cases literally) to any sound of any nature or source *of* or *akin* to air, as well as to the mediums that physically create them, without any separation between the sonic and physical (and by extension body and sound) perspectives.

A complex assemblage of actions and parameters may thus be encompassed within a single word, paradigm and conceptualization, hitherto taken as read or as a cluster of independent parameters. 'Souffle' (or air) is envisaged as an overarching element whose ineffability is an inspiring, fruitful aspect the compositions attempt to grasp. Just like the 'sound' in Chion's perspective, it may simply not be possible to grasp a 'whole' by definition beyond our understanding. Nevertheless, through envisaging souffle as a starting point for composition and developing it in several directions – from solo to orchestral applications, static to dynamic forms, porous timbral forms to pure white noise, in dialogue, merging or contrast with other elements and ideas and (con)fusion between mechanical, human and instrumental forms and 'states' – the research attempts to develop souffle as a versatile element whose plasticity and malleability can (re)create the resources for a musical language, and paradigmatic view of contemporary techniques, material and form.

In the research, the concept of souffle 'dissolves' (or more exactly merges) the dichotomy / duality between the human (breath related) and instrumental (non-breath related) modes of sound production, allowing focusing on the sound itself, the textures disconnected from the modes of sound production (and from the human/instrument duality) and reconnected in a new fashion. By 'diluting' the breath/air (instrument/human) differences, new borders emerge and become, in turn, materials for form, structure and articulations. Fundamental, human actions (such as respiration) may develop in new fashions.

Form

Chapter 1 investigates the *tactility* of air – air under the *contact* and *friction* perspective – a rich yet less explored pathway. Physical zones of (non-wind) instruments build a system of (souffle) filtration (1.1), whose developments lead to approaching air as a fragile, 'grazing' technique and state in interaction with other technical approaches and sound 'states' – traditional and extended (1.2) and over-pressed and saturated (1.3).

Chapter 2 explores the *resonance* of air, in search for the acoustic-corporeal (and instrument-human) threshold, i.e. the complex, liminal point of intersection of the human and the instrument, to develop air (souffle) towards a complex continuum fruit of the physical, tactile and 'resonating' combinations. The two forms of resonances the compositions develop – acoustic (extension, enhancement) and corporeal (body-instrument mirror

[12] Adding the word 'sound' – a souffle sound (*un son de souffle*) – would be redundant, and still keep the indeterminacy as to its source.

impacting perception) – create a wider compositional lens and a tool to develop air and air sounds (in all their forms) through various mediums: hybridization (2.1), augmented echoes and instrumentations – 'catacoustics' and sympathetic vibration (2.2), amplification and electronics (2.3).

Chapter 3 explores the *energy and multiplicity* of air (souffle), investigating unamplified solutions to fully develop the energy (dynamics, sound projection) and multiplicity (combination of the various air forms, complex textures and 'block' approaches) in large forces works. Developed in ensemble (3.1), concerto (3.2) and orchestral (3.3) contexts, these aspects create specific temporalities building on the *souffle continuum* (air-breath-friction), here augmented through the findings of chapters 1 (friction) and 2 (resonances), and the combination/application of new instrumental processes at a larger scale, exploiting the *souffle-based orchestration system*.

Methodology: matrix and double reading grid

The project develops through a dual matrix approach (table 1, see p.6) translated in the form of the thesis. Nine works create a composition corpus developed with and for the tools and investigations gradually deployed throughout the research. Each chapter (three axes, see fig.1 p.6) incorporates three subchapters/works addressing interrelated aspects (three overarching thematic/foci). Each axis (vertical reading of table 1) develops a triple approach through a gradual development process which is common to and overarches the axes (horizontal reading of table 1).

The methodology unfolds as follows:

- Deep technical investigations build a composition system based on the tactile, resonating and energetic-multiple forms of air (1.1 *Circle(s)*, 2.1 *Atma(n)*, and 3.1 *Holo(s)*), explored as a fragile and 'porous' element whose (omni)presence sheds new light on contemporary and classical forms and expansions (2.1 *Un eco di soffio*, 2.2 *Un eco di soffio II*, and 2.3 *Concerto pour piano*), towards radical developments, from which perspectives with other techniques, soundworlds and approaches emerge (1.3 *Ra'ash*, 2.3 *Tracer le souffle*, and 3.3 *Sha'aph*).
- The malleable forms of friction and 'tactile' developments (chap.1 'Touching air') extend to human-instrumental resonances of air and breath (chap.2 'Hybrid traces') developing instrumental and compositional techniques that exploit the strengths and energies (and weaknesses, instabilities and fragilities) of air as a material-matter and gesture-sound (chap.3 'Energy and multiplicity').

These interrelated approaches develop a cluster of research questions and sub-questions revolving around the development of the souffle paradigm:

- Can air (souffle) be (or become) a protean, polymorphic element?
- What are the fruits of its hybridisation and extensions with/through other musical phenomena?
- Can air (souffle) construct an element of harmonic density and extend through all registers, sounds, creating textures of complex energies and intensities?
- What are the instrumental/human synergies that can achieve this?
- What are the simple, multiple and radical or even extreme corporeal (and beyond-corporeal) (sound) forms and their interactions?

	Air	Breath	Souffle
	(extension 1)	(hybridities 1)	
	Toucher le souffle **Touching air**	**Corps en resonance** **hybrid traces**	**Multiplier le souffle** **Energy and multiplicity**
	Friction/contact	Breath/resonance	(Large) Forces
Towards a system new definition (extension 2)	*Circle(s)* (2018) Cello: Air/friction topology	*Atma(n)* (2018) Resonance(s): Human, instrument	*Holo(s)* (2018) Air as a force: An orchestration system
Porosity **Fragility** (hybridities 2)	*Un eco di soffio* (2019) Quietness and echoes: The share of air	*Un eco di soffio II* (2019) Deep resonance(s): Breath catacoustics	*Concerto pour piano* (2019) Air virtuosity: Until breathlessness
Extreme utilisation **Radicality** (perspectives)	*Ra'ash* (2020) (Deeper) into matter: Granulation - saturation	*Tracer le souffle* (2020) Resonance(s) extended: Composing the traces	*Sha'aph* (2020) Pulse and stasis: Dynamic/mass extremes

Table 1: Matrix and double reading grid

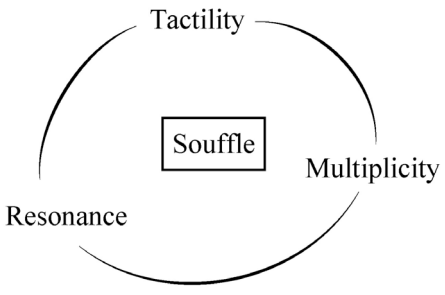

Fig.1 souffle: three axes

Research axes development: overview

Friction develops as a complex air and breath gesture and sound in the first chapter, parallel to, set against and taking precedence over the ‘other’ breaths (pneumatic, that of inspiration-expiration) and equally 'stored' and deployed through various sonic and instrumental spaces and states, from air halo to deep and raucous exhalation. A fluid and ‘floating’ (*flautando*) state, the air/breath-gesture in its grazed and touched developments seems at first ethereal and fragile, oscillating between different ‘white’ and inharmonic states, up to the silence of friction (1.1 and 1.2). As a gesture of friction, air/breath emerges as a porous, ‘spongy’ element capable of ‘plunging’ into the instrumental matter, resonating and 'digging' (into) it through its pressure: its *agglomeration* and *accumulation* make it a hybrid material and a force where the sound texture can unfold through multiple levels of density and amplification (1.3).

The complex relationship of the air/breath sound to the role of the human (here the musician), especially in the transversality and transmutation of air/breath, from breath to vibration, and to resonant silence – perhaps another static form of air or white noise – is more specifically explored in chapter two, which includes exploration of the ‘breath’ of instruments and machines, and their fusion or confusion with that of humans. In this context, investigations pertain to the possible complementarities and intermediate states between white noise – which oscillates between stasis and movement, micro-animation and saturation – and the breath regulated by arsis-thesis – that of men whose presence and absence are so many signs and tensions, questionings, and forms of communication. Resonance (that of human and instrumental bodies) becomes an object of extension, an *enveloping* element that emerges from the continuity between the physical and ‘expelled’ air (that of the voice or wind instruments) and touched and ‘rubbed’ air (of strings and other ‘contact’ instruments). A mirror, a prism, an ambiguity of the gestures, sounds and modes of production emerge. Human (2.1), instrumental (2.2), and electronic (2.3) resonances prolong the ‘expelled’ and ‘rubbed’ form of air and breath up to the traces, the echo, the confusion, until the invasion of white noise, in which resonances and amplified breaths intermingle and merge in a moving and static infinity, beyond (or perhaps as a new form of) breathing.

The decomposed and (re)composed resonances of air create amplification means that lead to denser soundworlds developed in the third chapter. Three works for large ensemble (3.1), concerto (3.2) and orchestra (3.3) develop the triple air-friction-resonance continuum towards a souffle-based orchestration system. The timbral and textural complexity thus extended (extended friction-gestures, resonances and human, instrumental and ‘pure’ air sounds and complex hybrid forms) generates a specific approach to the instrumental sound mass, that exploits the multiplicity of air and breath (souffle). Grain(s), saturation(s), resonance(s) and various filtrations agglomerate *around* and *inside* air and breath (souffle) to form a system of attack/resonance deploying souffle in all its forms of energy and intensity. Texture variations, orchestral masses and vertical blocks, or on the contrary elusive, horizontal and ‘circulating’ expansions generate two intertwined temporalities, communicating, complementary and merged, or contrasting and opposed: the first, vertical and striated, takes as a temporal basis the breath in its dual arsis-thesis development (e.g. tension and release, bright and dark, dry and deep) here modified, extended, saturated, clashed and interspersed by grain, resonance or silence, until suffocation or apnoea; the second, horizontal and smooth, stems from a more impenetrable expansion, that of white noise, wind and airwaves, oscillating between apparent stagnation and micro-animation – and between emptiness and fullness, latency and movement, and silence and resonance.

I: Touching air: the friction/contact perspective

A panting that had grazed this place [...] seem to reverberate infinitely within the one that they have marked. (Mallarmé) [13]

The overarching aim of the first chapter is to explore and build a system based on the 'tactility' of air. The compositions investigate paths through which a friction-based instrumental approach can achieve complex 'air' (souffle) sounds and soundworlds, thus reversing the predominance (and by extension bypassing the need) of 'corporeal' breath-based modes of sound production. Friction is approached as a versatile gesture capable of creating multiple air sounds and textures. The 'contact' perspective allows (re)considering air as a 'tactile' element and phenomena, and investigating (non-wind) instruments as extended 'air machines' – using their strings, bodies, or various parts as rubbing and filtration surfaces.[14] The investigation then extends to the interactions and reinforcements between 'physically' breath-produced air sounds – of voice or wind instruments which filter/amplify – and 'tactilely' (re)produced air sounds – of string and 'contact' instruments – towards a continuum expanding the complex colours and 'grain' of air.[15]

If friction is one of the first historical means for exploring air through imitation (see wind machines[16]), compositional developments of breath and air remain fundamentally linked to the techniques, sounds, and by extension perspectives of wind instruments and voice.[17] Friction actions such as rubbing are explored here as air and breath(like) gestures capable of creating rich air(like) soundworlds developed exclusively through 'contact' techniques (e.g. contact of a bow, rubbing of the hand on a string or part of an instrument). A potentially equally rich yet less explored mode of sound production, friction is approached as a tool, but also as a perspective allowing to (re)create air (souffle) textures and by extension new temporalities and perspectives on breath. The 'tactile' air (re)composition thus extends to time organization and form principles. In the applications, friction is a starting point, a filtered 'state' in constant interaction with the other states of the rubbed and 'touched' sound matter – from the continuous grain of wind-like sounds to the complex timbre expansions of overpressure techniques. This prolific continuity and intertwinement of and between gesture and sound is applied in subchapter 1.1 to the body and strings of the (amplified) cello (building on the Alberman-Lachenmann investigations[18]) and extended in subchapter 1.2 to the (omni)presence and 'porosity' of air in string techniques (classical and extended). Extending this, subchapter 1.3 explores the roughness and 'absorbing' quality of frictions and their contact surfaces, drawing from the Bedrossian-Cendo 'saturation' approach and expanding Lachenmann's idea of 'confrontation with the matter'.

The malleability of friction and its specific temporality – virtually unlimited, unlike the breath (exhalation) related modes of sound production – make it a rich and self-sufficient medium for exploring air (souffle). The

[13] Mallarmé, *Oeuvres completes*, vol. 1 (Paris: Gallimard, 1998), 484, 485.
[14] In chapter 3, this perspective extends towards hybrid utilization of non-wind instruments (piano, strings, percussions), both 'played' through friction and 'stimulated-vibrated' through the player's breath.
[15] The air/breath-friction continuum, chap.2 and 3.
[16] The wind machine is a friction idiophone used to produce the sound of wind in orchestral compositions. Historical utilizations range from baroque (e.g. Rameau *Les Boréades*) to post-war works (e.g. Ligeti, *Le Grand Macabre,* 1977).
[17] See for example the considerable development of wind instruments air sounds/techniques since the 1960s, illustrated by the large number of available handbooks which include in most cases several pages on air sounds (e.g. Weiss and Netti, *the techniques of saxophone playing*, 2010). Non-wind handbooks include little/no information on the production of air-like sounds (e.g. a few lines in Arditti, *the techniques of violin playing*, 2013).
[18] Alberman, D., Abnormal Playing Techniques in the String Quartets of Helmut Lachenmann, in Contemporary Music Review, 24:1, 39-51, 2005

velocities and pressures combined to the contact surfaces' resonance and 'roughness' qualities – using implements such as hands, bow, brush, fingernails (etc.), on the instrument's strings, wood, metal, skin (etc.) – form a filtration system; an approach through which speed, pressure, materials (re)produce air and breath(-like) sounds which can evolve in timbre complexity, colours and shares (1.1 and 1.2). The nature of friction as a sound and movement opens up to investigating other complementary aspects: the fragility of air when approached as an instrumental gesture (1.2), its nature as a 'filtered' movement and sonic state and possible extension towards other sonically (and gesturally) 'neighbouring' or 'affiliated' universes which can develop or even reinforce friction as a first 'filtered state' (1.3).

The friction perspective: chapter explorations

The processes and techniques examined in this chapter develop the first part of the research's core souffle (breath and friction) continuum, in which 'physical' and 'contact' forms (air and air-like) merge, reinforce and confuse each other (chap.2, resonance). This double perspective is extended to build complex temporalities, reinforced dynamics and instrumental synergies in large forces (chap.3, multiplicity).

This chapter presents three complementary perspectives, each of which is approached in the compositions (see below) and discussed in a subchapter (see fig.1).

Firstly, the idea of 'touching' and 'feeling' a sound, building on Lachenmann's instrumental 'concreteness' and idea of 'confrontation' with the matter, extends to the idea of 'touching' air and breath – the 'air tactility'. Lachnenmann's approach is discussed using Alberman's investigations, which suggest a taxonomy of air-related string techniques, drafting parallels which are fruitful paths for the research: frictions and phonetics, instrumental 'zones' and new gestures (extended in 1.1, *Circle(s)* for amplified cello). The broader questions of imitation and gesture-sound isomorphism and heteromorphism are then discussed, building on Chion's (and Solomos') reflection. The characteristics of frictions as air-like, but non breath-related modes of sound production, further underlines their complex nature and perception as sounds 'closest to concrete life.'[19]

Secondly, the fruitful malleability of friction as an element capable of both 'creating' and 'containing' air (here referred to as the 'porosity') is discussed. Exemplified by works of Sciarrino, this aspect broadens the reflection, addressing the 'inherent' and 'rebuilt' airy quality of friction techniques – conventional/classical as well as extended. This opens to discussing considerations such as contemporary utilizations and idiomatic forms, notation (e.g. of air-to-pitch ratio and air/sound interactions), dynamic softness and fragility, and control (or lack of control). These aspects are compositionally developed in 1.2 (*Un eco di soffio* for two cellos).

Thirdly, the malleability and porosity of friction are investigated under their gestural and 'contact' aspects (e.g. a light pressure, bow and string brushing action). This opens the reflection to the possible affiliations, transformations and even reinforcements between the air and non-air 'contact' forms (e.g. an air-like sound and a vibrated or overpressure sound) and their intermediate pathways (e.g. air sound incorporating harmonics, harmonics evolving towards 'pure' air). Developed in 1.3 (*Ra`ash* for harp and cello), this reflection builds, among other things, on the Bedrossian/Cendo 'saturation' approach.

[19] Solomos, *From Music to Sound,* p.70..

Presentation of the chapter's works

Circle(s) for amplified cello creates a repertoire of string/cello techniques and 'zones' through a gestural and 'topological' approach. The circle, as a gestural, compositional and notational shape, becomes a tool and process to work on air sounds and their evolution: gestural circle (e.g. circular bow), circulation of sound (e.g. from air to harmonics/multiphonics), physical circulation of the actions (e.g. from one 'zone' of the cello to another). The (potentially infinite) continuity the circularity offers generates the time approach and impacts the form construction – here a near-uninterrupted flow of air filtered in various fashions and incorporating other affiliated or emerging sound elements.

Un eco di soffio for two cellos explores the timbres and 'echoes' of air in string techniques/playing, to compose (with) the air 'porosity' (see below). Classical and extended techniques are revisited to 'extract' their underlying airy qualities – explicit sounds or shadows result that spring or emerge from the bow-finger-instrument contacts. Improvisation and repetition processes utilizing selected gestures and materials (glissando, bariolage, tremolo) investigate the richness but also the ever-evolving fragility of friction-related (air and air-containing) techniques. The piece's three movements build an overall quiet universe in which the two cellists 'guess' and mirror each other – systematically merging and (con)fusing their gestures and sounds until the borders of silence. They create through this a fragile 'meta-friction' instrument.

Ra`ash goes 'deeper' into instrumental matter. The work extends the 'contact' perspective towards resonance and reverberation, exploiting the extended friction-amplification 'surface' the uncommon instrumentation offers (harp and cello).[20] Velocity and pressure parameters explore the communicating states and shapes between extreme materials – furtive wind-like or whistle-like sounds to dense granulations – utilising the instruments' strings and bodies as malleable filtrations. The piece develops from the interactions between the triple filtered-ordinario-overpressure sound and contact 'states', approached as springing from and nourishing the first air (souffle) 'state' and perspective. By (literally) plunging and 'digging' into instrumental matter, the piece introduces the air (souffle) and resonance hybridization, a continuum developed in the next chapter.

Air, breath and friction: materials and matters, ambiguity of the senses, phonetic colours

Wind instruments (or blowing instruments, see German *blasinstrument*) resonate under the pressure of the player's breath or filter/amplify it in the cases of air sounds. The modes of sound production of bowed, struck or plucked string instruments as well as membranophones (including percussion) and idiophones obviously owe nothing to human breath (or mechanical/pneumatic air). But such instruments can achieve a wide array of air-like sounds, which stem in these contexts from touch and contact. It is here no longer through the energy and plasticity of air (or breath) that the sound builds and expands, but through the energy and plasticity of the surfaces in contact and friction. Variations in timbre and colours are thus the results of gesture speeds, amplitudes and intensities and other parameters; they are no longer associated with the cause (the action of blowing air), but with the consequence (the action of creating a breath or air sound).

A fruitful ambiguity and continuity emerge through this: not only an ambiguity of the senses (breath and touch) but also new continuity in sound and in time (breath *to* touch - and conversely). The 'touched' air and breath

[20] Harp and cello is a rare combination with a limited repertoire.

(friction) combines with the action of breathing and, depending on the combined conditions of speed, pressure and materials, produce sounds just as rich and 'real' as the breath of the human body or the wind instruments. Frictions thus become 'breath' gestures that can be set against/put in perspective with (here) the 'other' breaths – mechanical, pneumatic, that of inspiration and expiration – which become secondary.[21]

This friction (touch) and breath (air) conjunction appears in Mallarmé's words [chapter epigraph]. Beyond their perception strength (for themselves or merged with corporeal or wind instrument breath chap.2), friction and contact-based air-like sounds allow – and perhaps even imply – a different, wider temporality compared to breath-based air sounds.[22] Friction-based air-like sounds are for example disconnected with the process and need of air accumulation-triggering i.e. inhalation-exhalation or mechanical equivalent (see 2.3) to build the sound. The acoustic and corporeal limitations are purely gestural and spatial: distance, speed of the movement, space of/for the contact. If friction techniques allow to bypass the breath-related mechanisms and needs, they can be articulated in similar or complementary fashions, 'accumulated' and even deployed through various energies, spaces and states and shapes, e.g. granulated sounds to continuous flows, breath-like timbres to phonetic-variations.

Friction and phonetics are for example related through terminology. Fricative consonants[23] (e.g. sibilant [s]) are common, well-documented means for the air exploration in wind instrument or voice contexts.[24] They offer a potential instrument for investigating a 'phonetics of tactility' based on the exploration of the pathways between breath-based and friction-based (air and air-like) 'phonetic' actions.[25] If, as highlighted below for string techniques, the contact points are key to investigating these pathways and achieve potential 'equivalents', the principle is extendable to all types of instrumental bodies or 'surfaces' (percussion, piano, harp, etc.) combined at the chamber, ensemble and orchestral scales.[26]

If the air, sound and 'tactility' conjunction has deeper grounds in human evolution and perception and if the 'voluminosity' of sound still confusedly felt,[27] *tâter* (to feel/touch) a note has, for Solomos, never really been possible.[28] With a pitch, an interval, one can only 'vibrate.' Only the sounds 'closest to concrete life' can give the impression of 'being brushed against, of being touched.' A slow and methodical rubbing of the bow, the creaking of a string, 'gives the sensation of contact with matter, with concreteness' (Solomos). Hence the choice of composers such as Lachenmann to explore in detail the 'delicate and infinite worlds of sound' that can be produced through contact with the concrete 'matter' of musical instruments.

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[21] 2.1 and 2.3 develop complex combinations of vocal/instrumental (and electronic/mechanical) frictions, extended in parallel fashions (e.g. end of breath and friction residues/granulations). See also chap.3 discussion on orchestral interactions between frictions and air articulations in Lachenmann's *Shreiben* (2003).

[22] In chap.3, such an 'extended' temporality creates large forces composition tools/perspectives.

[23] Produced by partially obstructing the airflow through the oral cavity.

[24] See for ex. Weiss, M. and Netti, G., (2010) *The techniques of saxophone playing*. Kassel: Bärenreiter.

[25] Applications in chap.2 combine voice/breath/wind phonetic developments and friction approaches in various contexts. See also friction/air/timbre/resonance parallels in *Concerto pour Piano et ensemble* mov.2 (3.2).

[26] See 1.3, 2.1 and 3.

[27] The psychologist Maurice Pradines (quoted in Chion, *Sound*, p.109 - see footnote 5) highlights how the primal function of recognizing the form of the cause from sound waves was degraded (or at least relativized) in the course of evolution. 'One of the most important adaptations that life on land necessitated must have been, for vertebrates, the result of the privation of the aquatic protection.' In extending its reach by the registering of aerial vibrations, the tactile sense must have 'resigned itself' to the 'almost total loss of the sensation of form.' The voluminosity of sound, 'still confusedly felt, no longer corresponds, in any case, to any distinct representation of form or of the volume of sonorous bodies.' Pradines, M. (1981), *La fonction perceptive,* Paris: Denoël/Gonthier.

[28] Solomos, *From Music to Sound,* p.71.

Touching a sound, confronting the matter (Lachenmann). Air as a mediating, filtered state (strings)

Lachenmann's *musique concrète instrumentale* approach is probably the best illustration of this contact exploration and even 'confrontation' with the sonic matter, like the musician's 'confrontation with his instrument.'[29] Contact actions – rubbing, friction, pressure – are literal functions to work on instrumental 'concreteness', exploring territories beyond the conventional utilisations of instruments.[30] Pieces indeed constantly rub up against the instrumental matter: it is for Lachenmann a matter of 'feeling a sound' and 'building' an instrument.[31]

In his detailed article, Alberman investigates the air and friction parallels Lachenmann develops in his string quartets (the 'colour palette of timbres' of the unpitched and white-noise-like elements of bowed sounds) and suggests a taxonomy of string techniques.[32] These correlations are expanded to exploit the various friction-related possibilities and go beyond the temporal, timbre or dynamic limitations (through contact source multiplication, reflection on gesture and sound isomorphism and malleability in *Circle(s)*) and towards the idea of 'touching' air.

In Lachenmann's (string) works, air sounds appear systemically as the combination and result of three main conditions and parameters: cutting off the strings' vibration (through the 'muting grip'), fast-accentuated speed and light pressure of the bow (flautando technique), and choice of contact points and instrumental 'zones'. Bow speed-pressure and left-hand muting play a key role. With 'a light bow drawn relatively fast over the fingerboard (flautato), one can avoid producing a pitched sound,' notes Alberman. The flautato (or flautando) technique is defined as a quick and light 'breathing' bowstroke on a 'string loosely held in a muting grip'. The 'muting grip' (*Dampfgriff* - left-hand dampening) is essential to block all of the strings through 'a loose laying of the left hand on their actual vibrations', intensifying the perception of the subsidiary noises (*Nebengerausche*).[33] The 'toneless string noise' is, therefore, an 'almost a peripheral instantiation (*Randerscheinung*) of flautato playing' which extends to and forms, along with analogous playing techniques on the scroll, the tuning peg, the rib, the tailpiece, a 'more or less unique, characteristic repertoire of usable 'rustle variations' (*Rauschvarianten*).[34]

Air-like techniques are associated with soft dynamics as a result of the systematic flautando.[35] 'What emerges is a sound akin to soft breathing' notes Alberman in the dedicated 'light pressure unpitched bowed sounds' section. The effect desired by Lachenmann is indeed in many cases analogous to the timbre of breathing sounds 'altered by changing the shape of the mouth.' However, these breath and contact-friction phonetic pathways and parallels remain difficult to implement and predict. Lachenmann, instead of colours or timbres, chooses to

[29] *Ibid.*
[30] E.g. in *Pression* (1969 rev.2010), the material is exclusively made of the 'concrete' sounds of the cello and of the actions that create it (rubbing, friction, etc.). See also *Schreiben* (2003) discussion, chap.3.
[31] 'This idea of 'feeling' a sound leads me [...] to another image [...]: that of an instrument that I construct by exploring its construction, its sound universe, its functions and possibilities, this ritual itself having to derive from the structure of this 'instrument'. Lachenmann, H. (1993) "De la composition". In Buci-Glucksmann, C. & Levinas, M. (eds.), *L'Idée musicale*, Saint-Denis, Presses Universitaires de Vincennes., p. 233.
[32] The modes of sound production in Lachenmann's three string quartets are investigated/detailed (*Gran Torso* 1972, *Reigen seliger Geister* 1989, *Grido* 2001). Alberman, Abnormal Playing Techniques in the String Quartets of Helmut Lachenmann (see footnote 18).
[33] Alberman adds: 'Lifting it, on the other hand, leaves the open strings free. Where this muting grip is applied so that it suddenly 'closes the mouth', so to speak, through an unexpected blocking of an unstoppably eruptive up-bow gesture, a 'panting' sound effect results.'
[34] Lachenmann, H. (2004) On My Second String Quartet ('Reigen seliger Geister'),Contemporary Music Review,23:3-4,59-79
[35] See also discussion on soft dynamics (Sciarrino below) and problems/solutions in unamplified large forces works (chap.3)

specify the 'contact point, or place on the instrument, where the bow is to be drawn.' This tends to produce 'fairly reliably' timbres that are 'darker' or 'lighter'.[36]

Air is a mediating 'filtered' state of the gesture and sound matter, and a part of a wider range of sound families (*klangtypen*).[37] If the 'air' sound-gesture state and its associated 'rubbed' sensation of contact (with matter-concreteness) is part of Lachenmann's instrumental approach, it mediates with other analogous, affiliated or 'contiguous' techniques and gestural and sonic states. For example, as a 'filtered' friction form, air rarely forms a self-sufficient soundworld beyond independent sections, which are in many cases specific (see 'tailpiece' solo in Lachenmann's *String quartet n°2*) or designed to evolve towards other explorations (see discussion on air/non-air articulations in *Schreiben* for orchestra, chap.3). This applies to the techniques and gestures that create air. 'A dull darkening of tone of more peripheral significance in other pieces, the flautato technique trades in here for what I called 'air seized from tone (*Luft aus den Tonen gegriffen*)' notes Lachenmann in his introduction to his second string quartet.[38] 'It [the flautato technique] is, at first, a sonic centre – in other words, a central depot and hub for a characteristic wealth of variations of noise and sound' and 'mediates between absolute tonelessness on the one hand and full C-flat major consonance on the other.'

The 'feeling' and 'touching' of a sound extend here to a specific purpose: building category of sounds and techniques (souffle) serving as a basis for composition. The very consequences of friction, e.g. energies, velocities, 'sponginess' of the materials in contact (e.g. leading to squeaks, 'saturated' sounds by overpressure, whistling) are the results of a modification springing from, communicating with or extending and reinforcing breath/air (souffle) as a compositional approach and cluster of sound phenomena. It is the 'touched' air/breath (souffle) that causes (and brings forth) the intermediate, hybrid, porous states through an emphasis of one of the parameters – e.g. pressure (near-silent 'grazing' in *Un eco di Soffio*) and/or velocity (continuous flautando variations in *Circle(s)*, slow overpressures combined with fast and furtive expansions in *Ra'ash*).

The different air-sounds the instrumental contacts create extend the souffle perspective and create tools to enhance dynamics and broaden temporal and timbral paths. In subchapters 1.1 and 1.2, friction is for example approached and developed as a fluid, 'floating' and fragile element, oscillating between different 'white' states until the frontiers of silence. In 1.3, its agglomeration and accumulation make it a hybrid material and even a force, in which the sound texture deploys through three communicating levels of contact 'density' and instrumental amplification (filtered 'brushed/grazed', ordinario 'vibrating', and dense 'overpressed').

This fundamental sound-gesture intertwinement leads to investigating the complex gesture and sound isomorphism (and heteromorphism) of friction-based air sounds (souffle). For example, this includes exploring the correlations between speed, distance, grain and colour (see next section). Compositional explorations include contact and friction sources multiplication (1.1), work on extreme temporalities and gestures (furtive to near-continuous, barely touched to densely granulated, 1.2 and 1.3) towards the idea of extending and 'touching' air in various fashions.

[36] See also notation discussion in 1.2.
[37] 'Sound types'. See Tsao M. (2014). Helmut Lachenmann's "Sound Types". *Perspectives of New Music, 52*(1), 217-238.
[38] Lachenmann, *Musik als existentielle Erfahrung* (see footnote 6).

1.1 Contact multiplication, air/friction topology (*Circle(s)* for solo cello)

In *Circle(s)*, the friction surfaces and contact sources are multiplied. A multi-timbre, air and friction continuum (e.g. double/triple contact) develops in a solo configuration.[39] If the cello can be optionally amplified (microphones and/or by an acoustically rich space), the 'amplification' is here understood as that of the body and 'space' of the instrument (see resonance models chap.2). The colours, timbres, grain and textures of air of the rubbed cello (with bow(s) and hand(s)) are explored using the instrument's body in its entirety, towards an air and friction *topology*. The strings and parts of the instrument are 'mapped' (see score), exploited through single and double-bow playing and unconventional gestures and techniques.[40]

For example, the first movement is performed with two bows with different characteristics and qualities.[41] The bows are in contact with the body of the cello, but also (and more importantly) with each other. Through this, they build an expanded resonance system amplifying and filtering the continuous circular bow frictions (slow to fast, lightly brushed or with more pressure, with grain, through combinations of wood and hair of the bows). If the second bow creates a souffle *counterpoint* on the left side of the cello's body (responding to/mirroring the first bow, fig.2), it predominantly acts as a mediation element, an additional 'amplification' of the first bow's rubbing and friction (fig.3). Pressure and speed variations of this 'multiplied' friction lead to complex extensions, e.g. whipping and amplified squeaking (through speed increase) or 'stammering' responses and granulations (through accentuated pressure) (fig.3).

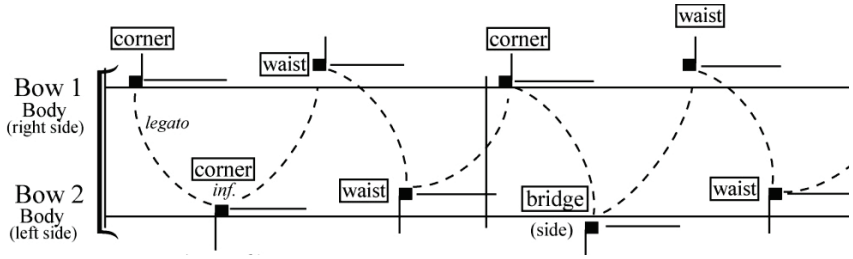

Fig.2 contact multiplication: two-bow left/right body/bride friction counterpoint, graduated timbres/colours

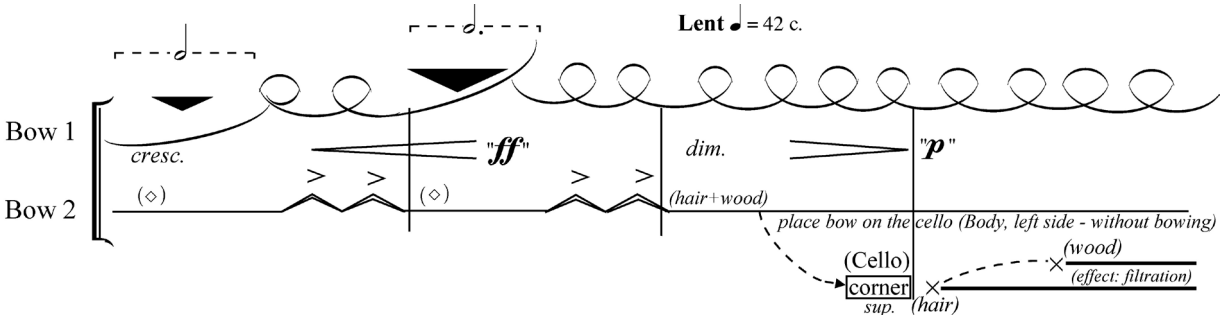

Fig.3 bow1 speed/pressure expansions, bow2 as whipping/mediating element

[39]Techniques develop the principle of contact/gesture multiplication – hand/bow(s) friction of strings, bridge, body of the cello – and two-bow techniques in movement I: bows in contact with the body of the cello and with each other, thus (over)amplifying their rubbing actions. In movement II, the specific left-hand fingerings/positions create contact 'multiplication' on strings. Fingers 'overhang' the bow's circular frictions, creating air/harmonic filtrations using the bow's hair and wood to create variations. Two interludes incorporate controlled finger pressure techniques, lowering selected strings to reach quadruple stops on four strings, building a fragile, rich sound 'matter' made of air, harmonics and grain. In movement III, the simultaneous playing on strings in front of/behind the bridge (through interposed bow wood/hair position) develops 'double' glissandos using fingerings on, on the side and under the strings (fingernails play on the strings side creating further forms of glissando/filtration). The fragile sounds created both behind/in front of the bridge build a soft airy and 'whistling' counterpoint where the circular gesture becomes that of the double 'sliding' air.

[40] Including visually, see 'causal blur' below.

[41] Cello bow (bow1) and violin bow (bow2).

The circle, as a gesture and 'shape', allows for an extended *flautando* ('floating') temporality, transmitted on and resonated through the multiple instrumental contacts and amplifications. The continuous circular friction of the bow – almost uninterrupted until the end of movement II (10 min.c.) – allows detailing the various air qualities and fragile variations stemming from the rubbing of the instrument's strings and parts. The 'air' legato is obtained by utilizing and 'linking' two bows (see above) and combining various wood/hair and hand/fingers 'contacts' and combinations with both the cello parts and strings. Double friction actions (e.g. hands/fingers and bow, use of both materials of the bow (wood and hair) to create double 'air filtré' glissandos on the strings both in front and behind the bridge (movement III) are for example key to build a complex, polyphonic system of air filtration expanded in *Un eco di soffio* (for two cellos, see below).

The 'circle' is approached as a breath and air gesture. The air-like 'spiral' allows for an infinite development – the circularity of the friction gesture allowing escaping the constraint of time (that of breath) and space (that of the instrumental body). The initial circular gesture of the two bows unfolds in the air and is then reinforced through various contacts with (and applied on) the instrument – here a versatile resonance chamber for this constant rubbing gesture and a (physically) massive instrumental body. Initially 'passive', the cello itself is put in 'circular' motion, expanding the circularity idea in unconventional fashions (movement I, fig.4). The 'circle' then becomes that of the bow in rapid circular rubbing on the strings, developing harmonic touches appearing and disappearing within a constant air spiral, whose colour variations unfold through the hair and wood of the bow friction. Filtration by 'double' finger positions overhanging the bow allows the constantly changing crystalline, harmonic, unpitched and multiphonic elements to emerge or be guessed at (movement II, fig.5). The circular movement is finally that of the glissando, on, behind and under/over the strings, creating double air filtrations, sometimes 'phonetic', whistling, moving and inharmonic (movement III, fig.5).

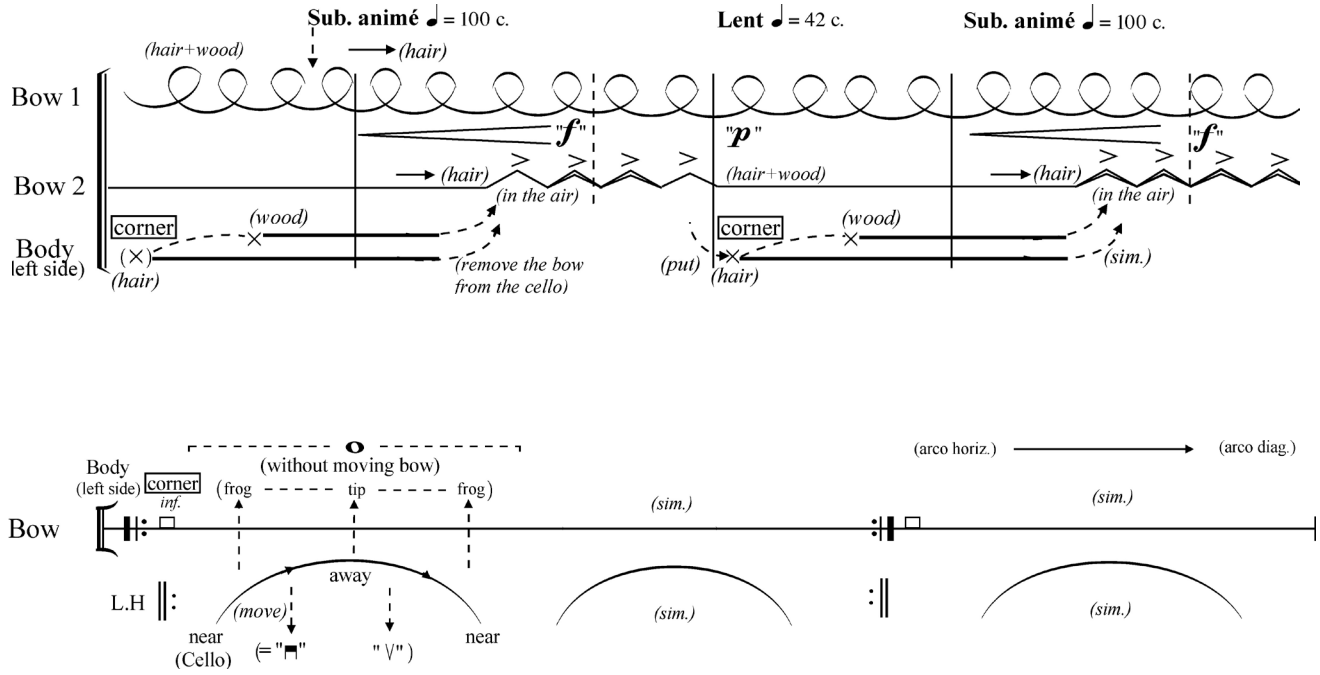

Fig.4 circularity development (I) in the air/amplified contacts; cello movements (end I)

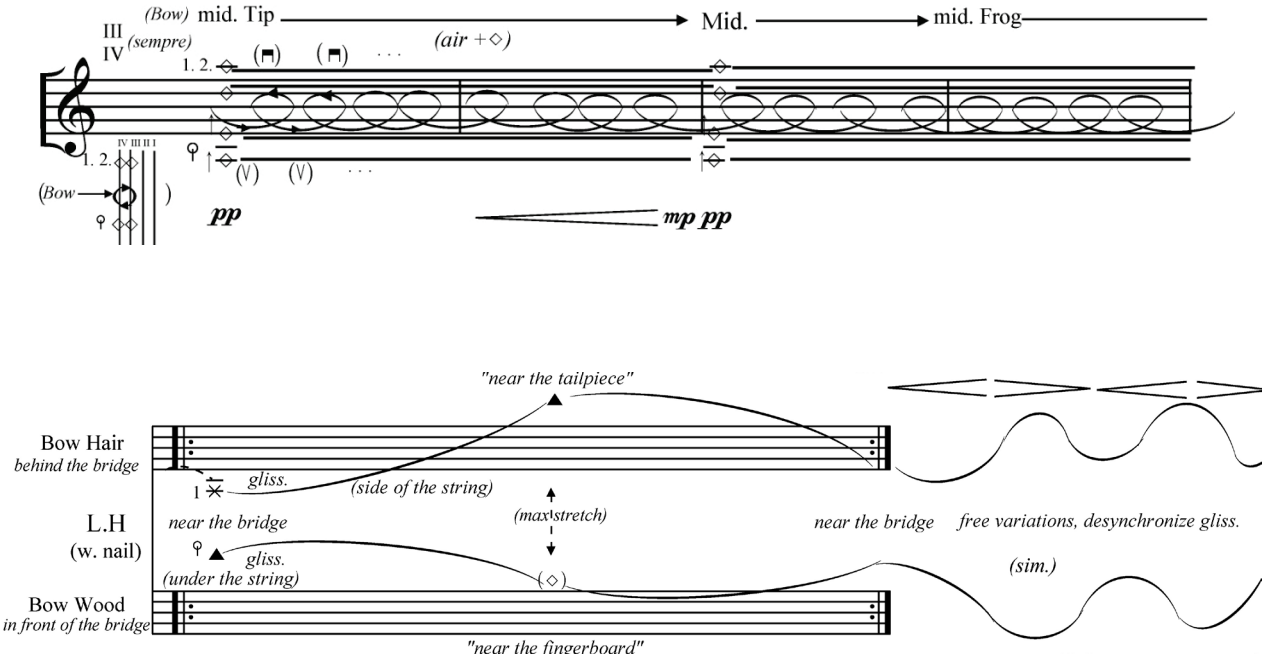

Fig.5 circularity development (II) circular brushing; air filtré (III)

Air 'tactility' and movement, sound-gesture isomorphism, unconventional techniques. The causal blur

Sound is not necessarily isomorphic to the gesture or movement that produces it. There is a possible (and frequent) shift between gesture and sound. For example, linear phenomena can produce sounds that appear circular (and vice versa). The limit of the isomorphism between the sound and its cause is referred to as the 'causal blur' by Chion (*flou causal*), and if there is no isomorphy, there is no 'absolute heteromorphy' either – including and perhaps even more importantly within friction techniques.[42] These changes are fruitful and it is precisely these 'ever-differing correspondences that are stimulating in the ergo-auditory loop' (*boucle ergo-auditive*).[43] A sound movement that would be a copy of the visual movement would be 'boring to produce and to listen to.' 'We are seduced, intrigued by the way in which the sound follows without following the movement of the cause.'[44]

The question of friction and perception/imitation is obviously wide and complex, as illustrated by Chion's 'causal blur.'[45] For example, listening to sound cues alone often proves to be both very accurate in some areas (identifying small variations in rubbing activity) and very inaccurate in others (it may be completely unaware of what is rubbing on what). Moreover, and beyond the 'great deal of code and convention involved', the causal blur is constantly 'manipulated by the audio-visual relationships.'[46]

Breath/air (souffle) is here above all envisaged as a movement encompassing many forms of contact and whose source, displacement and movement (here friction) allow for multiple results both in terms of timbre and its perception. For example, the first and second movement of *Atma(n)* (2.1) combine free/controlled isomorphic

[42] 'A sound obtained by running the tip of a pen over a piece of paper may well - if one listens without the vision - sound stationary and immobile.' Conversely, 'a sound that sounds circular can be created by drawing the sine curve on a paper.' Chion, *Sound,* p.111-113.
[43] *Ibid.*
[44] *Ibid.*
[45] Perception aspects beyond friction are approached in chapters 2 and 3.
[46] *Ibid.* p.116 (see 2.1 for more detail on visual aspect and souffle compositional development).

and heteromorphic linear curves and gestures. Friction techniques merge with and recreate corporeal breath sounds and forms. The instrumentation includes five 'air-through-contact' instruments (percussion, piano, and string trio) and only one actual wind (and breath) instrument (clarinet). Mutual friction reinforcements are therefore key to build (and go beyond) purely breath-mimicking action (e.g. here inhalation-exhalation and vertical up-down bow light brushing and equivalent bright/dark friction actions on piano and percussion, movement II) playing on their possible confusions, but also to build complex air 'traces' and textures through various isomorphic/heteromorphic gesture-sound combinations, controlled or freely combined at the individual/ensemble scales, and ever-evolving towards auto-generated white-noise in specific sections.[47]

In *Circle(s)*, unconventional techniques (including visually) also build on and constantly question these relationships in a *solo* context. For example, a semi-improvised, moving cello/static bow section (end movement I) 'reverses' conventional functions to achieve air-like colours and sounds through friction beyond their complex gesture/sound isomorphy/heteromorphy. Here, it is the cello that, by being moved by the performer, implements the friction action *on the bow* (first step of the process, see fig.4). If the frictions on the body of the cello (well-developed before in the movement) are here relatively similar in terms of sound result and mode of sound production (bow friction on the corner part, a medium-bright air-like sound) they are fundamentally different in terms of gesture and visual perception, playing on the 'causal blur' manipulation.

This unconventional action develops and gradually extends to a double movement with the (hitherto static) bow being 'activated,' brushing the strings of the cello circularly from the bridge zone to the highest fingerboard positions. The bow encounters 'obstacles' during this path. These obstacles are the parts of the cello, which, due to the simultaneous bow *and* cello movement, 'encounter' the bow. Brushed and touched, the cello parts influence the bow's path, and by extension the gesture of the performer and the resulting sound. For example, the upper sides and corner 'zones' (see description in score introduction) create, by their shape and 'angular' nature, 'accidents' which 'force' the bow to slightly bounce and interrupt its trajectory, creating new sound results each time these zones are reached, again and again, in the repeated circular articulation (fig.6).

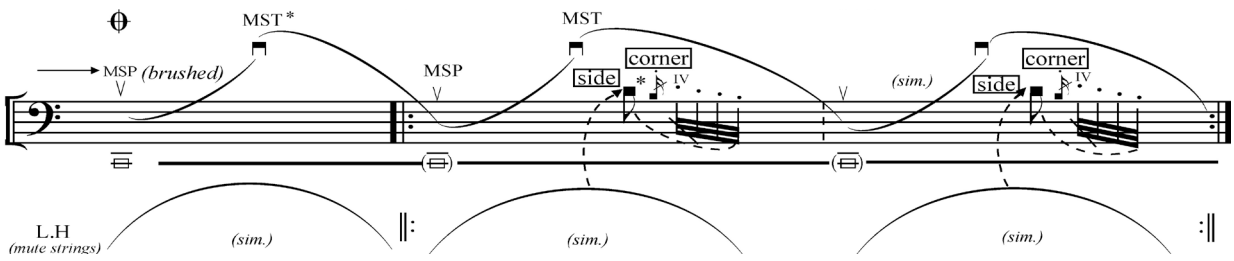

Fig.6 cello movements, bounces/accidents

Porosity of air, malleability of frictions: towards a double extension perspective

The air-through-contact approach builds a fluid and malleable element capable of (literally) plunging into the instrumental sound matter, brushing, resonating or even 'digging' (into) it. These characteristics lead to exploring the extreme aspects of contact techniques, the overpressures and timbral distortions and the near-silent, barely grazed effects. Hence, here again, the importance of the material and object creating the friction

[47] See air fermata/unconducted traces in dedicated subchapter (2.1).

(e.g. hand, bow, wood, on skin, metal, strings), of the applied filtration (e.g. hand position, fingering) and of the gesture (e.g. circular, vertical, idiomatic, extended). These elements create sounds that are intrinsically linked to the contact nature and variation (e.g. continuous wind-like 'wave' can evolve to a granulated or even scratched articulation, a soft whistle to squeaked sound, see 1.3) and create possibilities for interactions or transformation between different (possibly contrasting) sound materials, here stemming from (or resulting in) air.
If friction may in principle involve all types of contact materials to generate various (air-like) colours, speed and/or pressure variations (of and beyond flautando) create fruitful paths towards other (often half pitch/noise-based) timbres and elements (see for example Lachenmann's flautando *Rauschvarianten* and *Nebengerausche* above). As pointed out by Chion, a change in the gesture speed can determine a qualitative leap e.g. from the discontinuous to the continuous. For example, if an object is scraped with a certain speed, the sound is 'no longer iterative' and becomes a 'continuous sound with grain'.[48] These 'qualitative leaps' can be desired or controlled by the performer or composer (as in Lachenmann's *Nebengerausche* use of the flautato technique) but also emerge as accidental (perhaps inevitable) elements, e.g. squeaking or granulation due to more or less important speed and/or contact pressure change(s). This leap can be detailed (e.g. 'grain' evolution through slowing down of friction and increased pressure) or not (e.g. a similar change resulting from an improvisational or 'composed' situation, see 'souffle metalanguage' in 3.2). By extension, even the most conventional friction-based modes of sound production (e.g. in classical string technique) can result in such controlled (or accidental) paths towards air timbres, grain and shares. (The increased 'air' component in the sound of a *flautando* bow is a common example and application, as discussed above.)

This leads to a double perspective explored in subchapters 2 and 3: on the one hand, the extreme filtration of sound in mostly soft dynamics, leading to working on timbre complexity and air 'porosity' (exemplified below by Sciarrino), and, on the other hand, the extreme contact forms and granulations exemplified by the 'saturation' approach.[49] Crucially, and as detailed before, these two perspectives are here approached as not only communicating/interrelated but also as stemming from and reinforcing air (souffle) as a cluster of sound phenomena and composition perspective.[50]

Timbre, air and tradition: Sciarrino and the air 'porosity' (contact/strings)

Sciarrino's approach opens to investigating air, grain and timbre details, and by extension the characteristics and developments of friction-based air-like (souffle) sounds and techniques in their idiomatic and 'extended' aspects. For Sciarrino, it is to 'take the instruments that exist as they are, but revitalize them and, consequently, invent new sounds and techniques that the established tradition prevented from being chosen.'[51] Air is indeed an inherent part of the friction mode of playing, traditionally hidden in the 'established tradition' of classical music, and sought for and even valued and 'revitalized' in contemporary or traditional contexts.[52]

Arguably, air is omnipresent in Sciarrino's soundworld. However, it is not necessarily a basis for composition. For example, air sounds by or for themselves (without any other texture/timbre components/elements) or

[48] *Ibid.* p.239.
[49] Drawing, among other things, from Lachenmann, Xenakis and spectral explorations (see 1.3).
[50] These 'hybrid' pathways extend in chapters 2 and 3 with/beyond friction techniques.
[51] Salvatore Sciarrino, quoted in Vinay, G. (2001). L'invisible impossible : voyage à travers les images poétiques de Salvatore Sciarrino. *Filigrane. Musique, esthétique, sciences, société* 2(1), p. 155.
[52] See 3.2: air/breath and classical/contemporary virtuosity.

'reworked' textures of air (as in Holliger's orchestral expansions, see chap.3) are relatively rare.[53] This is secondary since Sciarrino exploits another key characteristic of air, which we refer to as the 'porosity'.

Air (souffle) is envisaged as a more or less present texture element or colour, part of a broader timbral development and approach, in overall soft dynamics. The air component of (or in) the sound is developed through (or enhanced by) the near-systematic utilisation of soft to very soft dynamics, the result of the chosen gestures and techniques (e.g. a 'brushed' vertical bow) and/or an emerging element 'contained' in more complex timbres (such as multiphonics). These aspects (dynamics, chosen techniques or complex sound) tend to enhance the share, emergence and perception of air (souffle) as well as other 'subsidiary noises.' In some pieces, Sciarrino recommends or incorporates amplification (natural, instrumental and artificial).[54] In most cases, air is an emerging element, which constitutes a part of the individual sounds and/or of the texture. Air participates to a broader approach to timbre in which it may (or may not) be an important aspect, among the other elements (such as pitch).

In *Sei quartetti brevi* for string quartet (1971), a reservoir of sounds stems from combinations of harmonics and vertical/horizontal bow. Relatively common techniques and musical actions (e.g. glissandos, tremolos, diminuendos) become part of a detailed work on timbre and create a soundworld in which air ('soffio') is omnipresent. 'Classical' and 'extended' techniques are to some extent constantly 'hybrid', oscillating between air and sound. Air 'variations' are influenced by dynamics (e.g. *pp* actions contain more 'air'). Harmonics (natural/artificial) and (equally soft) tremolos and glissandos create additional airy variations.

Significantly, air ('soffio' - souffle) describes the techniques as well as the dynamics and musical intentions.[55] If Sciarrino uses no detailed notation or numerical description of air-to-pitch or noise ratio (see considerations on notation below), the notion of 'soffio' is widely incorporated into the musical material and discourse. 'Soffio crine' refers for example to the brushing of the strings with bow hair, whereas 'soffio legno' describes the same action using bow wood. 'Soffiando' ('soufflant' i.e. gradually adding/incorporating air) is often used in combination with diminuendos (in many cases 'al niente'). Dynamics and air extend in parallel to instrumental techniques: harmonics (mostly developed *ppp*) are for example systematically associated with the 'soffio' word indication (e.g. first piece). This describes both the musical actions and their evolving airy timbre quality.[56]

The air (souffle) component is emphasised by the vertical (or non-horizontal) utilisation of the bow, which 'brushes' and slides on the strings with variations (speed, movement/gesture amplitude, with the bow's hair, wood, or both). For example, the two different materials for friction – wood ('soffio legno') and hair ('soffio crine') – develop a similar movement 'lengthwise to the string' always 'appoggiato' (without pressure, almost without horizontal movement). These are air-colouring actions. The hair/wood differences create variations

[53] See mouthpiece 'solos' in *Un'Immagine di Arpocrate* for piano and orchestra with choir (1979). A performer breathes for several minutes through a brass-instrument mouthpiece, alone; a spectacular, even 'unreal' solo.
[54] 'Either artificial or natural reverberators may be used' (*Sei quarttetti brevi* performance note. Sciarrino gives ex. of 'metalized rooms.' See also open flute utilisations (*Lettera degi antipodi portata dal vento,* 2001) and microphones (e.g. *Immagine Fenicia*, 1996-2000)
[55] As in French, air-like sounds are referred to as 'souffle' (*soffio*) in Italian.
[56] *Sei quarttetti brevi* score instructions.

influenced by speed – e.g. slow lengthwise brushing movement to fast and repeated 'brushing tremolo' (tasto-ponticello), 'whipping' vertically to reproduce the tremolo effect.[57]

As highlighted by Dufourt in the first spectral manifesto, the plasticity of sound, its minute alterations have acquired 'an immediate suggestive force' through the 'resurgence of unstable acoustic forms that classical instrument making had carefully attenuated.'[58] Air (souffle) is indeed a part of the gestures and techniques, a part contained in audible shares which most unedited/close-miking recordings are able to 'reveal'.

While carefully hidden through instrument making (yet still present), these unstable acoustic forms (among which air emergences within friction are key) are also approached here as able to emerge through a 'new' situation presented to the performer, who by extension becomes, again, 'untrained' and able to go beyond (possibly standardized) interpretations of (classical or extended) techniques (see below).

Un eco di soffio for two cellos develops these aspects, which are here even more present, since the basis for development stems from techniques fundamentally rooted in string performance (see below), yet revisited in new situations that allow them to become again 'unknown' and by extension newly fragile. Air (souffle) is approached as the 'implicit' noise component, revitalised through new approaches to (old and more recent) techniques. The piece works on the extreme 'grazed' contact and dynamic softness, expanding through this the possibly inherent (or underlying) air (souffle) quality of friction-based techniques, including classical techniques. 'It is not so much a question of introducing noise as of recognising that, without it, music does not exist. That music has become noisier (*bruiteuse*), in order to accentuate the demonstration, is perhaps a secondary issue – nothing prevents us from hearing, in supposedly non-noisy music (*musiques supposées non bruiteuses*), its implicit noise component,' notes Solomos.[59]

[57] This technique, developed in *Sei capricci* for solo violin (1976) (n°3), expands in 3.2 at the concerto/orchestral scale.
[58] Dufourt, H. (2011) *La musique spectrale. Une révolution épistémologique*. Paris, Éditions Delatour, p. 289-290.
[59] Solomos, *From Music to Sound*, p.79.

1.2 Quietness and echoes, idiomatism and extensions, fragility and fusion (Un eco di soffio for two cellos)

Un eco di Soffio for two cellos stems from the combination of three 'idiomatic' techniques (tremolo, bariolage, glissando) to extract their 'echo' of air, fruit of the various contacts between the bow, the hands and the instrument. Deeply rooted in traditional string practice, these idiomatic techniques and gestures are (re)considered under a different light, their utilizations and new characteristics at the 'limits' of air and sound becoming a first material and perspective (see fig.7).

The two cellos (and cellists) are approached as a single entity, a 'timbre-augmentation' and 'meta-friction' instrument. There is no solo during the piece (lasting more than 20 minutes). The approach to sound and dynamics broadly evolves between relative and extreme softness, bringing forth and emphasising the hybrid results, and air sounds and air shares within the sound.[60] The air/sound 'porosity' of friction techniques reappears in ever-changing forms through repetition and guided improvisation processes. Fragile utilisations and complex timbres stem both from 'extended' and 'classical' techniques, blurring the borders between these two approaches. Air (souffle) is in this context an overarching element linking these conventional-unconventional utilizations.

The piece develops techniques of *Circle(s)* (circular frictions, instrumental 'zones') working on their augmentation through 'duplication' (e.g. 'double' filtrations in introduction, II and end-III). The piece multiplies rubbing and harmonics 'touches'. Improvisation processes and repetitions generate texture and colour variations, utilizing the overall dynamic softness and technical complexity (see below) as means to work on the fragility and ever-changing quality of air sounds.

Three movements and three complementary processes are developed. The first movement stems from the combination of circular frictions and bariolages. These two techniques are systematically 'melted'; they 'rub' (into) the (double) instrumental matter, in medium/fast 'grazed' speeds including common as well individual tempo changes. The second movement utilises two types of harmonic 'touching', developed through glissando techniques: 'ordinario' harmonics performed on various (mostly extreme) zones and nodes of the strings, and 'white-noise' harmonics utilizing the string zones behind the bridge. These latter string zones are of a much shorter length, yet create rich, ever-changing results. These two harmonic zones and 'approaches' (a development of *Circle(s)* movement III in which they unfold in a solo configuration) develop slow glissandos (tailpiece to bridge, bridge to soundboard) which, echoing each other, 'enter' deeper in the sound matter through extremely soft (yet complex and fragile) string grazing (with both fingers and nails) and harmonic touches. Additional techniques (tremolos, finger positions next to/behind/in front of the bow) 'fragilize' these actions furthermore, influencing their very modes of sound production towards ever-changing air shares and timbres through improvisations (fig.7). In movement III, tremolo techniques and harmonic mixtures (with bow constantly evolving in position and 'sliding' from one tasto or ponticello position to the other) create mixes with the previous techniques (glissando, bariolages), adding further layers of air/timbre variations in the previously developed sound matters (fig.7).

[60] The term 'air shares' refers to the air-to-pitch or noise ratio, i.e. the presence and 'share' of air within the sound, a proportion which can vary according to dynamics or techniques.

The borders between 'extended/new' and 'classical/conventional' techniques are here blurred and porous. As highlighted by Chion, if certain extended effects are created by 'special' playing techniques, instruments (e.g. percussion) or combinations of timbres, others are still 'produced by the simplest means' e.g. using a given instrument's extreme notes 'where the ear ceases to clearly distinguish degrees of pitch, just as the human eye, below a given threshold of luminosity, sees colours less distinctly.' The highest harmonics nodes (extreme zones up on the soundboard and down near the bridge, see score introduction) also extend beyond the conventional string zones (bridge to tailpiece, here complementary harmonic-white noise zones played laterally with fingernails) and serve as 'double' extreme register. Combinations enhance the natural shares of air and 'subsidiary noises' around the three main 'idiomatic' techniques. For example, in movement III, the bow movements (tasto-ponticello) and tremolo combinations result in short to very short (even 'touching') distances with the fingers, which play here in extremely high positions (up to the 12th harmonic partial). According to the combined bow and finger positions and 'clarity/instability' of the fingered harmonic node, the sound evolves between complex, almost pure or 'muffled' air sound to hybrid results between air and harmonics (fig.7).

Although less fully exploited than in *Circle(s)*, the body and bridge parts create key transitions (e.g. introduction, II-III transition, end). A particular aspect of this exploration is the detailing of the bridge and its 'zones' (see score introduction). The bridge is approached as a 'miniature' instrumental body whose parts and modes of sound production (both with bow and hand) are detailed: left and right side angles (bright/medium air-sounds), centre (more complex result mixing the sounds of the strings which can be muted or not), foot and side (bright to very bright – even squeaking sound, with lateral bow), and muted or unmuted by the left-hand (which tends to produce dark-bright air-like variations – combined in most cases with lateral playing).

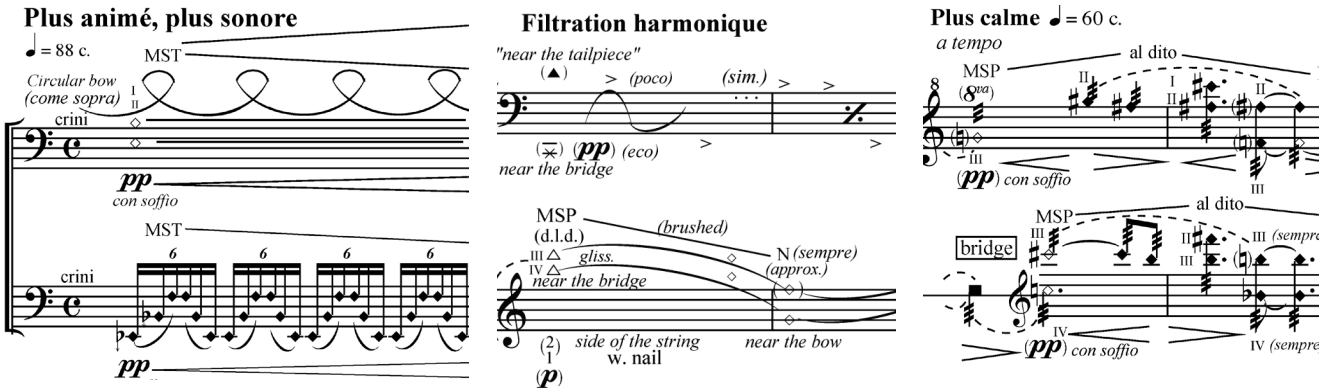

Fig.7 'idiomatic' techniques: bariolage/circles (I), glissando (II), tremolo (III)

Performer 'untrained', fragilized idioms: classical-extended borders, notation, improvisation

These various, idiomatic, extended, complex or uncommon techniques and approaches are approached as able to question and challenge the performers' capacity and pre-existing knowledge of extended as well as classical techniques.[61] Any spontaneous action to produce a certain sound character produces side-effects that are impossible to hear and control at the very moment the sound is produced, except when it is a sound that has been practised for a very long time, like the musician with his instrument, notes Chion.[62]

[61] 'Extended techniques' refers here to 'contemporary' techniques, mainly developed from the 1960s. The 'extension' idea is absent in most non-English equivalents, e.g. *modes de jeu contemporains* (French), *neue spieltechniken* (German).
[62] *Ibid.,* p.97.

The ‘un-training’ of the performer and the fragile and new sounds correlations this can create allow working on gesture and air and friction complexity, revisiting idiomatisms even more deeply. Processes include independent tempos, improvisations, using notation and techniques, that become again fragile or unconventional, to create ever-changing developments.

These processes incorporate and develop through sections of guided improvisations, in which the two performers also listen to, guess at, and react to the other, in a sound universe evolving at the frontiers of air and silence. In movement II, the air of the rubbing bows and rubbed friction surfaces (strings and bridge) is either hidden by or takes over the other elements (e.g. harmonics, bow brushing, glissandos with fingernails), letting us guess the underlying ‘human’ breathings of the two cellists (see recording). The glissandos (main ‘idiom’ of the movement) unfold at very slow speeds in the two ‘richest’ harmonic zones (fingerboard to bridge, which ‘condensates’ the highest partials, and bridge to tailpiece i.e. behind the bridge, which allow here for white-noise-like expansions). The bow movements are also slow, leading to a visually near static action, yet full of sound developments: changing harmonic nodes and unstable transitions, white noise variations, improvised ‘accidents’ (see below). The two cellists play mostly in echoes and ‘canons’ (fig.8), which mirror and tend to reproduce a previous effect with a short time lag, while never exactly reflecting it.[63]

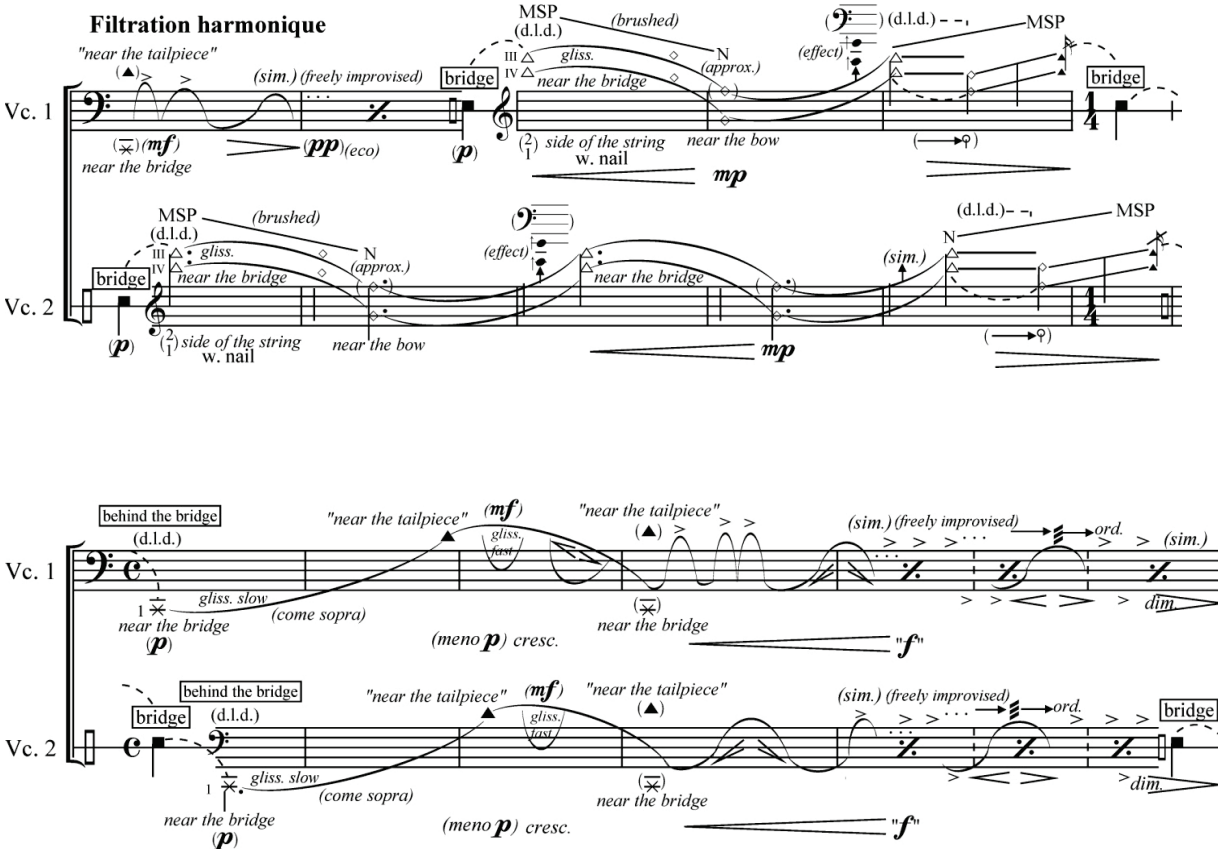

Fig.8 echoes and ‘canons’ improvisation/notation (II)

[63] Beyond the instability of the extreme playing zones and fragility of the techniques and actions, additional instructions (e.g. tremolo addition, sudden increase of glissando speed or dynamics expansion, see fig.8) fragilize these actions even more. For example, in the ‘Bruit blanc, riche’ sections (e.g. letter A), the performers are given ‘action’ cues, which are not *exactly* specified in terms of their temporal unfolding within the measure/section. This additional ‘tempo’ fragility forces the performers to *react to each other*. Rohan de Saram and Claudio Pasceri, who premiered the piece/performed it several times, had their own way to ‘meet’ during the sections in this movement: work/tempo freely and ‘meet at the bridge’ passage; have more strict tempo cues and interactions, etc.

Air/friction and notation

As illustrated above in two 'cellistic' contexts (solo/duo, 'six' movements in total for two works whose combined duration extends to more than 45 minutes), several approaches become possible when it comes to working on the colours and share(s) of air (souffle).[64] Air is a sound category belonging to the inharmonic and unpitched/noise-based soundworlds. Hence, the various possibilities for notation of the complex colours and porous borders between air and sound in contact/friction techniques. Lachenmann doesn't detail air shares or colours but (as seen previously) contact points and actions to undertake. If other composers such as Mark André choose to detail shares and levels of air for wind instrument techniques (e.g. five gradations in *...In...* for bass clarinet, 2001), this detailed notation shows some limits for friction techniques. It is not used by André in these contexts, who instead gives broader colour indications (e.g. dark/bright) through a notation that, following Lachenmann's path, is hybrid between action notation and result notation. In Sciarrino's pieces, the indications in the score are relatively minimal but irrigate the broader musical discourse and poetics – souffle appears as a result during the performance, not written or controlled in terms of proportion – leaving some space for the performer, opening to exploring the fragility and improvisation-variations (as in *Un eco di soffio*).

The score of *Un eco di soffio* is full of details and densely notated. If each detail has a specific function, the overall sheer number of instructions tends in some cases to destabilize, even overwhelm the performers. This aspect was widely discussed with Rohan de Saram who, to my surprise, drew some parallels with Boulez's *Livre pour quatuor* (1948-1962). Boulez's bypassing of 'idiomatisms' – in other words of non-written instructions that a trained cellist (or performer) takes for granted when seeing a musical indication – made the work extremely complex to play and render in his past (and direct composer-performer) experience with the Arditti quartet. I realized that, although taking up relatively well-known even idiomatic techniques, the sheer number of details 'extended' by itself this mere idiomatism principle. The notation arose as a function within this exploration, allowing the piece to further challenge the 'anchorage' of techniques, and their sound result, towards the new 'air' fragility of their development.

[64] See footnote 60 for definition of air 'shares'.

1.3 Whistling arrows, trembling breath, overpressures: the saturation extension (Ra'ash, harp and cello)

The malleability and mediating capacities of air through friction, mostly developed under its 'porous' and filtered aspect in the previous subchapter, extends here to a broader approach. If air (through friction) contains, is contained or can be 'seized from tone' (Lachenmann), it can equally expand beyond the mere harmonic and grazed touches, towards the wider soundworld of overpressures.

Expanding Lachenmann's idea of confrontation with the matter, *Ra'ash* proposes to dig into the gesture-breath, exploring the other extreme end of the instrumental 'contact' spectrum. The triple meaning of the title (whistling sound of an arrow, human trembling or shudder, earth trembling) is by itself an illustration of the three states of the human breath and sound matter on which the piece works, a dialogue between these three states through friction – starting from air, to 'dig into the breath'. The various states are superimposed, merged and paralleled, and recreate themselves through breath: wheezing, panting effects and short breath apnoea, deep 'beyond human' exhalations. Fast friction-based air sounds and whistles mix with denser overpressures and granulations. These materials are approached as springing from friction as a 'gesture of air' (souffle). Air (souffle) evolves between (and serves as a basis to work on) three contiguous states (filtered-ordinario-overpressure) which are approached as a 'tactile' continuum to develop the souffle malleability.

The overpressure state and 'excess of gesture and matter' (Cendo, see below) has been widely explored by composers of the so-called 'saturation' school. Like their spectral predecessors (the current mainly developed in France in the past 20 years) who had 'established an acoustic principle as an aesthetic paradigm', the 'saturationists' find in saturation a 'compositional model', notes Rigaudiere.[65] Sounds stem from excessive contact and pressure. For example, in Cendo's first string quartet *In Vivo* (2011), the three movements explore a single gesture: the granular sound produced with 'excessive bow pressure'. [66] Indeed (and not without similarity to the 'souffle' approach), it is a matter of articulating a musical discourse based not on a type of acoustic material, but a *state* of this material – in this case, a 'critical state' (Rigaudiere). In his article *an excess of gesture and material: Saturation as a compositional model* (2014), Cendo highlights for example two saturation categories and 'states' on which he works: absolute saturation (*total saturé*) and infra-saturation (*infrasaturé*).[67] String techniques include various forms of crushed sounds, battuto, longitudinal tremolo, playing behind the bridge or beyond the strings, bow hair cracking, playing with the bow winding.

This approach is at first glance the other extreme end of (or opposite to) the souffle approach and paradigm, since the 'saturated' state (e.g. degrees of overpressures in the case of 'contact-based' instruments and friction techniques) is the fundamental state, as opposed to the (also at first glance) filtered and 'grazed' approach and contact of souffle. But as in the souffle 'tactile' approach, it is thanks to the finesse and details of the writing within this extreme 'state' that the saturation can be 'composed', thus acquiring a 'real consistency and a dynamic potential that can be structured' (Rigaudiere). It is also mainly the task of the acoustic instruments to maintain the ambiguity of the source of the sound produced, considered as the product of a hybridisation. For

[65] Rigaudière, P. (2014). La saturation, métaphore pour la composition? *Circuit*, *24*(3), 37–50.
[66] Cendo, R. (2014), An excess of gesture and material: Saturation as a compositional model. Dissonance, no 125, p. 21-33
[67] Absolute saturation denotes 'a dense writing style, played very loudly, which seeks to achieve a fusion between various complex timbres'. Infra-saturation is 'characterized by an extreme reduction in intensity and can come about in one of two ways: either by an extreme slowing down of the [overpressure] gesture, or through the suppression of all 'pressure' and processes of multiplication of gesture/timbre.' *Ibid.,* p.30.

example, Rigaudiere notes that in Bedrossian's, Cendo's and Robin's string quartets, [68] saturation, when it is stratified and 'invests the dimension of depth', can produce granular textures that are much more 'alive, innervated and organic than what electronics can generate'. What seems to emerge is a 'musique électronique instrumentale' – an extrapolation Lachenmann's 'musique concrète instrumentale'. [69]

In *Ra'ash*, it is by plunging the friction of the hands and bow (as well as other implements) into the instrumental material and matter (here the body and strings of the cello and harp as an extended friction and resonance surface) that the piece intends to illustrate the extended porosity and 'sponginess' of air as a form of contact. The interest here is not only to 'reverse' the approach, but also to explore the communicating and even reinforcement forms between the 'grazed' air filtration and the 'over-pressed' sound expansion – expanded in the next research steps to other techniques and possibilities. [70] In *Ra'ash*, the excess of gesture and matter is not only the one of air-like frictions and actions (that develop towards complex, even virtuoso forms, see below) but also the one of the sound and gesture 'states' in constant modification and evolution. As gestures, air-like frictions (souffle) – possibly more than 'physical' air/breath techniques to which they combine and 'resonate' in chap.2 – have the capacity to evolve through and control contiguous materials (unpitched, inharmonic or complex, and saturated filtration states). They are an inherent part of it or can lead to it: air is envisaged as a gestural and sonic bridge, a common denominator and gestural/textural element which can evolve between these different filtered to saturated states of the sound matter *stemming from friction*.

The velocity of the actions and filtration states evolutions – air and harmonics, 'whistling arrow' sounds (evoked by the title *Ra'ash*), resonated breath, trembling and panting – evolve through various processes towards the 'hollowed' states or saturated densities. Overpressures on the instrumental bodies (with hands, implements and bows), extreme granulation of sound and furtive filtered air frictions dialogue and merge in virtuoso developments, in which repetition and improvisation processes allow, as in *Un eco di soffio*, for variations and ever-changing results.

For example, speeds and pressures create changes and evolutions of 'affiliated' or contrasting combinations. In b.43 to 45, the harp's saturated sound of friction (strong pressure application of both hands on the soundboard, a loudly resonating granular sound) expands to and builds the cello's blow-like sound (on the bridge), whose soft 'imperfect' results (harmonics emerging from the bridge's sound – the strings are purposely not muted here) arise within the saturated 'over-pressed' resonance. This situation is also reversed. In b.46, the sound of the cello's over-pressed strings (with bow) ends up in the harp's rubbed air and wood friction, in which, again, it transforms and merges, through a soft tremolo action (harmonic/air) on the bridge. Those expansions live in and evolve through the instruments' reverberation (see below), and merge in some cases with the performers' (actual) breathing.

The approach to form itself stems from the sound matter 'state' evolution, from the 'purest' furtive arrow-like whistling and whipping sounds (see fig.11), which gradually evolve through slowing down of frictions and pressure application, to form complex, deep and resonating granulations (see fig.12). Those sound and 'touch'

[68] Bedrossian/Cendo/Robin are the three emblematic 'saturation' composers.
[69] Rigaudière, La saturation, métaphore pour la composition? (see footnote 65).
[70] In chap.2 this aspect develops towards the human/instrument-resonance/air hybridization through granulation/saturation techniques.

states evolve slowly (as in b.48-53, fig.9) as well as in fast alternation (fig.13), 'forcing' in some cases the performers to execute radically opposite action and forms of instrumental contact in a short, condensed temporality. These materials thus develop a form of virtuosity, either 'focused' on a type of material or gesture-sound state (e.g. focus on overpressure, focus on fast 'whistling arrows' and 'whipped' sounds) or in alternation and combination (fig.10-13).

The predominance of hand/wood and string or bow/wood and string frictions with different levels of pressure, overpressure and filtration create dialogues between the different states (see score/process fig.9). The integration of voice and breath as reinforcements or ambiguous elements introduce the dialogue of (corporeal) breath and resonance/reverberation, questioning the possible relationship between breath and 'saturation' (see fig.12). Explorations expand to reverberations, which link the communicating states and shapes of airy, inharmonic, and 'over-pressed' matter.

Breath, resonance, friction and saturation communicate and form a 'whole' leading to achieving denser textures. For example, resonance emerges as a key 'melting' element in b.44-45. This conglomeration and accumulation of materials, techniques and sound phenomena is key to enhancing air and breath as sound materials, revitalizing their dynamic potential and sound projection possibilities.[71] Focused here on the friction and 'tactile' aspects, these elements are applied to air techniques in all their forms (e.g. in the case of wind instruments' sound, multiphonics are approached as having similar functions to overpressure techniques). They create means to develop and 'augment' air (souffle) as a complex cluster of sound phenomena.[72]

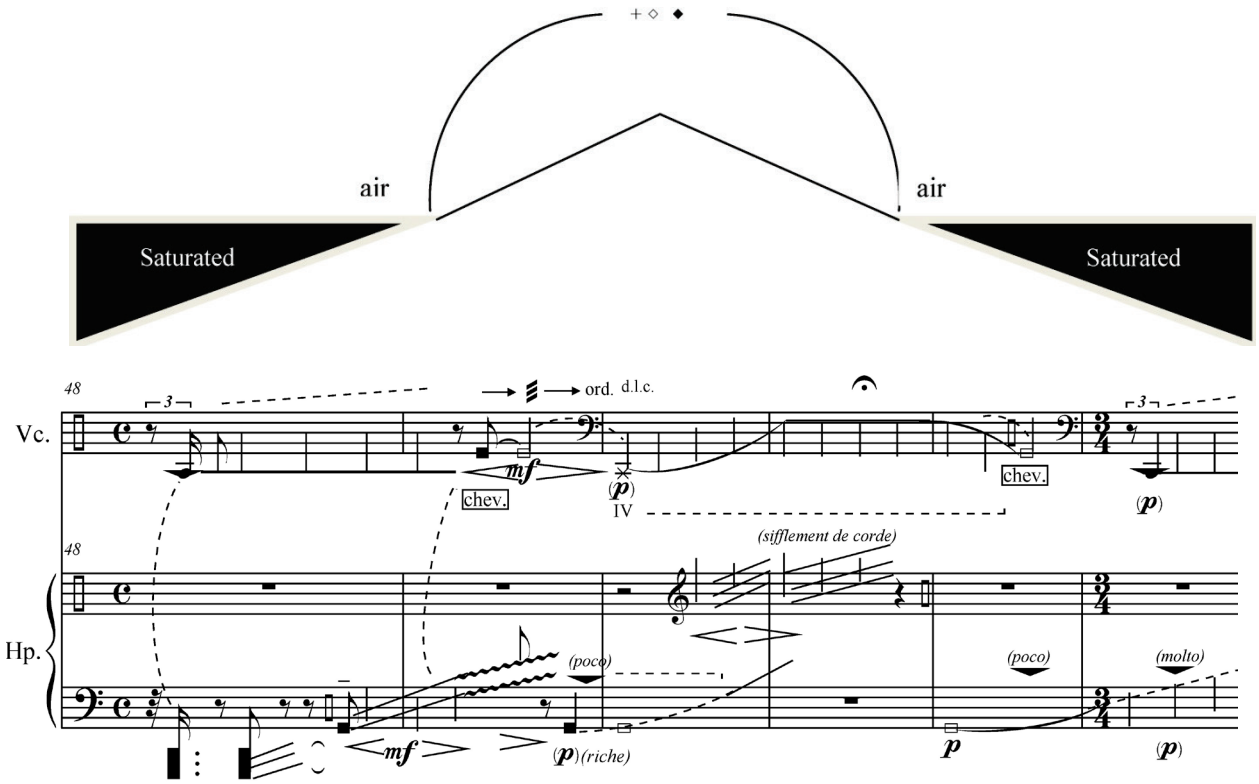

Fig.9 Process and score realisation (b.48-53)

[71] Perception/orchestration aspects/challenges/solutions (e.g. keeping air/breath as a foreground element in complex combinations of materials, sound phenomena or techniques) are discussed in 3.1.
[72] In chapters 2 and 3 (3.1 includes detailed examples in ensemble contexts).

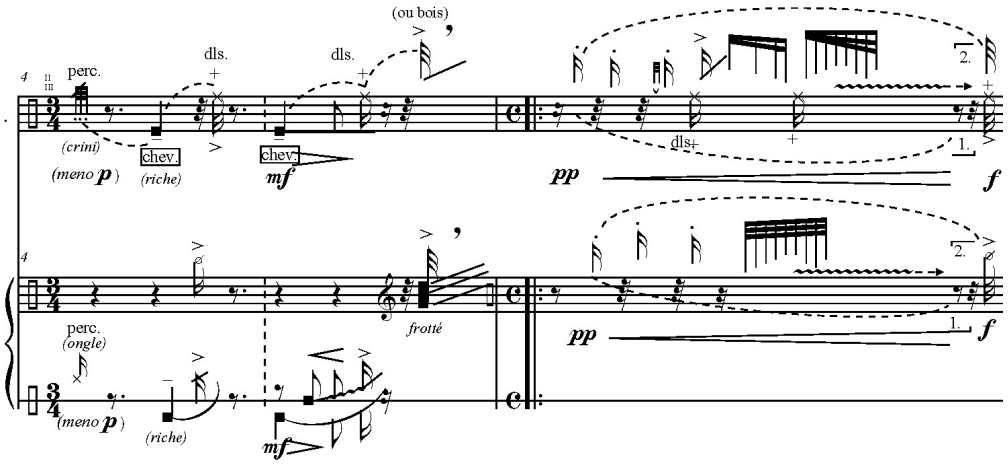

Fig.10 fast/virtuoso alternations

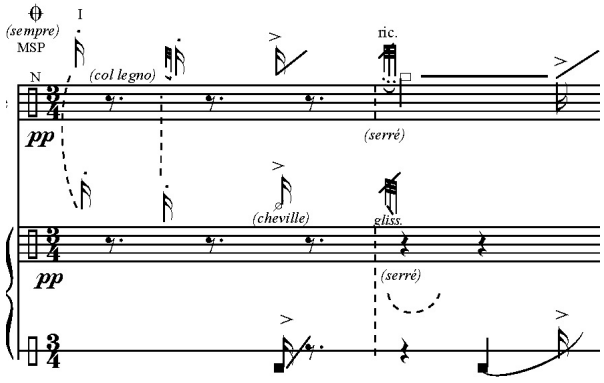

Fig.11 'Whistling arrows'

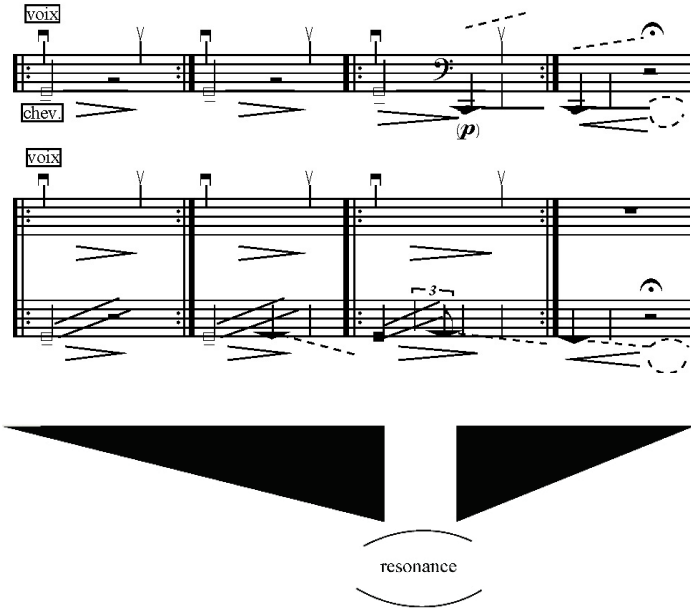

Fig.12 Friction, breath, granulation expansion and 'air' reverberation (score/process)

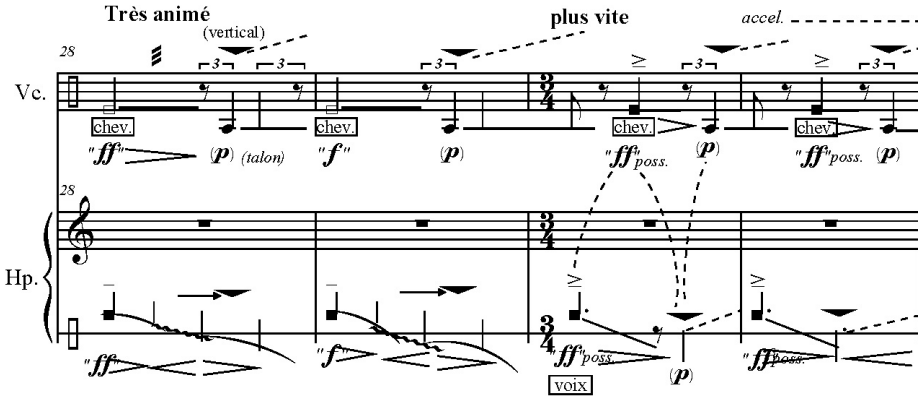

Fig.13 Alternation of overpressure and filtered pressures

II: Corps en résonance - hybrid traces. Extending the souffle continuum

One might think the instrument is the one breathing and not the performer […] yet one hears the breath and begins to breathe with it. (Sciarrino)[73]

Following the first chapter 'tactile' air extension, the second chapter explores the building of the *souffle continuum* (air/breath, friction) and its expansion through resonance. Resonance emerges as a hybrid *sonic* and *corporeal* element extending the fundamental ambiguity of air and breath which, as highlighted by Sciarrino [chapter epigraph], possess a specific power of perception impacting both 'intra' (performer-instrument) and 'inter' (performers and performers-audience) communication.

Souffle and resonance are envisaged as a 'whole' able to reshape the performer and instrument (and human-object) interaction – extending it, blurring it. A first complex form of human and instrumental, and corporeal and acoustic 'resonance', the air, breath and friction sounds mirror, merge and confuse themselves; they expand through resonance and resonance-related phenomena such as echo, sympathetic vibration, reverberation, sound spatialization. By emphasizing and hybridizing souffle and resonance, the three works of the chapter aim to (re)build a musical language in which the 'frontier' elements (air, resonance) and their porous thresholds expand to articulate the 'central' discourse of air (souffle) and create an overarching layer for composition. The overarching aim is to generate tools to overcome the natural weaknesses (e.g. specific dynamic range, lack of sound projection) of air techniques in all their forms through the convergence of air (souffle) and resonance as a phenomenon and concept.[74]

The composition and reflection stem from a double understanding of (and approach to) resonance: resonance as an *acoustic extension* and *sound continuation*; resonance as a broader concept implying two bodies (human and/or instrumental) in *echo* or *reflection* (re-sonance as in 're-sounding'). These two approaches nourish each other, creating a versatile tool for acoustic enhancement and a wider compositional lens for the *souffle* exploration.

The compositions examine how the sounds and gestures stemming from the *souffle continuum* (air, breath, friction) can develop within different types of instrumentation (acoustic and amplified, solo and ensemble) and levels of 'density' and 'porosity' (e.g. as part of hybrid textures or timbre qualities), investigating the multifaceted role of resonance in these contexts. The 'augmented' souffle-resonance continuum develops through various directions investigated in the three compositions, each of which explores specific aspects of this complex intertwinement.[75] Developed in solo and chamber instrumentations, such explorations are even more central in the large forces applications (chap.3), where the continuum extends towards an orchestration system developing the air (souffle) energy and multiplicity.

Three complementary approaches to the air (souffle) and resonance continuities are investigated.

In *Ātma(n)* for ensemble (2.1), resonance is an 'invading' phenomenon and a composition process. Gradually spreading within the ensemble's textures, resonance generates the work's structure through a gradual

[73] Sciarrino S. (2008) *Entretiens: Salvatore Sciarrino et Gianfranco Vinay.* Metz: Centre Acanthes. Transcribed from archival recordings by Alice Teyssier and translated by Aaron Helgeson.
[74] A central aspect in the next chapter (large forces applications).
[75] See table 2 in 'typology', p.33.

hybridization with air (souffle) and other elements. *Un eco di soffio II* for clarinet and piano resonance (2.2) incorporates an external body, a prepared grand piano whose sympathetic resonance is both triggered and controlled by the performer. An instrumental extension developed for the piece (the extended pedal, see 2.2) allows approaching resonance as a malleable air-generated (and souffle-developing) object and phenomenon. *Tracer le souffle* for amplified accordion and effect pedals (2.3) explores the multiplicity of the air (souffle) sources and traces towards the extreme extension of resonance, here an ambiguous, complex mirror. The pneumatic, human and instrumental forms of air, breath and friction and their electronic reworking are here contained within a *solo* configuration. These forms extend each other until complex reverberations, leading to complementary, obfuscated forms of air and white noise; they create through this further (con)fusions, ranging from fragile human-electronic merging blurring the air and resonance borders, until forms of saturation.

Air resonance(s): souffle and resonance continuities and temporalities

If air and resonance can be approached as parallel elements (see below) belonging to the frontiers of sound – air and breath as first elements of sound generation, resonance as a sound extension until extinction – they can acoustically merge and confuse each other (e.g. extended reverberations merging with or as forms of air, white noise as a complex form of air and (or) of resonance, see *traces*). This acoustic merging can itself be reinforced by or reinforce the first human-instrumental merging, e.g. the fruit of the mixture of the human breath and instrumental air and friction(s) (see *equivalences*).

For Levinas, resonance is an instrumental archetype that can be paralleled with exhalation: 'I don't reduce the expiration of sound to wind instruments alone. It is an archetype that can be found with any sound body. One can evoke the resonance of a piano, the pressure of a bow, a percussive attack, a synthetic sound.' [76] Resonance is in this context understood in the broad sense of the 'after' – what *follows* the attack and *reverberates* or *extends* it – an element that is intrinsically led to decay in a more or less gradual fashion, yet systematically towards sound extinction (until a new attack or stimulation) – just like the human exhalation.

The temporality resonance creates with regard to air and breath is multifaceted. As a *filter of the 'now'*, resonance acts as linking and reinforcement material, allowing developing the richness and overcoming the weaknesses of air sounds: specific register/dynamics, softness and/or fragility (see below). Air (souffle) techniques can build (and rebuild themselves through) resonance, triggering it, or extending it (2.1, 2.2). As a *complex echo or 'reflection'*, resonance transforms the air and breath mirror. Resonance is both a part within and a link between the human and instrument interactions, reinforcing the ambiguity of the breath-related sounds and actions (2.1, 2.2). As an *extension of the 'after'*, resonance can emerge from breath and friction and nourish the continuum they create, as an element of fusion or obfuscation. If resonance can create traces of air, air (and breath) can also be approached as traces of (or in) resonance. This opens to fully considering the energies and forces of and within the reverberations and developing the traces of air as composition materials (2.2, 2.3). White noise and 'non-finite' (or 'static') air-related forms or states can for example create other complementary fusions; they can become forms of resonance (2.3).

[76] Levinas, M. *La Chanson du souffle, une épiphanie du visage*. Publication in the author's website. January 2006. http://www.michaellevinas.com/ecrits/la-chanson-du-souffle-une-epiphanie-du-visage (Accessed October 3, 2019).

Overview of discussions in chapter introduction

The chapter explores the air and resonance continuities through a typology exploring the temporalities, energies, and processes and functions their hybridization can create. The *augmented continuum* (air-breath-friction-resonance) serves as a tool to transform corporeal and instrumental air sounds in all their techniques, forms and expansions.

The chapter introduction unfolds as follows:

Firstly, the ideas of *fragility* and *force* of air, breath and friction as gestures, movements and sounds and their development through *spatialization* are discussed. These aspects nourish the complex air-resonance continuities by envisaging air as a sound result but also as a triggering force developed through various instrumental-spatial configurations.

Secondly, the dual acoustic and metaphoric-conceptual approach to resonance highlights a wide range of possible perspectives (e.g. resonance as a musical, temporal, corporeal idea). Exemplified by Grisey's liminal approach (building on the thresholds of sound parameters) and Pierre Henry's souffle exploration in *Le Voyage* (1962), the concepts of *liminality* and *continuity* (of or between parameters or sound phenomena) are discussed in the light of their souffle and resonance application and extension. A prolific instrumental-human, time and function intertwinement emerges within the complex thresholds of air and resonance.

Thirdly, the novel or specific instrumental configurations of the three compositions (see below), which further (re)shape the human-instrument mirror (also approached in its gestural and choreographic aspects), expand the reflection to new, complementary questions: the possible *emptiness* (or conversely *saturation*) of (or within) the air (souffle) and resonance continuum and hybridization; the *temporality* of (or within) the air and resonance textures, extended to the work on traces and 'infinite' forms of air and reverberation. Sciarrino's approach to emptiness in *Vanitas* (1981) and Lyotard's 'vibrating anamnesis' reflection in the article *L' Obédience* (1986) are put in perspective with the souffle traces, reflects and memories in the chapter's works.

Finally, the three resonance models (instrumental, space, technology, introduced below) are discussed in more detail. Following an overview, a perspective with three works of Boulez – one of the 'most prolific composers of resonances' for Solomos[77] – investigates key utilisations of the models and their 'souffle' applications and expansions. A typology of interactions details the functions, energies and processes resonance creates within the compositional developments of the chapter.

(The ideas and concepts discussed as part of this introduction are developed in each subchapter.)

Typology: topological configuration (models), energy and time interactions, processes and functions

The details of resonance are prolific tools for sound transformation and air (souffle) (re)composition. Resonance is approached as a composition tool, an 'enveloping' material which includes a range of acoustic phenomena (e.g. sympathetic, beatings, the directionality of sound) through which the gestures and sounds of air and breath can dialogue, mix and merge.

[77] Solomos, *From Music to Sound* p.150.

In the compositions, resonance *opens a multiple space* (physical, instrumental, temporal, musical, see below). This space builds the resonance of air. The extension of air (souffle) through resonance – and by extension through instrumental, physical and electronic/amplified spaces – is a key aspect of their multifaceted hybridization. Building from three complementary models of resonance – instrument, space (2.1, 2.2) and technology (2.3) – a typology of air (souffle) and resonance interactions and continuities explores the temporalities, energies, and processes and functions their hybridization creates (see below). A specific approach to form and a system of souffle-based orchestration (chap.3) develop through the resonance and air/breath mutual reinforcements. The chapter explores these various continuities – parts of the 'augmented' air/breath-friction-resonance continuum – also extended here to the mechanically-implied continuities (2.3).

The research defines three forms of air and resonance *topological configurations* (or *models*, see Dufourt below), *energy and time interactions* and *processes and functions*. They are investigated in three contexts: ensemble and spatialization (2.1), solo and sympathetic resonance (2.2), and solo and amplification/electronics (2.3).

(The typology development in the three works is summarized in the table below. A summary of secondary subchapter-specific research questions (secondary RQ's) is included.[78] A fourth human-instrument 'resonance' category (the first resonance approach) establishes the 'corporeal' perspective with the developments of the 'acoustic' resonance models.)

- The *topological configurations* (or models) stem from the interactions of air and breath (souffle) with *instrumental resonance* (natural, sympathetic, modified, controlled) *through space* (specific architecture/place, using spatialization) (2.1 and 2.2) and *electronics and amplification* (2.3).

- The *energy and time interactions* develop (and develop from) these resonance models. Micro and macro developments in timbre/texture create materials and energies building complex sonic 'matters' with various air-resonance shares or densities (2.1 and 2.2) combining until fusion or saturation (2.3). The approach to time continuity/discontinuity includes processes such as direct reflection, accumulated actions 'energies' and resonance response, until white noise and traces.

- These interactions translate into *processes and functions*: resonance as a linking matter or reinforcement material, complex echo and 'invading' element (2.1) and even obstructing phenomena (2.2). Resonance creates dialogue-amplification functions (2.1 and 2.2), extended to a second life in traces (2.3), *reworking* air to create further timbral mixtures.

[78] These research questions are different or complementary to the main questions.

	Topological configurations	*Energy/time interactions*	*Processes and Functions*	*Continuum extension*
2.1: *Atman* Secondary RQ: Does resonance reinforce the merging and ambiguity of air and breath in their human and instrumental forms, increasing fusion or creating further confusion?	**Instrument** Amplification-filtration Sympathetic vibration Vibration-enhancements (beatings, scordatura) **Space** Spatialization-movements Polarizations Sound directionality	**Invading element** Gradual invasion Disappearing phenomena Shares-hybridity Texture porosity **Time interactions** Air and/in resonance Resonance and/in air	**Form generation** Nourish-emerge (from) breath-friction continuum **Merging – regulation** Dialogue-amplification Regulation of air-timbre interactions	**souffle-resonance-space** Mixed ensemble **(Con)fusion** Gestural/corporal/sonic Equivalent processes Breath time-form element Improv-asynchronisation
2.2: *Un eco di soffio II* Secondary RQ: Can (sympathetic) resonance spring from (and rebuild) air and breath? Can air/breath emerge from (and merge with) resonance?	**Instrument** Double wind-piano resonance Sympathetic resonance Piano evolving mirror-mute Extended pedal system **Space** Movements Piano polarizations Sound directionality	**Catalysed element** Direct reflection Merging and echo Enveloping element Obstructing phenomena Controlled accumulation Timbre porosity **Time interactions** Air in/through resonance Resonance in/through air	**Sound expansion** Echo extensions Resonances of air Fragility/instability **Legato - reinforcement** Dialogue-amplification Air sounds extension	**air/breath-resonance** Augmented solo **Radical mirror** Amplified breath Echoes and states Corporeal sounds Electronic interactions
2.3: *Tracer le Souffle* Secondary RQ: Can 'non-finite' air 'states' (e.g. white noise) become forms of resonance? Are there latent breath energies in reverberation traces? Does the extended, even saturated air and resonance merging create further (human, instrumental and nonhuman) (con)fusions ?	**Instrument** Air-friction in solo config. Human-mechanical breath Accordion stereophony Microphones as instruments **Technology** Amplification-effects Double layer: acoustic/amplified-processed 'Imperfect' processing	**Fusion element** White noise Traces Expanded energies **Time interactions** Continuity/discontinuity machine/electronic/human accumulated traces/actions	**Traces obfuscation** Second life in traces Memory **Emptiness - saturation** Mixture complexity Pneumatic energy	**Air/friction-resonance-technology continuum** Augmented solo Human-mechanical continuum Friction/air/breath/ electronic/pneumatic 'equivalents' Respiration as time/form element

Table 2: *Resonance(s):* chapter/work overview

Air fragility, air as a force. Resonance spatialization.

Air makes the mill go around; sound does nothing. (Döblin)[79]

The specific characteristics of air (and air-containing) sounds, some of which are fragile or unstable (as seen in chapter 1 under the 'tactile' perspective) reappear through the resonance filter.[80] Pure as well as hybrid forms of air (souffle) are reshaped and even rebuilt through resonance, as an expansion, but also enhancement function. This allows developing the air and sound 'porosity'. Marked by various degrees of 'purity' or timbral complexity (from 'pure' air to complex air/sound/noise mixtures[81]), air sounds are *passed through* a second overarching filtering element, which can merge, enhance, extend and even revise them.

As a sound, but also as a movement and force of projection, air and breath build (or result in) instrumental resonances and reverberations through both 'direct' and 'indirect' actions, e.g. air/breath utilised as a projection force expanded towards sympathetic utilizations. This leads to a double acoustic and physical approach – air as a *sound*, air as a *movement/force* (2.1, 2.2) – and an attack/resonance system, expanded towards an orchestration system in chapter 3.

[79] Döblin, A. (1980) *Gespräche mit Kalypso: Über die Musik*. Olten: Walter-Verlag (p.33).
[80] Fragility-instability (e.g. evolving timbre complexity, grain, colours) apply to 'tactile' as well as wind-based sounds (e.g. see 2.2)
[81] E.g. air part of extreme registers, whistling sounds, multiphonics, extended techniques, white noise…

Spatialization develops the souffle-resonance continuum within changing spaces, incorporating sympathetic resonance and reverberation. In *Ātma(n)* (2.1) and *Un eco di soffio II* (2.2), spatialization and sympathetic resonance/instrumental reverberation are approached as complementary elements and perspectives. The evolving positions of the performer(s) build changing polarizations and configurations utilizing instruments or percussion as natural reverberations and resonance-enhancing resources. In these two works, the piano is a resonant body and amplification, but also a physical anchor within the performance space. Gradual changes of positions impact the performer(s)' actions on and interactions with the piano's resonance – natural, controlled, prepared and modified; reached from the sides, back or surroundings of the piano.[82]

Breath resonance(s): a complex acoustic-human (time-function) intertwinement. Thresholds, liminal states

Alongside the sonorous, external, material form, there is the non-sonorous or silent, internal, spiritual, general form.[...] These two forms are connected at more than one point, both resting on the same intimate structure, a structure we have described under the name of resounding. (Minkowski)[83]

Resonance, as a reflecting object and spectral, spatial, human and instrumental phenomena opens fruitful perspectives and associations with air and breath (souffle), raising new and complementary questions. While Minkowski [paragraph introduction] hypothesises the existence of a complex, intertwined internal and external (and sonorous-silent) structure of 'resonance', Anzieu remarks that acoustic and 'psychic' resonance deeply interrelate.[84]

How are these two forms of resonance articulated? The hypothesis is that the souffle perspective can shed new light on the complex intertwinement between the 'acoustic' resonance and resonance in its 'psychic' sense (intra-individual as well as inter-individual), and ultimately resonance as perceptual phenomena and phenomenological event. 'Liminal' states (see below) expand, merge and blur parameters between the 'inner' space/life of breath (the body) and the outer space/life of the sound and its resonance. The 'inner' space of the body (the breath) thus reaches the 'external' space of sound (through air-timbre transmutation and sound projection) which, through resonance and reverberation, is reworked and creates 'mirror-affiliations' that can communicate in various fashions. As discussed below, these pathways and thresholds are fruitful for composition.

If resonance encompasses many different definitions and aspects of music, composition and beyond, it lies here on a double understanding and definition.

Firstly, resonance is not exclusively understood as belonging to the acoustic field. 'Resonance occurs when a body, under the influence of another body in vibration, enters itself in vibration.'[85] Approached as unfolding within, as a part (or result) of the human-instrument reflection, 'resonance' leads in this context to questioning the complexity of the human/instrumental 'double' and duality. The reflecting aspects of breath – between the

[82] See dedicated subchapters. These aspects are furthered in the next chapter (large forces): *Holo(s)* (3.1, double polarization); *Concerto pour piano et ensemble* (3.2, piano 'resonant' virtuosity).

[83] Minkowski, E. (1936) *Vers une cosmologie. Fragments philosophiques.* Paris, Aubier-Montaigne
(See also *emptiness and saturation* below)

[84] 'It is not by chance that the concept of acoustic resonance has provided scientists with the model for all psychic resonance and group psychologists and psychoanalysts with the model for unconscious communication between people.' Anzieu, D. 'L'enveloppe sonore du soi.' *Nouvelle Revue de Psychanalyse* 13 (1976): 161–80. The article hypothesizes the 'sound envelop of the self'.

[85] Tanner, R. "Critique de la théorie de la "résonance", in Weber, E. (ed..), *La résonance dans les échelles musicales*, Paris, CNRS éditions, 1963, p. 63-100.

performers in the sense 'to enter into resonance' and between the performer(s) and the instrument(s) – creates fruitful ambiguities and composition paths building on the human/instrument prism and communication/perception power of air and breath sounds (e.g. see Sciarrino's comment in the introduction).

Secondly, the investigations stem from a temporal, spatial and textural understanding of resonance: the resonance that corresponds to the sound flow that follows excitation and impulse and whose waves propagate in an environment (resonant chambers of an instrument or an architecture/place, see topological models) marked by different degrees/qualities of reverberation – possibly extended or reworked through other means or phenomena (sympathetic vibration, echo, technology, explored in this chapter's works). Resonance includes in this context both the spectral flux and the propagation medium which can enrich it in sound density and time duration, contributing to a strong connection between space and time – conjunction which is at the centre of the gesture of composing and the act of listening: resonance is both the *hic et nunc* ('here and now') and the 'after' reflection (see *temporalities* above).

This complex time-function intertwinement is itself a fundamental part of the perception of breath. For example, respiration-related ultra-musical rhythms (arsis and thesis of breath, ebb and flow of the sea, etc.) have specific impacts on temporality perception. According to Chion, they can render duration unreal, making it escape linear time: 'they don't make perception of a before and after easy. [...] They undo time.'[86] This conjunction is fruitful. It is a key element to reach a specific state, working on the thresholds not only in time but also in sound.[87]

This attempt to reach a specific threshold-state appears for example in Grisey's compositional reflection. Grisey, who preferred the word 'liminal' to 'spectral' to define his approach, refers to the music of *Les espaces acoustiques* cycle (1974-1985) 'as the negation of melody, polyphony, timbre and rhythm as exclusive categories of sound, in favour of ambiguity and fusion. [...] Parameters are only a reading grid and musical reality lies beyond them, in the thresholds where an attempt at fusion takes place.'[88]

Reaching a 'liminality' becomes a full composition parameter and musical aim in these contexts, a state from which 'perception begins to work'.[89] However, this liminal state based on the 'thresholds where an attempt at fusion takes place' can be manifold and extend beyond the 'reading grid' of melody, polyphony, timbre and rhythm. Here, a constant hybridization between resonance and air (souffle) allows achieving and maintaining an equally ambiguous, intermediate sonic and physical 'state', a temporality and sound liminality between the 'inner' space of breath (the body) and the outer life of the sound resonant projection (instrument, space) – here the very thresholds where attempts at fusion take place. This core transmutation from the state of 'subject' (the body/the individual) to the state of 'object' (the instrument/the sound) is key to investigating the complex power of communication of souffle (air and breath), which, to expand Cohen-Levinas' commentary on voice, possess the unique capacity to 'respond of the being' while 'being capable of distancing from it'.[90]

[86] Chion, *Sound*, p.40.
[87] See discussion on temporality/perception in chap.3 introduction.
[88] Grisey, G. 'Structuration des timbres dans la musique instrumentale', *in* Jean-Baptiste Barrière (ed.), *Le timbre. Métaphore pour la composition*, p. 377.
[89] Solomos, *From music to sound*, p.39.
[90] Cohen-Levinas' comment on contemporary vocal expansions in *La voix au-delà du chant*, p.20.

Liminal pathways, continuities. Pierre Henry's Le Voyage

Although in a different composition field, Pierre Henry's *Le Voyage* (1962) provides a possible illustration of this breath-composed resonance and evolving sonic-corporeal state. One of the first major *musique concrète* explorations, the work is based on the Wheel of Life described in the Tibetan Book of The Dead.[91] The first and last movements 'Souffle 1' and 'Souffle 2' open and close *Le Voyage*; they represent death and rebirth.

'What struck me was the absolute continuity of the sound: a breath like that of a long gas leak, disconnected from breathing', says Chion.[92] Indeed, 'Souffle 1' consists of a single flow of souffle (air/breath) which passes through three states: 'a first part where the souffle is calm, a second where, with the human element intervening, the sound is more uneven, and a third where, after an explosion, the sound becomes smooth again.'[93] In this context, the 'human element' is the very source of 'unevenness' and the breath – as opposed to the air, the wind, the white noise... – the threshold of discontinuity, towards the 'explosion'. The continuity of air is also synonymous with the multiplicity of its sources, Henry seems to remind us in his note for the piece: 'swelling in the ears of the dying, the last clamours of earthly life. A thousand whispered voices, a thousand cars, a thousand sea trumpets, the tearing of teeth, of hands, the radio pushed to its limits. And a wind, a wind that comes closer, and which he recognises as his breath.'[94]

This threshold, a wind that comes closer which he recognises as his breath (here the symbol of the rebirth in 'Souffle 2') indicates the change of perspective the breath and its resonance create: imperceptible in sound and in time, complex as 'a thousand whispered voices', far away and continuous as the wind, this background element *zooms in* to become the human breath. But was it the breath already – or perhaps its threshold, Henry seems to ask us, as wind and breath emerge as equal human-earth transcendent forces giving (again) life to the human in a permanent cycle. Henry also questions the nature of this continuous transcendent force and earth/wind-related sounds. Industrial society has given rise to the acoustic straight line, to the continuity of mechanical noise: 'many mechanical sounds are linear and unchanging, unlike the sounds of nature, which are born, develop and die, like living beings'.[95] Here, whispered voices merge with wind, cars, radio 'pushed to its limits'; the combinations arise as a continuous air-wind-white noise amalgam, and a flow whose thresholds with the human breath are unclear. The human and beyond-human (white) noise ambiguity of souffle finds here one of its first key compositional illustrations.

Novel instrumental approaches, human-instrument mirrors.

Human and nonhuman air-breath forms build new instrumental approaches, which the 'augmented' instrumentations attempt to further. Stemming from the human-instrumental (2.1, 2.2) and white noise/mechanical prism (2.3), the instrumental (re)composition of the air resonance develops (through) this continuity, working on liminal points furthering the intra/inter human-instrument (con)fusion.

[91] Here, the notion of resonance (given the power of the figurative theme) can also be interpreted symbolically.
[92] Chion, M. (2015) "La venue du souffle, sur trios sens de ce mot". In Joubert M. & le Touzé, D. (eds.) *Le souffle en musique*, Lyon, Presses universitaires de Lyon, pp.13-23.
[93] Chion, M. (2003) *Pierre Henry.* Paris, Fayard, p. 9.
[94] Pierre Henry, *Le Voyage*, Philips, 412 706-2, Phogram S.A., Paris, 1967
[95] Méric, L. (1994), *Le bruit. Nuisance, message, musique*, Genève, Georg Editeur SA, p. 45.

Novel instrumental approaches create means for investigation. The extended pedal – a physical extension of the piano's sustaining pedal – provides new possibilities in *Un eco di soffio II* (2.2).[96] The resonances of air and other sounds are reworked through the extension, with which the clarinettist can control the sympathetic vibration and reverberation he/she generates around the piano.[97] In *Tracer le souffle* (2.3), the application of electric guitar effect pedals to the amplified accordion opens new paths for the air/resonance border and traces exploration.[98] The composer-performer collaboration throughout the piece construction allowed in-depth exploration of this complex (yet unexplored) configuration.[99]

As highlighted above, liminal air (souffle) and resonance pathways and 'states' are key to exploring the thresholds of human and instrumental sounds and gestures and actions. In the three works, human respirations transform and translate into their instrumental, resonant or electronic equivalents – acting as 'mirrors' and extensions. Air sounds, breath and air-like frictions merge, resonate and reverberate and 'adapt' in sound and in time, both within the individualities and their intra/inter-actions (*Ātma(n)*, 2.1), as part of the direct human-instrument reflection (*Un eco di soffio II*, 2.2) and human-instrument-electronic continuum (*Tracer le souffle*, 2.3). The thresholds of air and resonance are malleable and porous; they extend each other. Human breath and instrumental air create echoes which, through various processes – e.g. structural function (2.1), sympathetic vibration (2.2) and electronics/amplification (2.3) – enhance and confuse each other towards an extended continuum, the fruit of the complex intertwinement of air and resonance.

Respiration echoes and equivalence(s), choreographic impact of air/breath 'states' and actions

Air and breath (souffle) 'irrigate' multiple levels of perception and 'permeate' instrumental techniques (traditional and extended, and beyond air sounds as seen in chapter 1). As a cycle and mechanism, respiration (and its perception) emerges as a fruitful, ambiguous composition tool and time element, whose 'resonances' develop through several instrumental-corporeal layers. Exploring both the physical and acoustic dialogue of breath, a first compositional level merges the human and instrumental forms to develop intermediate, 'hybrid' gestures and sound expansions building on the human-instrumental ambiguity. A second development creates further layer(s) of air and other sounds reworking the overall sound complexity (and ambiguity) through resonance/echoes and other 'residual' elements expanding the textures.[100]

As pointed out by Chion, if the echo presupposes a time lag, simultaneous echoes – or almost simultaneous, relative to the scale of the human present – exist: the constant reflection of our voice returned by the environment. 'We become conscious of this reflection when, on rare occasions, it goes missing. The problem is that, for reasons related to the physics of sound, this sonic mirror becomes mixed up with the "original".'[101]

Here, this 'mixing' is multiplied. Equivalences in corporeal-instrumental sounds (colour, timbre) and gestures (inhalation, exhalation) play both on the performed and perceived actions to investigate how the (corporeal) breath sounds and actions can change the (instrumental) gestures and sounds of air, and how the 'whole'

[96] See p.65-66 for further discussion.
[97] The performer accesses 'excitation points' triggering the strings sympathetic vibration – evolving according to position – while modifying the resulting reverberation (see 2.2).
[98] Effects include whammy, reverb, tremolo, etc. (see p. 87-89 for more details on the technical configuration).
[99] See 2.3
[100] See *residues* in chap.3
[101] Chion, *Sound*, p.95.

resulting texture and sonic-physical 'state' (here the fruit of the breath-friction-resonance-electronic fusion) can, in turn, change the very act of breathing. The 'inner' voice of breath is mixed with and extended, obfuscated by the instrument's 'external' voice: the friction, the breath-like mechanical, pneumatic, amplified or re-processed air action. As the process develops in time, the performer(s) adapt and transform their breathing through the lens of these reworked echoes.

The concept and process of 'equivalents' using the cycle of respiration develops these human-instrument *mirrors*. In *Ātma(n)* (2.1), the textures are based on human-instrumental inhalations and exhalations 'equivalences' developed through combinations of individual and ensemble 'counterpoints'; such processes build from mixtures of air sounds and direct breath reflections in *Un eco di soffio II* (2.2), and through timbre-air electronics expansions in *Tracer le souffle* (2.3).[102]

These complex human-instrument echoes and pathways extend to (and are extended by) acoustic resonance and reverberation. Amplified and reworked, equivalences and their combinations create resonances (instrumental, sympathetic, electronic) which in turn nourish the first human-instrument 'mirror' texture.[103] Building dense expansions as well as imperceptible echoes, these respiration-based mirrors also question the characteristics of the musical space they open and the sound (con)fusion they create: textures made of air and traces of air, dense 'enveloping' air and resonance mixtures, softly reverberating spaces, immersion and even overwhelming presence of air and resonance/reverberation leading to saturation (see below). The 'equivalence' process is also a corporeal-gestural 'state' generating the works' phases. It is for example extended to trembling 'stops' – here the stops of breath leading to 'frozen' apnoeas (e.g. *Ātma(n)* movement V, *Tracer le souffle* movement III) through which air resonance(s) are able to (re)appear as 'silent' extensions of the gesture-breath action.

The choreographic impact of air and breath-associated actions (human as well as instrumental) are therefore key to building the souffle continuum and composition. Full sections of the works spring from the gestural features of air techniques (in all their forms) and breath-related states.[104]

In *Ātma(n)*, the inhalation/exhalation-associated tension and release principle generates sonic-choreographic phases. The performers' breath sounds and gestures (body and instruments) build rhythmic movements, accelerations, breath-held 'apnoea' and frozen positions. As the spatialization process develops, these extend to parallel choreographies in moving spatial configurations. In *Un eco di soffio II*, repeated inhalations/exhalations (amplified through clarinet and extended by the piano) build 'hyperventilated' resonances. Air sounds and breath, in their 'extreme' corporeal utilisations, 'saturate' the (sympathetic) resonance mirror. In *Tracer le souffle*, the double mode of sound production (air and friction, left and right hand) generates the core corporeal-gestural-mechanical continuum, here on a single 'elastic' body. The accordion's bellows opening/closings create various air sounds and airwaves reworked by the granulated air-like frictions (on the bellows' surface) and by the performer's 'pure' or phonetically modified breathings. These elements develop mixed breath and gesture-based sound articulations, such as choreographed 'bellows-cracking' paralleled with 'air-trembling' phases, near-silent 'out-of-air/out-of-breath' positions and 'frozen' gestures and air and breath interruptions.

[102] These aspects are also central in chapter 3 to investigate the air multiplicity and energy.
[103] See 2.1 for a full description of this process.
[104] See dedicated subchapters.

Emptiness and saturation: infinite resonances, unleashing of forces. Souffle and Traces

'And the song of birds on summer nights; and then those same birds, at moments, fall silent; and then you hear very faintly the sound of waves.' (André Gide)[105] *The paradoxical pleasure experienced before a sudden unleashing of forces.'* (Arbo, on Romitelli's aesthetics)[106]

Emptiness and saturation are recurrent concepts and questions within the air (souffle) and resonance exploration – individually and perhaps even more importantly as part of the 'whole' created by their compositional hybridization. From approaches to air and resonance as dense and immersive elements to representations of emptiness by air, echo or vibration, the compositions attempt to build on and 'elucidate' this complex relationship (and possible additional ambiguity) within and between the sonic, human, instrumental and 'mechanical' continuums. The communicating time-sound states and 'shapes' between air and reverberation-created 'emptinesses' and air (or white noise) saturated sonic spaces irrigate the compositional investigations. Arbo (on Romitelli, epigraph) evokes for example the dynamic sublime, the pleasure experienced before a sudden unleashing of forces. Can this unleashing of forces occur through the air (souffle) and resonance emphasis and hybridization? Such questions become even more prominent through the technology incorporation (mechanical, amplified and processed air and emptiness and saturation forms in 2.3) and, in the next chapter, through the orchestral and large forces expansions (instrumental mass and empty/saturated instrumental-orchestral spaces). Does the 'excess' of air (or its 'saturation' or 'emptiness') and of resonance/reverberation systematically lead to continuous, possibly 'static' white noise-related forms? To what extent are machine or non-human forms of air (such as rustles, pneumatic energies, white or electronic background noises...) empty-saturated (or continuous-discontinuous) forms of resonance and (or) air?

The ebb and flow of the sea represents emptiness in André Gide's *The Fruits of the Earth* (paragraph introduction). In *Vanitas* (Sciarrino, 1981, see discussion below) emptiness is approached as the echo and 'sounding shadow of the breaths (*des souffles*), of sonorous breathings (*des respirations sonores*).'[107] Pierre Henry's *Vrombissement* (subtitled *le vide du vide*)[108] springs from recorded 'vacuums'. Close listening, reworked recordings reveal various (imperceptible) sounds and sources in space and create, again, continuous forms of resonance and (or) air.

As highlighted by Chion, the cessation of a sound often allows us to become aware of it afterwards, revealing a 'hidden sound, itself already present, but previously either masked or audible yet scotomized.'[109] For Chion, this *raising of the curtain* on *another sound* that had been hitherto masked is 'potentially infinite'.

Vanitas emptiness (Sciarrino), vibrating anamnesis (Lyotard). Traces, reflects and memories of air

Two complementary reflections expand this: Vinay's comments on Sciarrino's representation of emptiness in *Vanitas* (1981)[110] and Lyotard's 'vibrating anamnesis' reflection in the article *L' Obédience* (1986).[111] They are briefly discussed to introduce the notion of *traces* in the works.

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[105] Gide, A. (1958) *Les nourritures terrestres*, in *Romans.* Paris: Gallimard, p. 223.
[106] Arbo, A. (ed.) (2005) *Le corps électrique. Voyage dans le son de Fausto Romitelli*, Paris, L'Harmattan, p. 43.
[107] Presentation of *Vanitas in* Sciarrino S. (2001) *Carte da suono scritti 1981-2001*, Mascalucia, Edizioni Novecento.
[108] '*The emptiness of emptiness'* in *15 formes de vide sonore - Investigations* (15 forms of sonic emptiness – Investigations), 1959. (Roar, hum, whir are possible translations of *Vrombissement*).
[109] Chion, *Sound*, p.38. Scotomization is a psychological term for the mental blocking of unwanted perceptions.

Firstly, Vinay notes that Sciarrino's representations of emptiness in *Vanitas* arise not as much as 'the results of a music rarefaction', but rather as 'the recurrence of a sonic reflection.' A background resonance (*résonnance de fond*) becomes a medium 'to express an emptiness that resonates infinitely.' For Vinay, it is precisely through the 'resounding emptying' of the sonic image that the meaning of *Vanitas* (still life) is expressed, expanding Sciarrino's comment on emptiness as an echo of breath (see above). Emptiness, which 'in Western civilisation is a static and negative concept' is transformed through this into a 'dynamic and positive concept.'[112] Emptiness becomes a 'symbolic reflect of souffle'. Secondly, Lyotard (drawing a parallel with painting) notes that 'after the exploration of the constraints on the chromatic organisation of surfaces, all that remains is colour.' Similarly in music, 'the analysis of pitch regulations finally leaves only the material, the vibrating sound, as the remainder (*l'enigmatique presence du vibrer*).'[113] For Lyotard, composers' attempts at pointing out (or revealing) this 'enigmatic' vibrating material or 'residue' are at the heart and foundations of post-war musical evolutions – 'an anamnesis of what was given the name of music' – towards what Lyotard refers to as a '*Tonkunst*.'[114]

It would be, beyond perception, a matter of searching for a fascinating 'residue' – pointing to the 'vibrating', the unconscious... A 'residue' that seems to remain despite any conscious action, in many respect 'mythologized as the representative of another vibratory reality'.[115] This enigmatic 'resounding' (see Minkowski above) would build the empty and the full; the imperceptible and 'Unanimous concert of celestial wonders / Rolling with grand harmonies in the silence' in Lamartine's poetical evocation.[116]

Traces, reflects and memories of air are key composition mediums in the chapter's works. Fruits of the air and resonance hybridization, the traces are approached as complex elements and energies, able not only to build and develop (during) the works but also as elements expanding (beyond) them.

A vibrating trace extended *Un eco di soffio II* (clarinet and piano resonance, 2.2) after its first performance and until the reprise in a mirror version – a seven-day interval and duration. Auto-generated through piano preparations and conceived to automatically vary through instrument-audience/visitors interactions, this 'permanent' trace expands the last sounds of the piece: heartbeat, respiration.[117] In *Tracer le souffle* (accordion and pedalboards of effect, 2.3), air traces act as pneumatic energies and 'reworked' memories. Expanding through reverberation and loops, their complex 'sum' is ultimately presented, reworked by and merged with the grain of the microphones' friction. These energy-memories then slowly deconstruct. Minimal movements of the performer's foot (pedal-controlled 'trace' volume) control the very details of their appearance (and slow disappearing) during, and at the end of the piece. As the traces ultimately vanish and the performer imperceptibly freezes his actions – a slow 3-minutes process – their borders with silence appear as blurred and confused.

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[110] Vinay, L'invisible impossible (see footnote 51)
[111] Lyotard, J-F. (1986) 'L'obédience', *InHarmoniques* 1: 110-111.
[112] Vinay, L'invisible impossible.
[113] Lyotard, 'L'obédience'.
[114] *Ibid.*
[115] Chion, *Sound*, p.36.
[116] Lamartine, from 'Première Vision' in *La chute d'un ange*, in *Œuvres poétiques complètes* (Paris: Gallimard, 1963), [L'unanime concert des célestes merveilles / Roulant dans le silence en grandes harmonies]
[117] The piece was developed as part of an art exhibition, in which the piano (used for sympathetic resonance), its 'grafting' (the extended pedal) and preparation (vibrators) were approached as interactive objects sounding/resonating beyond the piece (see 2.2).

In *Ātma(n)*, air traces expand to enveloping, immersive functions. Two *fermatas* auto-generate evolving traces through the combination of the six players' movements and improvisations. Unconducted, these phases signal the peak and end of the air and resonance hybridization process. Human and instrumental forms of air and breath build white noise textures which evolve in space through sound directionally changes and evolution of the performers' positions. A second soft, near-permanent airflow (the sound of the vibraphone's rotating motor) initiates, resonates and expands during and beyond the piece, imperceptibly extending the performers' last frozen actions.

Resonance models: instrumental, space, technology

Composers from different backgrounds, historical periods and aesthetic approaches have expressed their interest in resonance (or resonance-related processes) in many different ways. In his theory of the 'corps sonore' (1726), Rameau deduced harmony from resonance.[118] In Lachenmann's works (e.g. *Ausklang* for piano and orchestra, 1985[119]), resonance is the fruit of the movements' energy and builds through mediation between resonance and motion. This conjunction is at the heart of Lachenmann's sound and gesture mediation.[120] In Nono's *...sofferte onde serene...* (1976) for piano and tape, the tape is 'like a gigantic resonance composed in the form of a mirror, from reworked piano recordings.'[121] Resonance is a 'double' and immediate echo and shadow of the 'human' performance. One of the last works of Feldman, *Coptic Light* (1986, for orchestra) sounds like a large resonant extinction that is constantly being (re)composed.

These resonances stem from different models or inspirations, building composition principles and functions. In my works, the resonances stem from three main propagation spaces approached as complementary resonance models. *i)* instrumental: the resonance chamber of an instrument or the 'space' of an instrumental body which can filter, amplify or modify air sounds in colour or intensity; *ii)* space: the instrumental/sound sources spatialization which modifies sound directionality and air-resonance interactions, and the resonance of a place or architecture which enclose the sound of air and allow it to develop; *iii)* technology: the resonance(s) of the technological extensions which develop air-sounds through electronics, amplification and sound diffusion.

From their models to their metamorphoses into processes and functions, these resonances draw a new space. They give air (souffle) a specific energy and temporality in which the human-instrument breath continuum plays a key role.

A full review of the three resonance models (instruments, space, and technology) and their historical impact on composition is beyond the scope of this research. The next sections provide an overview of existing utilisations and 'souffle' applications in the three works of the chapter. A parallel discussion with three selected works of Boulez (a prolific 'composer of resonances') establishes a perspective with existing applications and resonance-model combinations in other contexts.

[118] Rameau, *Nouveau système de musique théorique, 1726.* See Christensen, T. (1987). Eighteenth-Century Science and the 'Corps Sonore': The Scientific Background to Rameau's Principle of Harmony. *Journal of Music Theory*, vol. 31, no. 1, pp. 23–50

[119] This work is discussed in 3.2 (concerto developments).

[120] Pace, I. (1998). Positive or negative 2. The Musical Times, 139(1860), pp. 4-15.

[121] Nono, L. (2007) "Notice for *...sofferte onde serene...*". In Nono, L. *Écrits* (transl. Feneyrou, L.) Genève, Contrechamps.

Souffle and (in) resonance: utilization and expansion of the three resonance models

1) Instrumental

Instrumental models are the first mediums for the air/breath (souffle) expansion in the works. They create resonance 'spaces' for air sounds around three main principles: instrumental extensions, sympathetic resonance systems and (re)created spaces. These principles enhance the resonance(s) of air (souffle) and (re)build its first instrumental resonant chamber(s) and space(s), which can also expand through the two other models.

Throughout history, resonance-related inventions such as the pedal-control of the piano reverberation (built and refined through the classical/romantic periods and until today) have had a decisive influence on composition.[122] Systems which develop resonance and timbre through sympathy (e.g. the lirone, the Indian tambura) and/or through specific tunings (e.g. scordatura in baroque string playing) create natural amplification possibilities which have impacted traditional as well as contemporary practices.[123] Ensemble models which are characteristic for their strong harmonic resonances (e.g. Indonesian gamelan) have had a decisive impact on the 20th century, from Debussy to Boulez.

Instrumental models can also *rebuild* a space. For example, in *Concerto pour un piano espace* (Levinas 1980), the resonance of the Villa d'Este cave served as an inspiration. The ensemble's sound is amplified and reverberated in the piano, which, 'thanks to the resonance effect of the pedal, incorporates in its components of timbre the natural reverberation of the liturgical spaces of 17th and 18th-century music.' This *timbre* is 'close to the brilliance of the voice, but also includes a part of noise and percussion.'[124]

The 'augmented' instrumentations in the compositions create versatile energies, timbres and spaces. A complex instrumental resonance system was tailored for *Un eco di soffio II*. The system includes novel tools and preparations for reworking air reverberation and sympathetic vibration. The discrete intervention of a second vibration-controlling player and the approach to the body of the piano as a complex, evolving reverberation space contribute to the system expansion (see 2.2). In *Ātma(n)*, this extends to an ensemble approach. Combinations include various instrumental vibration-timbre enhancement and modification mediums (e.g. through scordatura) as well as extended utilisations of sympathetic resonance at the individual and ensemble scales (see spatialization below).

2) Space and spatialization

Space models extend and deploy the instrumental synergies. Space interactions and configurations and spatialization parameters develop the air-resonance continuum. Olivier Warusfel notes that 'thanks to space, we can merge sounds, separate them to have an increased auditory legibility, make them move in different directions, create poles and interferences between rhythm and movements in space.'[125] For Nono, sound 'reads' space, and space 'discovers, reveals sound; sound combines with other sounds in space, and are recomposed in it.[126]

[122] From classical orchestration to contemporary 'resonance' composition and electroacoustic explorations.
[123] E.g. Berio *Sequenza X,* for Trumpet and Piano resonance (1984); Grisey *Prologue*, version for viola and resonators (1978)
[124] Levinas, M. (1980), *Concerto pour un piano espace*, program note.
[125] Warusfel, O. (2007), "Entretien avec Olivier Warusfel. De l'acoustique virtuelle à la réalité virtuelle" in *Musique, architecture*, revue *Descartes* n°56, p. 90. (Warusfel is the head of the Room Acoustics team, IRCAM.)
[126] Nono, L. (1984) "Conversation entre Luigi Nono, Michele Bertaggia et Massimo Cacciari" In Nono, L. *Écrits* (transl. Baud, T.) Genève, Contrechamps. p. 489-490.

Space interactions and configurations indeed greatly contributed to the construction of the classical and contemporary musical language(s). Romanesque churches, reflecting the successive notes of the plainsong, probably originated harmony.[127] The Renaissance and Baroque multiplied polyphonies (double, triple or quadruple choirs, canons with several dozen voices) and the later Romantic orchestral expansions of instrumental and vocal *timbre* through complex spatial dispositions[128] paved the way for its later parametric independence and 'profusion'.[129] Space becomes a fully composed parameter in the second half of the 20th century. Architects such as Renzo Piano have for example tailored structures for works such as Nono's opera *Prometeo* (1985). Pauline Oliveros' *deep listening* phenomenon was forged by the 45-second reverberation of an underground cistern in Fort Worden (1989).[130]

Space parameters build new interactions in *Ātma(n)* and *Un eco di Soffio II*. Evolving performers' dispositions merge and separate air sounds and their spatialization, directionalities and polarizations. Throughout the works, parallel physical and sonic performance spaces emerge through evolving foreground and background layers of air and resonance. The notion of solo/ensemble resonance polarization(s) – or *anchors* in space – contributes to these explorations (see dedicated subchapters).

The spaces of these works' first performances also impacted their composition and implementation. *Ātma(n)* was premiered in an acoustically rich, resonating space (the Kalv church, Gothenburg, Sweden). The merging of air and resonance and the spatial perception/dispersion of air sounds developed thanks to the space's qualities and physical possibilities, including as part of the changing ensemble configurations and performers' movements. This allowed building the final surrounding air-resonance texture and 'trace', expanding in and beyond the (visible) performance space. *Un eco di Soffio II* was composed for a multidisciplinary art exhibition and experimentation. The prepared resonance and vibration of the piano[131] could fully expand in the exhibition's space – a 5-floor *Maison de maitre* in Brussels.[132] The space and performance context impacted the work's resonance perception and 'second life' as a *trace* beyond performance. The audience was invited to listen to the work near the piano, surrounding it and freely moving around it, to explore and perceive its resonance in various fashions. The sounds of (and beyond) the piece could expand through the five communicating open floors of the *Maison de maitre* (here a form of 'open' filtration) and be listened to in various fashions.

3) Technology

Technology models can develop air and resonance towards new modes of performing and listening, from close microscopic 'spaces' detailing and even revealing instrumental or vocal grain and matter (e.g. through close microphone amplification) to immersive forms and sonic expansions (e.g. combined with specific sound

[127] Lingering in the gallery and by superimposing each other, they give the impression of harmony' 'preparing the ground for its actual arrival', notes Michael Forsyth. Forsyth, M., *Architecture et musique. L'architecte, le musicien et l'auditeur du 17e siècle à nos jours*, Liège, Pierre Mardaga, 1985, p. 32.
[128] See Berlioz's *Grand traité d'instrumentation et d'orchestration modernes*, 1843; modern edition (1993): *Traité d'instrumentation et d'orchestration*, Paris, Lemoine.
[129] Timbre as primary, multifaceted parameter in post-war and recent works.
[130] See for ex. Oliveros, P. (2005) *Deep Listening. A Composer Sound Practice*, New York, iUniverse.
[131] A rare, resonance-rich Steinway 1920 model, see 2.2.
[132] See performance/exhibition space map in 2.2.

diffusion(s)). These two 'spaces' and functions – detail maximisation and resonance expansion/immersion – combine in *Tracer le souffle*.

The accordion's air and friction sounds are reworked through close microphone amplification, sound processing and reverberation-expanding effects, which are melted with the performer's breath and corporeal actions. The 'space' of the body and the 'space' of the instrument are revealed and detailed, but also reworked through an overarching (performer-controlled) electronic layer. The latter is approached as an air/resonance hybridization extension reworking the sounds and expanding the souffle continuum. Through the amplification-effect combinations, microscopic details (e.g. the bellows' friction 'grain') build expanded air textures, which also grow during the work through loops re-recordings (see traces above). This results in dense surrounding 'air' and white noise forms that fill the space in various fashions (until saturation) – opening to new air and breath modes of sound perception. The 'fragility' of air through technology is also explored. The frontiers of effect-processing (extremely low performed dynamics, changing distance to microphones, unusual techniques or extreme high/low registers) build renewed, unexpected fragile and ever-changing processed, unprocessed and barely processed air sound-worlds (see below).

The three resonance models: Boulez, souffle applications, work presentations: towards a typology of air-resonance interaction

The typology investigates the path taken by the 'writing' of resonance to extend the continuum of souffle (air/breath-friction), transforming it, making it perceptible in a new form. According to Dufourt, sound, 'like any distribution of mass and energy, can be reduced to a characteristic dynamic configuration, a sort of Gestalt of energy singled out by geometric deformations, by complex topological configurations.'[133] The model of sound (as per Dufourt's definition) applied to air (souffle) opens to new interactions. Building (and building from) the compositional developments of the chapter, the typology explores the role of the topological configurations (or models) that develop the air and resonance energy and time interactions, translating them into processes and functions impacting the pieces' construction.

The following paragraphs discuss *non-souffle* applications of the topological configurations (or models) of resonance in three selected works of Boulez. These examples create perspectives with the *souffle-expanded* models in the three subchapters/applications. Boulez's works illustrate (non-souffle) combinations of the models and their possible translations into time and energy interactions and processes and functions – parameters developing here the typology.

1) Instrumental models: elastic time energies in Éclat; augmented functions in Ātma(n), Un eco di soffio II

Instrumental models are at the heart of the construction of Boulez's *Éclat* (1964-65) for ensemble. Resonances are *composed* through the combination of percussive/resonant instruments (piano, harp, celesta, glockenspiel, vibraphone, mandolin, guitar, cimbalom, bells, tubes). This unconventional instrumentation allows working with resonance and achieving 'singular resonance profiles.'[134] Boulez describes the work as an alternation of *moments of action* and *moments of contemplation*. 'In the moments of *contemplation*, the sounds are transformed without being modified.' A 'past musical event continues in resonance'. In moments of *action*, 'we

[133] Dufourt, H. (2011) *La musique spectrale. Une révolution épistémologique*. Paris, Éditions Delatour.
[134] Schoeller, P. (1986) Mutation de l'écriture : Éclat, Stria, Désintégrations. *InHarmoniques* 1:199-210.

create this event'.[135] Resonance-built 'contemplation moments' (to use Boulez's words) indeed create a form of threshold, a transitional state and 'liminality' (see discussion above) that the specific instrumentation allows generating and sustaining. For Boulez, it creates a 'non-directional' conception of time. Composed 'contemplations' between compressed 'actions' allow a flexible and elastic time approach building the structure through attack/resonance energies and resonance interactions and extensions: 'one does not go towards a goal, but lives in the compressed instant.'[136]

In Ātma(n), the resonance is a gradually spreading energy, an 'invading' phenomenon nourishing the work's construction, regulating the timbre interactions. Instrumental resonances are at the heart of the hybridization process, an evolution from 'pure' air textures to complex timbral mixtures. Differently from *Éclat*, the instrumentation includes attack/resonance (percussive-resonant) instruments (piano, percussion) and 'drier', non-percussive instruments (string trio, clarinet). However, the latter are modified or enhanced, compositionally 'reconstructed' to extend their capacities to undertake such percussive/reverberating functions. The clarinettist's sounds are amplified through and resonate in the piano through sympathetic vibration and reverberation. The scordatura of the string trio – a '12-string' microtonal combination (see 2.1) – enhances vibration. Combined, the reconstructed vibrating features – e.g. open strings or harmonics naturally creating rich beatings – impact the texture and air and resonance merging and expansion. Breath participates in this process as an attack 'action' but also as a resonance extension. Throughout the piece, human (and human-instrumental) forms interact with and generate resonance – emerging from it, reinforced by it, and triggering it.

The hybridities thus develop through three types of time and energy interactions: air triggering, within and extended by resonance. This triple synergy aroused as a first process and function tripartition: resonance as a *consequence* of air, resonance as *dialoguing element* with air, resonance as a *legato element* sustaining or enhancing air. The utilisation of air as a direct resonance-triggering force and material allows working on unmediated paths between breath and resonance (and from air to vibration, gesture to echo...) and – to apply Boulez's principles – from 'action' to 'contemplation'. Breath is in this context a timbre and form construction element. By contributing both to the textures and resonance generation (e.g. see 'equivalences' above and in 2.1) and to the rhythmic and structure construction, breath creates key conjunctions between these processes and elements.

In *Un eco di soffio II* (clarinet and piano resonance), instrumental models are considerably extended to work on air/breath. The piece expands the typology by exploring resonance as a sustaining material and air reinforcement, but also as an extended echo and even obstacle. The piano is an 'augmented' external body which extends the resonance enhancement and reverberation functions. The piece includes a second player (non-visible to the audience) remotely controlling the piano vibration preparation (see 2.2). The clarinets (bass/Bb) and piano are modified-prepared to create a double filtering system increasing possibilities for the air expansion and resonance production-generation and their interactions. Sympathetic resonances evolve according to the performer's position and piano configurations.

A physical extension of the sustain pedal developed for the piece, the extended pedal allows controlling the dampers' activation beyond the keyboard position – from the sides or surroundings of the piano. The musician

[135] Boulez, P. (1970) Interview with Martine Cadieu, quoted by Jean-Pierre Derrien, "Pierre Boulez", *Musique en Jeu* n°1, p. 122.
[136] *Ibid.*

can access different 'excitation points' triggering the sympathetic vibration of the strings – here through air and other sounds and attack materials – and modify directly the resonance 'responses' through the extended pedal variations. Both 'direct' (contact e.g. percussive) and 'indirect' (contactless i.e. sympathetic) resonances interact with air and breath, mirroring or deconstructing/reconstructing their multiple wind-amplified forms.

In addition to the extended pedal and preparation extensions, other instrumental parameters build a versatile system of resonance filtration. The piano becomes an evolving reverberating space and amplification reworking the clarinet's sounds through its physical configurations. The body of the piano acts as a filter modifying the resonance's timbre and projection. The manipulation of piano parts (lids, body) is composed, creating filtrations. Lid-opening variations (front/back lid(s) closed or open/semi-open) combine with the performer's polarisations around the piano (left, right, keyboard, tail) impacting sympathetic vibration and sound projection in various fashions (e.g. predominance of certain types of vibration, dampened/undampened sound and projection).[137]

2) Space-instrument models: triangular mirrors in Sur incises; spatialization(s) in Ātma(n), Un eco di soffio II
Space (spatialization) and instrumental models build sound extensions in *Sur incises* (Boulez, 1998). The piece's material stems from the previous solo piano work *Incises* (1994), which has been considerably extended. A triple trio (3 harps, 3 pianos, 3 percussions) positioned in three complementary 'axes' in space creates a 'triangular' resonance space. 'What I wanted here was the idea of a mirror of the piano sound modified by the percussion and harp, also the idea of echoes mirroring the same type of sonority', says Boulez.[138] Each instrument of the 'triple trio' has a precisely defined, hierarchical mirror energy and echo function paralleled to its position in space. The pianos (in the foreground) have 'a strong and virtuosic presence, and they imitate and echo one another;' the percussions (in the background) 'add tone colour and rhythmic activity', and the harps (next to the pianos) 'tend to serve as shadows, reinforcing articulations and harmonies', notes Coult.[139] As a result of this triple instrumental spatialization expansion and conception of resonance, there is 'a sense that the very sound and mechanisms of the piano are being deconstructed.'

The space and instrumental models combine to extend the air/resonance hybridization process in *Ātma(n)*. Instrumental disposition evolves. Two physical 'poles' in space gradually emerge as the piece's air/resonance hybridization and 'invasion' process develops. Spatialization builds pathways between the air and resonance perspectives. Reaching its peak utilization, resonance is enhanced by the ensemble disposition, whose evolution builds two layers with two distinct functions: the background resonance 'mirror' (three piano-polarized performers) and the 'vibrating foreground' (scordatura-enhanced string trio). As the hybridization develops, the increasing utilisation of the piano as a pluri-stimulated percussion/resonance body and instrument and the associated physical 'polarization' expand the air/breath-resonance continuum in a changing space.

Changes of position impact the air/resonance interactions. Specific sections combine guided-improvisations and spatialization evolution. The resonances (fruits of the 'air' actions) arise in this context in a more random fashion within the texture, fruits and parts of a gradual asynchronization building in a changing space. The

[137] See dedicated subchapter (2.2).
[138] Quoted in Di Pietro, R. (2001) *Dialogues with Boulez*. Lanham, MD, Scarecrow.
[139] Coult, T. (2013). *Pierre Boulez's Sur Incises*: *Refraction*, *Crystallisation and the Absent Idea*(*l*) in Tempo, 67(264), 2-21.

air/resonance causes and consequences (and dialogues/interactions) are blurred, melted within an overall 'diluted' mixture, a both static and animated trace and 'protean' element in which corporeal breath plays an underlying sound and structure role. Primarily building acoustic extensions (e.g. through position and sound directionality changes), the performers' movements also have a strong visual impact. The gesture multiplicity arising within the extended, spatially-polarized air-resonance continuum impacts perception by developing parallel 'choreographies'. For example, in the cello-cadenza section (IV), a complex level of simultaneous musical, gestural and visual actions 'splits' the audience's attention in two densely animated layers – creating a fruitful tool to play on resonance, air and their perception in space (see 2.1).

3) Space-instrument-technology: ensemble and proliferation (Repons), solo and multiplicity (Tracer le souffle)

In *Repons* (1981-84), space and instrumental models are extended by technology. The title is the French word for *responsory* – a 'dialogue' between cantor and congregation. The instrumentation consists of an ensemble and six soloists (placed above the audience, surrounding them). Six groups of loudspeakers form a complex electroacoustic system placed between the soloists. The system records, transforms, and circulates their sounds throughout the hall, exploiting their resonating characteristics 'to the limits of the technology available at the time.'[140] As in *Éclats*, the soloist group consists exclusively of percussive-resonant instruments.[141] Their resonances are transformed/spatialized through live electronics. The sound engineer, who controls this resonance expansion, 'can be considered the seventh soloist'.[142] The reworked resonance of the soloists creates *responsory* processes, not only between the spatialized sources (soloists/ensemble/loudspeakers) but also between the processed and unprocessed resonances (the 'manipulated' solo group, the 'untouched' ensemble). Through this triple electronic-instrumental-spatial continuum, resonances develop at multiple scales and between instrumental families: within the ensemble (whose 24 players also form groups/soloists), the six solo players and spatialized instrumental/electronic sources. This results in a *proliferation* that the expanded instrumental-spatial-electronic configuration allows sustaining throughout the piece (45 minutes).[143]

Tracer le souffle (amplified accordion and pedals) explores air (souffle) and the multiplicity of its resonance traces. The sound proliferation unfolds within a multifaceted *solo* configuration. The accordion, as an extended air machine but also friction and percussion object, creates new extension pathways. Microphone amplification and effect pedals expand possibilities, towards textures exploring the frontiers of air, breath, and white noise and resonance. A specific effect combination[144] extends the 'traces' towards air/white noise and resonance 'saturations'. The two microphones are approached as versatile playable extensions. Accessible to the performer's hands and breath (left and right sides of the accordion), they arise as full, independent friction implements, wind instruments and percussion – extensions of and ultimately extended by the accordion. Similarities/confusions between the breath of the body and the instrumental and microphone-created/processed air expand within a system mixing and transforming its multiple sources.

[140] O'Hagan, P. (2006) "Pierre Boulez and the Foundation of IRCAM". In Langham Smith, R. & Potter, C. (eds.) *French Music Since Berlioz*, Burlington, VT, Ashgate Publishers, Inc., p. 303–330.
[141] Harp, cimbalom, vibraphone, glockenspiel/xylophone, two pianos.
[142] Lyzwa, J-M. (2005) *Prise de son et restitution multicanal en 5.1, problématique d'une œuvre spatialisée*: *Répons*, Pierre Boulez. Paris, Conservatoire National Supérieur de Musique et de Danse de Paris.
[143] Despite its recognition as 'Boulez's most ambitious masterpiece of electronic and acoustic fusion', the piece is rarely played due to its complex technical-spatial implementation. Service, T. (2016). 'Pierre Boulez: 10 key works, selected by Tom Service'. The Guardian. ISSN 0261-3077.
[144] Tremolo, double whammy, double reverb, double loop, delay, ring modulation… (see dedicated subchapter p.87-89).

The electronic transformations (hand and foot controlled[145]) are impacted by the dual acoustic and amplified/electronic layer the setup creates. Barely or imperfectly processed materials create unexpected responses in which the acoustic/amplified borders are blurred. Distance parameters (instrument/microphones) result in semi-amplifications/effect-processing bringing forth a double acoustic/processed – or *imperfectly* processed – layer. Effects such as tremolo, which 'chop' the air sounds (mechanical, breath, friction) create, according to the performer-instrument-microphone disposition, various acoustic-amplified-processed mixtures that (re)create an unexpected form of space-instrument-electronics continuum within a solo configuration. The fragility of the electronic-processing of specific sounds or phenomena (air, microtonal beatings, extreme registers) builds a fruitful material in the last movement. Ring modulation and other effects are 'disturbed' through microphone distance parameters and by the constant tremolo and 'trembling' of the performer, which impact their processing efficiency. Acoustic and transformed layers, shares and sounds and microphone utilisations develop as processes, working on the constant multiplicity of air layers and traces towards a 'proliferation' effect and 'orchestral' expansion (chapter 3 investigation) within and beyond a 'solo' configuration.

[145] Up to 8 solo-controlled effect parameters: one pedalboard with 6 simultaneous effects (among a bank of more than 400); two expression pedals acting on the parametric details of selected effects; a hand-controlled general mixing table (volume, pan, etc.) and a hand-delay/looper (also with various accessible detailed controls, e.g. time, repetitions, overdubbing functions) (see 2.3).

2.1 Human breath, instrumental air: hybrid resonances in *Ātma(n)* for chamber ensemble

The subchapter explores resonance as a composition process. *Ātma(n)* springs from the air/breath (souffle) and resonance hybridization. Throughout the work, resonance arises as an overarching element and 'unifying' principle within the human and instrument interactions and air-friction continuum.[146] Each movement of the piece focuses on specific aspects of the souffle-resonance continuum, gradually revealing an expansion from 'pure' air sounds to hybrid textures. The resonance 'invasion' process extends through spatialization. Reaching its peak, the process decays. The final part returns to 'pure' air developments, focussing on the first form of 'resonance': the ambiguous human-instrument mirror.

Air-sounds dialogue with and merge through resonance. Air, as a sound but also as a force, generates resonances and (re)composes the vibration. Pure and 'porous' (air and air-containing) sounds build complex textures; they also generate resonances. Polymorphic and poly-vibrating, air (souffle) develops through various density scales utilising the inherent timbral porosity – evolving share/density in individual timbres building the 'macro' porosity of the ensemble's mixtures.[147] These multifaceted, interdependent scales create hybrid forms which incorporate the human and instrumental breath(s) and their resonance mirror.

Air, Resonance: typology of interactions

If *Ra`ash* (1.3) opens the path to the 'tactile' air-through-resonance extension by exploring the resonance 'residues' in friction actions, in *Ātma(n)* it is the invasion of the air-friction continuum *through* resonance that takes place. Resonance emerges as a complex 'invading' (and disappearing) phenomenon nourishing the form construction and regulating the air/timbre interactions. Several texture combinations arise during the piece, developing the typology of the air and resonance interactions, expanded in the next chapter (solo breath-based 'resonant' forms).

The air-resonance hybridities develop three energy and time configurations – air *within*, *creating* or *responding* to resonance – from which a function tripartition emerges: resonance as a *consequence* of air, resonance as *dialoguing element* with air, resonance as a *legato element* sustaining or enhancing air (e.g. air/resonance texture movement V). The human breath incorporates in this triple-function framework as a reinforcement and timbre and vibration element that contributes both to the dialogues, mixtures and generation of resonance (e.g. hybrid human-instrumental texture p.26). Spatialization (also developed in 3.1) extends the air-resonance dialogue and interaction.

Key texture expansions emerge from two guided-improvisation sections (air fermata-traces, end III/V) in which the air-resonance interactions and causes/consequences are blurred. Air, resonance and breath merge through gradual asynchronization (e.g. auto-generated texture p.16). Fruits of unconducted air expansions, resonances arise more 'randomly' as seamless elements within the overall textural flow. Air and resonance melt within an overall fluid and 'diluted' texture: a 'protean', ongoing trace in which respiration-related tempi and corporeal breath play an underlying sound and structure role (individual tempi and free respiration-based gestures).

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[146] Ātman (Sanskrit): 'the pervading principle, the organism in which other elements are united and the ultimate sentient principle'.

[147] The timbral porosity of air permeates the textures. Combined air and air-containing techniques create a complex, porous 'whole'. Controlled, natural or unpredictable within individualities (e.g. in specific techniques or dynamics, see 1.2), these combinations generate the overall air and timbre processes building (and building themselves within) the texture.

Form and process

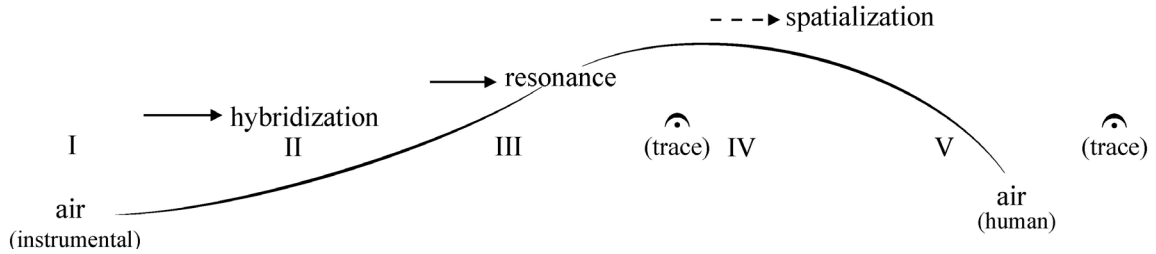


Fig.14 *Ātma(n)* form: ascending and descending hybridization 'arch'

The work consists of one ascending and descending hybridization 'arch' composed in two phases, whose peak and end are 'signalled' by the two unconducted air fermata-traces (fig.14). The first phase (movements I to III) gradually builds the hybridity through an evolution from 'pure' air textures (I) to complex timbral mixtures (III), incorporating resonance and other elements that emerge in II and culminate in III. Starting from this peak hybridity, the second phase (movements IV and V) reverses the initial balance. Air (souffle) arises as a background element, while resonances (and resonance-triggering materials, e.g. percussive impacts) build the foreground (IV). Vibration phenomena (including beatings and sympathetic interactions) then expand in a cello 'cadenza' developing the vibrating features of the string trio's scordatura (see below). Evolving through spatialization, the air/resonance textural hybridity goes back to its initial form (V), incorporating this time the 'unfiltered' breath (the performers' inhalations and exhalations) developed towards new resonances.

In the first ascending phase (movements I to III), composed *movements of air* evolve. The gradual hybridization utilises the porosity of certain instrumental techniques: fragile and/or changing air 'shares' and timbres.[148] The resonances generated through the sounds and movements of air and breath – sound elements but also instrumental-corporeal projection 'forces' – participate in and create these phenomena. 'Impact' actions contribute to the air/resonance mixture evolution by incorporating 'blown' utilisations of instruments, generating the strings/surface's vibration or achieving unconventional forms of air/breath amplification (e.g. using violin or piano strings/body as resonators). Beatings and sympathetic vibration 'augment' texture density through resonance-related means.

In the hybridization 'peak' and subsequent 'descending' phase of the piece (movements IV/V), percussive and 'saturation' techniques (see 1.3) build denser timbral mixes. Resonance and vibration are foreground elements; air remains as an underlying texture component – a part in (and form of) resonance.

Two specific sections (III to IV transition, end of V) develop complex *traces* of air and resonance. Unconducted and incorporating guided-improvisations, these 'air fermata-traces' signal the peak and end of the hybridization (see form). The principle of auto-generation through multiplicity is central. Asynchronous developments build auto-variations, which incorporate the timbre fragility of air techniques, working on the

[148] See *Form and examples* below (and 1.2 for air 'shares' in classical techniques).

complex breath/air/friction and resonance combination. Individual loops/tempos generate complex air textures and traces.[149] Combined, the individual materials build a white noise 'trace' at the ensemble scale.

In the second 'air fermata-trace' (see form), this principle expands. Spatialization *movements* create additional transformation means playing on the performers' changing positions (on/offstage) to fully develop the complexity (and ambiguity) of the air/resonance hybridisation (see *form and examples*).

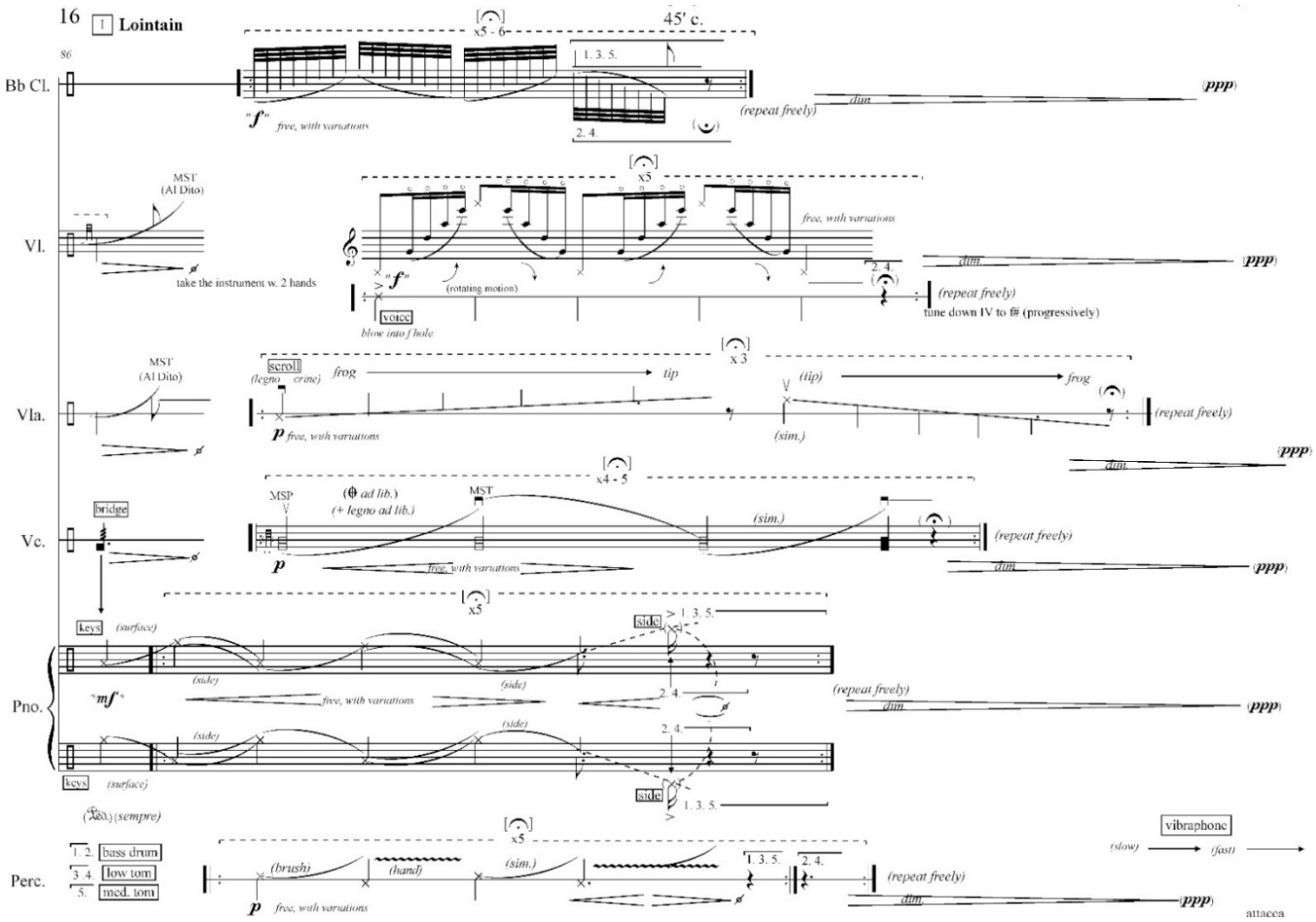


Fig.15 'air fermata-trace' (III-IV transition). Air texture auto-generation/variation

Space and flows: spatialization and ensemble evolution. Peak and 'descending' phase

In the hybridisation peak and 'descending' phase (movements IV-V), the ensemble configuration evolves. Gradual position changes – clarinettist and percussionist, and violinist and violist – impact the air and resonance expansion and interaction. The percussionist moves between two positions – percussion and back of the piano – playing on a dual setup. Initially developing sound directionality variations from the ensemble position (fist part IV), the clarinettist also moves to the side of the piano, utilising the strings and body as rich mediums for sympathetic vibration, enhancement and reverberation/amplification (second part IV).

Various ensemble configurations emerge (see *Form and examples*). The growing utilisation of the piano as a percussive/resonant instrument and the associated physical and instrumental polarization (three performers)

[149] A process developed in 3.1, large ensemble context.

develop the air/breath-friction-resonance continuum within a changing space. Changes of position impact the instrumental resonance process and generation and by extension the air and resonance textures/interactions. Primarily aimed at building sound extensions, the performers' movements also have a strong visual impact. The choreographies arising within this space-extended souffle continuum impact perception, developing spatially polarized resonance and vibration actions and extensions (cadenza section second part of IV, see below).[150]

Breath and human-instrumental merging: equivalences

If respiration acts as a key sound and form element (see form and examples), the 'actual' human breath (i.e. instrumentally unfiltered) is only explicitly present during a few discrete or broadly 'hidden' interventions during the piece (e.g. nose inhalation end II). It is only at the end of the piece and final step of the 'decaying' hybridization (end IV and V) that the 'actual' corporeal sounds (re)appear and serve as explicit bases for texture development. Selected instrumental gestures accompany the audible breath, building body and sound equivalences, creating timbral mixtures and processes playing on human and instrumental echoes. Air-like frictions, filtered air combine with unfiltered breath sounds, creating hybrid 'breathing' textures. Merging, these combinations emerge as ambiguous gesture and sound fusions creating illusions, confusions.

Air-like fictions are paralleled to corporeal 'equivalent' actions to which they are systematically associated at the individual human-instrument scale (e.g. dark friction and mouth-exhalation). These combinations develop and echo each other at the ensemble scale, reaching increased levels of texture ambiguity/complexity. Reinforced and 'blurred' mixtures emerge. To this complex air, friction and breath gestural and sonic reflection, acoustic resonance gradually incorporates. The instrumental reverberations/vibrations created by the breathing and/or the 'equivalent' action participate in and reinforce the overall texture and mixture as a second overarching, enveloping element.

This expansion of the first body-instrument 'resonance' through acoustic resonance emerges within the 'intra' and 'inter' human-instrument sound interaction and (con)fusion, impacting texture composition and perception. Enhanced here through the ensemble's spatialization, breath/friction-generated vibrations and reverberations reappear in new fashions. Resonance not only amplifies and envelops the breaths (as sonic actions), but also merges and extends them, including after their extinction. As the performers' gestures and breaths stop or briefly interrupt (between two inhalation-exhalation actions or as part of fully composed 'apnoea' intersections, e.g. b.148), a second 'acoustic' mirror reappears as the foreground element. This second echo and resonance, here instrumentally/spatially extended, is approached as a complex composition element and sound entity envisaging resonance as 'the sound of apnoea'. Extended in 2.2 (through sympathetic expansions) and 3.1 (larger ensemble), this idea is utilised as a 'latent' breathless energy.[151]

[150] This process extends in *Holo(s)* for large ensemble (3.1) to work on air perception through multiplicity of its (physical) sources. The gesture choreography/function throughout piece is discussed below ('movement 1' section).
[151] See 3.1 for discussion of this idea.

String scordatura and air expansion: vibration and timbre material

Part of the piece's material germinates from the string trio's scordatura. The microtonally-(re)tuned strings create a fruitful basis expanding vibration. A rich timbre material per se, the scordatura is also a function, part and consequence of the air-resonance interactions. Developed and triggered through various modes of sound production, the complex vibrations resulting from this 'twelve-string' combination emerge from 'direct' impacts (e.g. on strings and/or body) and 'indirect' actions (e.g. breath stimulation). Open strings act as underlying elements, playing a specific role within the evolving air/resonance interactions as 'shadow' results of/in air-like frictions and bowed sounds on strings, body and bridge (e.g. II).

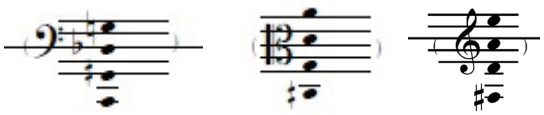


Fig.16 Scordatura: cello, viola, violin

A 'dual' scordatura (viola and cello) creates a first reservoir. A second (re)tuning (violin, end III) builds the triple combination.[152] Individual (each instrument's 4 strings) and global (string trio's 12 strings) combinations generate or enhance vibration phenomena (such as beatings), giving a specific resonance colour to the open strings, increasing timbral richness and complexity of natural harmonics.

Throughout the piece, the scordatura(s) expand vibration-related material and possibilities at three different, complementary levels:

1) *Within each 'solo' instrument*. The scordaturas extend timbral complexity by creating a range of microtonal developments. For example, the cello scordatura builds a rich vibration material, naturally springing from the four strings' microtonal interactions, creating beatings that can expand to combinations of natural harmonics and open-strings interactions.[153] (e.g. cello cadenza 'double harmonics', IV)

2) *Within the string trio as a whole.* The combined scordaturas create complex sound interactions between the three string instruments and their 'twelve strings'. The rich open-string combinations,[154] whose vibrations also develop through 'indirect' or sympathetic actions (including through breath) and natural harmonic expansions, increase the spectrum of possible microtonal associations and vibration 'frictions' (see cello cadenza 'orchestration').

3) *Within the ensemble*. Other 'detuned' elements germinate from and expand the scordatura. For example, the untempered piano harmonics (e.g. $7^{th}/14^{th}$ partial) and clarinet multiphonics systematically stem from or extend the scordatura micro-tonal features; 'gestural' re-tunings (e.g. blocked clarinet bell) interact with string trio's open strings, creating additional microtonal and 'vibrating' developments.[155]

[152] The violinist lowers string-IV to F# during the 'air fermata-trace'.
[153] E.g. open string III (G ¼#) and string I (G) *slightly augmented* octave, creating beatings.
[154] E.g. interactions of C and Db of the cello (open strings IV-II) and C ¼# of the viola (open string IV) naturally resulting in rich (easily achievable) vibration/timbre, including beating effects.
[155] E.g. minus ¼ tone (sounding) D of the clarinet combined with the C/Db open strings of the cello (IV/II) and C ¼# viola (IV) b.97.

Form and examples: processes, air/resonance hybridization

The following section discuses examples of the air/resonance hybridization process as it develops and creates the form. The resulting interactions are parts of the air and resonance interaction typology development (detailed in 2.2).

1) Air movements orchestration: textures and sounds, gestures and choreography (movement I)

The first movement (and hybridization starting point) 'contains' the material of the piece. The techniques build a timbral system developing various degrees of brightness and darkness, creating breath and friction sound affiliations to work on texture composition. The combined elements build an overall orchestration process triggering the air-resonance hybridization.[156]

Air is orchestrated. In the introduction (b.1-2, fig.17), the cello bow-frictions on the bridge (two dark/bright colours through the bridge-muting technique) emerge within the clarinettist's instrumentally amplified breath – a similarly evolving dark to bright filtration through phonetic glissando. The violin and viola bowed tailpiece and sides, a combination of two bright and medium/dark air-like sounds, are echoed by the bass drum's skin brushing – another evolving, medium to dark air-like filtration through centre/edge position variation. Piano and percussion, and later cello open strings (e.g. b.10), create an underlying 'vibrating background' also evolving from 'dark' to 'bright' through contact points changes (e.g. p.2) – a gentle resonant element initiating the hybridization. Vibration stimulation through breath (blown instrumental surface/vibrating material, e.g. vibraphone bars 'air-guero' b.4, fig.17) introduce a key 'direct' hybridization means: the movement/force of air to create resonance/vibration. In addition to the air, air-like and air-based material, soft granulated sounds gently introduce techniques (e.g. b.25) developed in the 'peak' hybridization.

The combination of protean techniques/sounds creates textures approached as *complex sound objects* but also composed as *breathing movements*. The first gesture – breath amplified through the violin and viola f-hole (echoed in the clarinet 'sliding air') – extends through the lateral/vertical bowing on body and bridge (string trio), a combined air-like filtration that builds, along with the vibraphone accelerating motor rotation and soft piano fallboard percussion, the first 'breathing' texture of the piece. These (visually intriguing) actions and gesture combinations articulate an overall dark to bright air filtration, a crescendo-inhalation abruptly cut and gesturally frozen just before its tip (end b.2, fig.17). The pianist's fingers, gently tapping the (yet to be open) fallboard, reach the fallboard's edges and abruptly stop while the percussionist suddenly cuts the vibraphone's motor – a soft 'rotating' air flow throughout the work – in a characteristic 'click' sound. After a short 'breath-held' interruption, the gestures become, again, 'alive', giving way to soft respiration-like echoes (b.4, fig.17) equally abruptly cut – this time more briefly – by a 'squeaking' glissando on the piano fallboard and the vibraphone's blown 'air-guero' generating a soft resonance halo.

Similar breath-based processes-actions develop in the 'pure air/breath' phases (I/V) giving rise to a complex gesture choreography, creating textures and movements envisaged as sonic and visual elements. As gestural actions and sound/form expansions, air and breath impact the piece's construction, including in the hybridization and spatialization phases (see below).

[156] See chapter 3 for a description of the air (souffle)-based orchestration system and developments of this aspect.

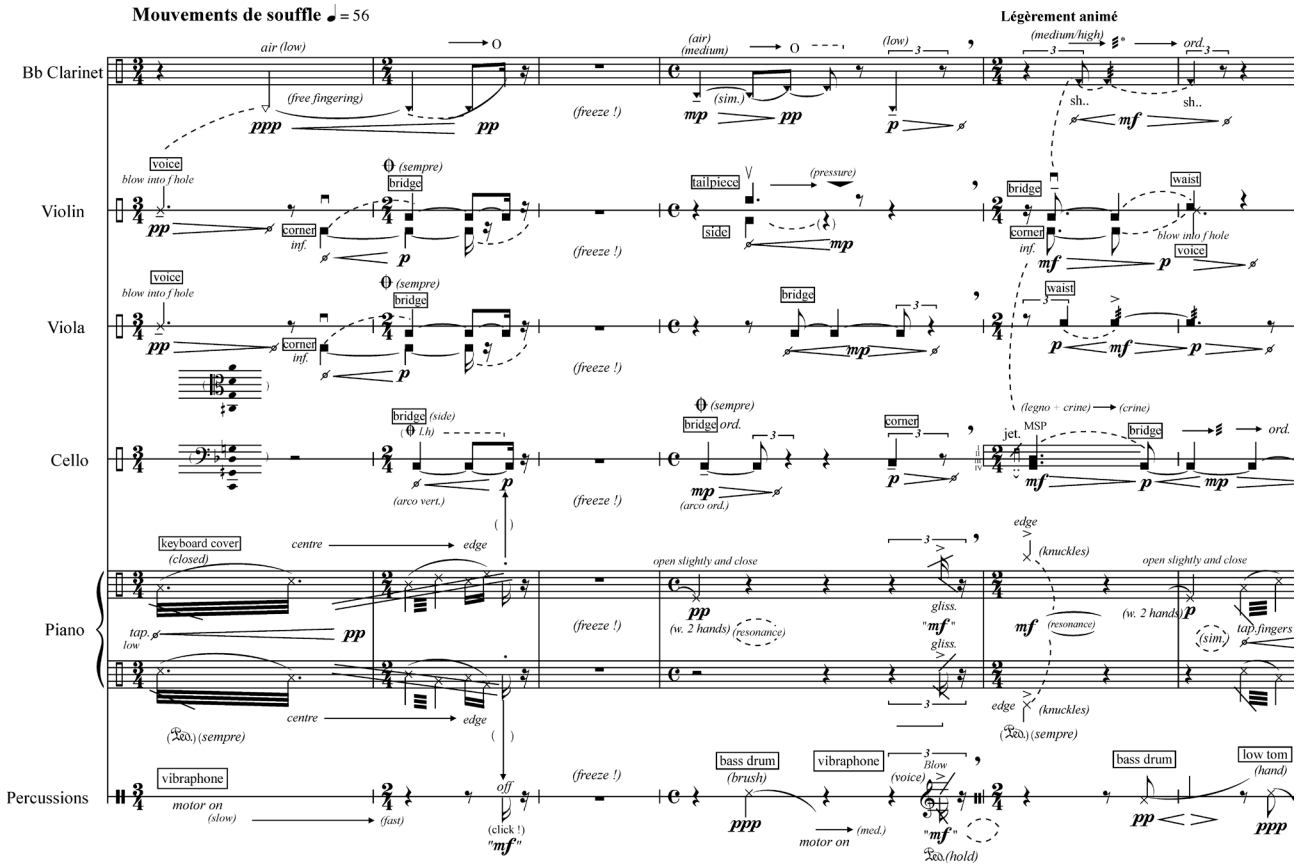


Fig.17 air orchestration, movements/choreography and techniques/gestures

2) resonance emergence, hybridization (movement II)

While the first movement combines air, friction and gentle resonating expansions, the second movement develops a wider reservoir of friction-based techniques (brushed strings, piano gueros, rubbed percussion) to extend texture 'hybridity'. The process incorporates elements such as the string trio's open strings/harmonics (see scordatura), air-containing sounds (e.g. clarinet dyads) as well as the 'vibrating results' of air/breath and friction techniques (e.g. piano blown-strings and keyboard-guiro reverberation). Denser textures incorporating resonance, percussive actions and over-pressed frictions fill the musical space, increasing its hybridity as the techniques/sounds evolve (e.g. letter D, fig.18).

The transformation of frictions is central to the hybridization.[157] The initially continuous air-like sounds evolve (e.g. fast piano gueros, brushed strings through circular bow).[158] Slowed down, overpressed, they create sound 'perforations' (e.g. b.51). Granular expansions combine with air-like sounds as interrelated actions. For example, the string trio and skin percussion evolving frictions incorporate overpressures creating 'cracks' within the air-like sounds (e.g. b.45, fig.18). Piano gueros, slowed down and pressured, equally expand into equally cracking sounds 'granulated' through pressure on keys, merging with piano strings 'scratched' grain (e.g. p.10). The string players' 'bouncings' (jettato-battuto with bow wood, here another 'grain') extend to air-like brushings, while the clarinettist's filtered breath evolves towards more 'grainy' flutter-tongue articulations. These elements create poly-vibrating mixtures and hybrid textures stemming from articulated and 'resonant' forms of air and friction.

[157] See 1.3 and 3.1 for detailed discussion of this key gestural (filtration-air-saturation) 'continuity' and sound aspect.
[158] See friction and sound isomorphy/heteromorphy in 1.1 (p.16-17) discussing *Ātma(n)* utilisations.

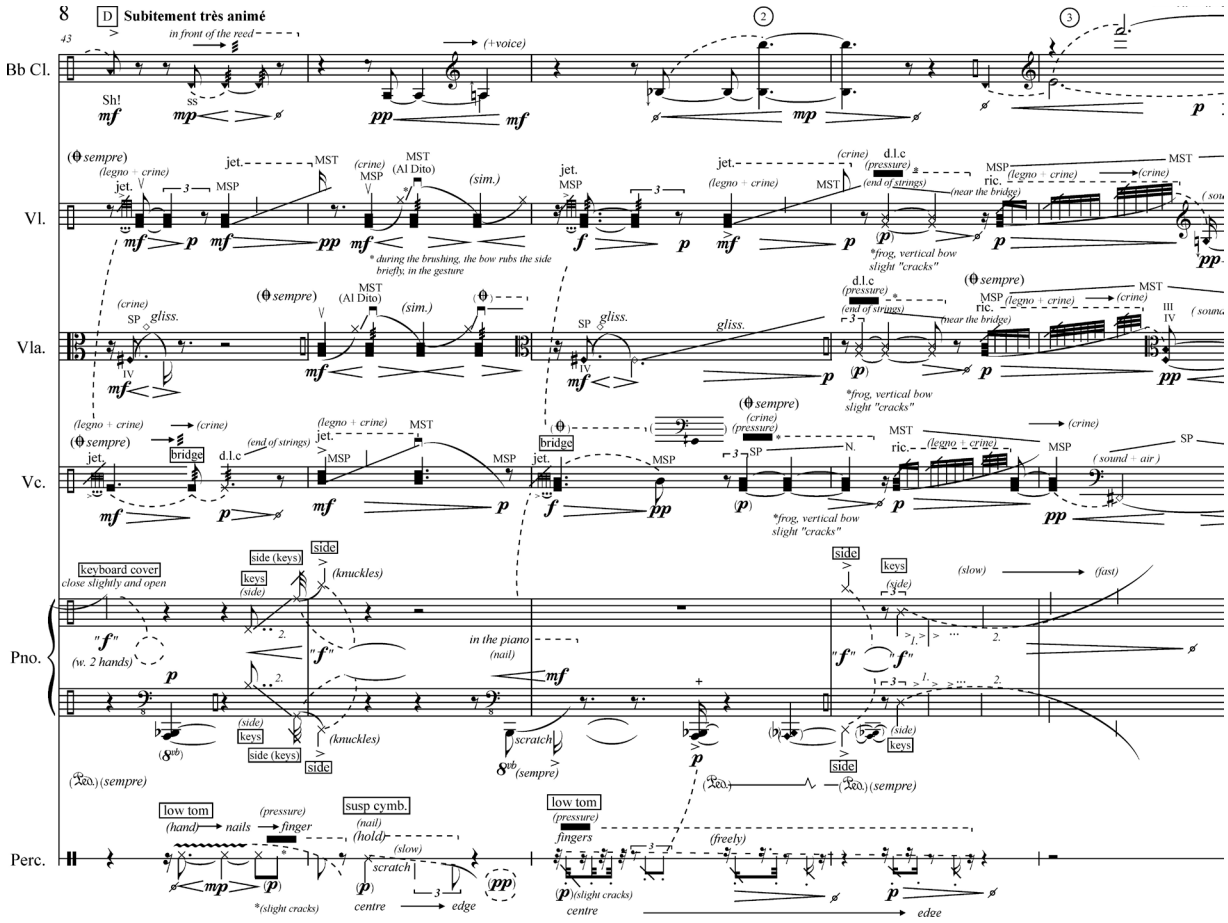


Fig.18 texture hybridity increase

Granulations also create resonances (piano reverberation, percussion vibration) into which they ultimately vanish (b.58-60). In the last phase, a 'breathing' texture (clarinet/strings) superimposes to the piano and percussion *resonating grain*. As this dual element emerges, the first explicitly 'human' sound of the piece appears – an exhalation/inhalation (mouth/nose) without any instrumental reworking or filtration (b.59). Discreetly reworked through 'equivalents', this briefly introduces processes of movement V (see below).

3) extended mixture: vibrating air and breath textures (III)

The third movement leads to the hybridization peak. Mixtures of air-sounds, resonances and other materials (e.g. multiphonics, overpressures/granulations) generate denser, hybrid textures. Air-like frictions, air/breath-based and porous air-containing techniques mix with percussive impacts and complex sounds, generating changing air and resonances 'shares' within the texture, a complex mixture of breath, friction, vibration, noise and other elements.

Vibration-associated phenomena such as beatings act as texture components, contributing to the hybridization expansion.[159] The resonance filtration detail (e.g. gradual dampening of piano strings and vibraphone bars, letter F) and air/air-like techniques (virtually all parts of string instruments are utilised: f-holes, scroll, ribs, sides, tailpiece) create a range of possibilities to *compose* the texture. Unstable, fragile expansions (e.g. cello multiphonics, here starting/ending on the bridge's air-like timbre and evolving through bow-positions, p.11) as

[159] Beatings contribute to the overall texture 'hybridization' as additional 'physical' colours. They aren't precisely controlled (e.g. specific number per second as in Xenakis' *Nomos Alpha*, 1965) nor used as a formal process (as in Grisey's *Partiels*, 1975, section 2).

well as *projected* vibrations/amplification through breath (e.g. piano and strings amplifying breath/vibrating through its force of projection) build further hybrid variations.

Mixtures of air, resonance and other elements emerge. For example, the b.60-63 texture (fig.19) mixes fragile, complex air-containing sounds (clarinet altissimo/multiphonics, reworked string harmonics/multiphonics) and pure and 'vibrating' air (e.g. bow/hand brushings with pressure variations 'forcing' random emergence of grain/vibration, e.g. tailpiece, percussion skin).

As they develop at the ensemble scale, these elements create variations. Textures are composed as *movements* articulated towards dynamic/hybridization peaks. For example, the texture b.65-66 (fig.20) mixes air 'impacts' (e.g. blown air generating the percussion's skin vibration) and resonance filtration (e.g. piano keys/pedals filtering). Various 'signals', combinations of air and percussive actions, develop instrumentally amplified inhalation/exhalation movements (e.g. letter H, fig.21) articulating texture and texture-hybridization (start, peak, end).[160]

As in the rest of the piece, respiration acts as an underlying (increasingly explicit) sound/form element. Based on the principle of inhalation-exhalation, friction-based 'circular' and breath-based 'human' actions build two gestural forms and complementary soundworlds. Two distinct respiration movements and principles develop through the combination of breath and friction actions.

In b.76-77 (fig.21), the 'tactile' form (friction-related modes of sound production, e.g. cello and viola circular bow, piano gueros[161]) predominates, transforming the 'human' form (breath-related modes of sound production). Clarinet and violin (here a 'wind' instrument) *recreate* the circular effects through air filtrations, whose dark/bright sound variations (up/down air 'guiro') assimilate to friction and contribute to the overall inhalation-exhalation movements. In the following section (letter H, fig.21), the 'human' (breath-stemming) from predominates, impacting all modes of sound production. For example, the instruments' bodies (strings' f-holes, vibraphone bars) become resonators of breath extending the performers' exhalations, creating perspective with 'tactile' inhalations through colour-association (bowed bridge, rubbed bass drum skin/vibraphone bars). This tactile and human, gesture and sound continuum and intertwinement (introduced in chapter 1) is a fundamental aspect further discussed in 2.3 (solo) and chapter 3 (large forces).[162]

The movement ends in a 'white noise' 'air fermata-trace' where desynchronized combinations auto-generate the texture (see above, fig.15), momentarily 'diluting' the hybridization expansion in an unconducted trace, a pause before the hybridization peak and decay yet to come.

[160] See also utilisation of inhalation/exhalation impact 'signals' in 3.2.
[161] See *Circle(s)* solo cello, 1.1.
[162] See 3.1 for detailed comment on this dual air-gesture interaction, extended towards a micro-macro sound/time form-building function.

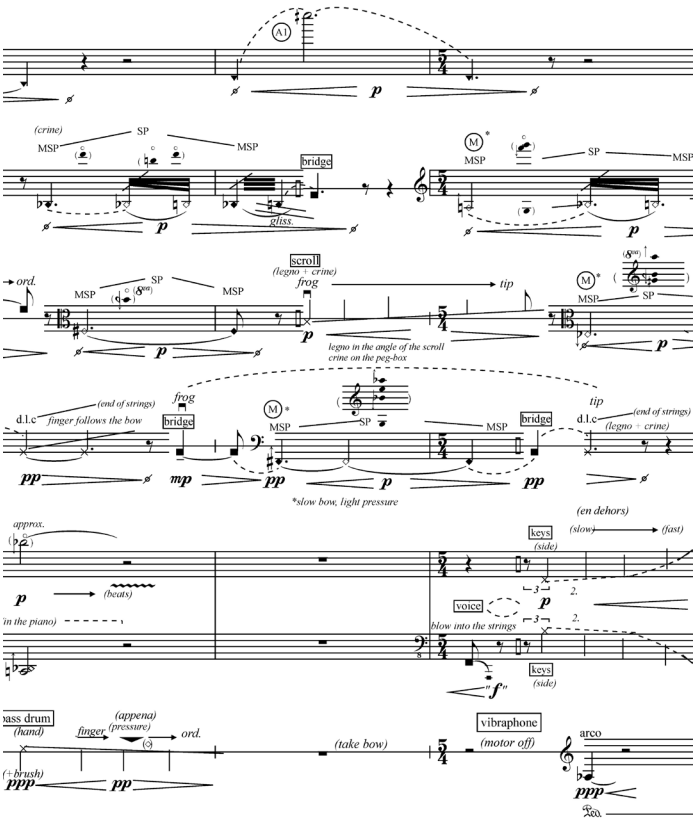


Fig.19 hybrid, pure and 'vibrating' air (b.60-63)

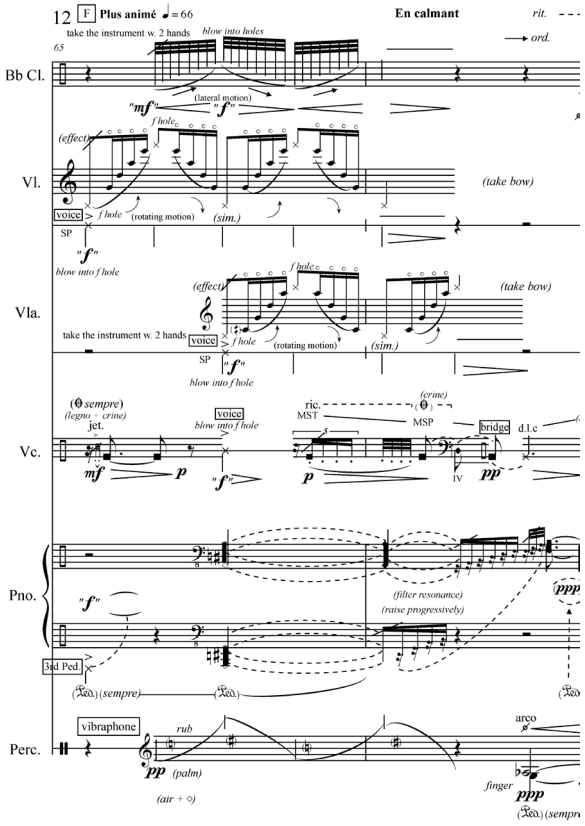


Fig.20 physical stimulation, resonance, air filtration (b.65-66)

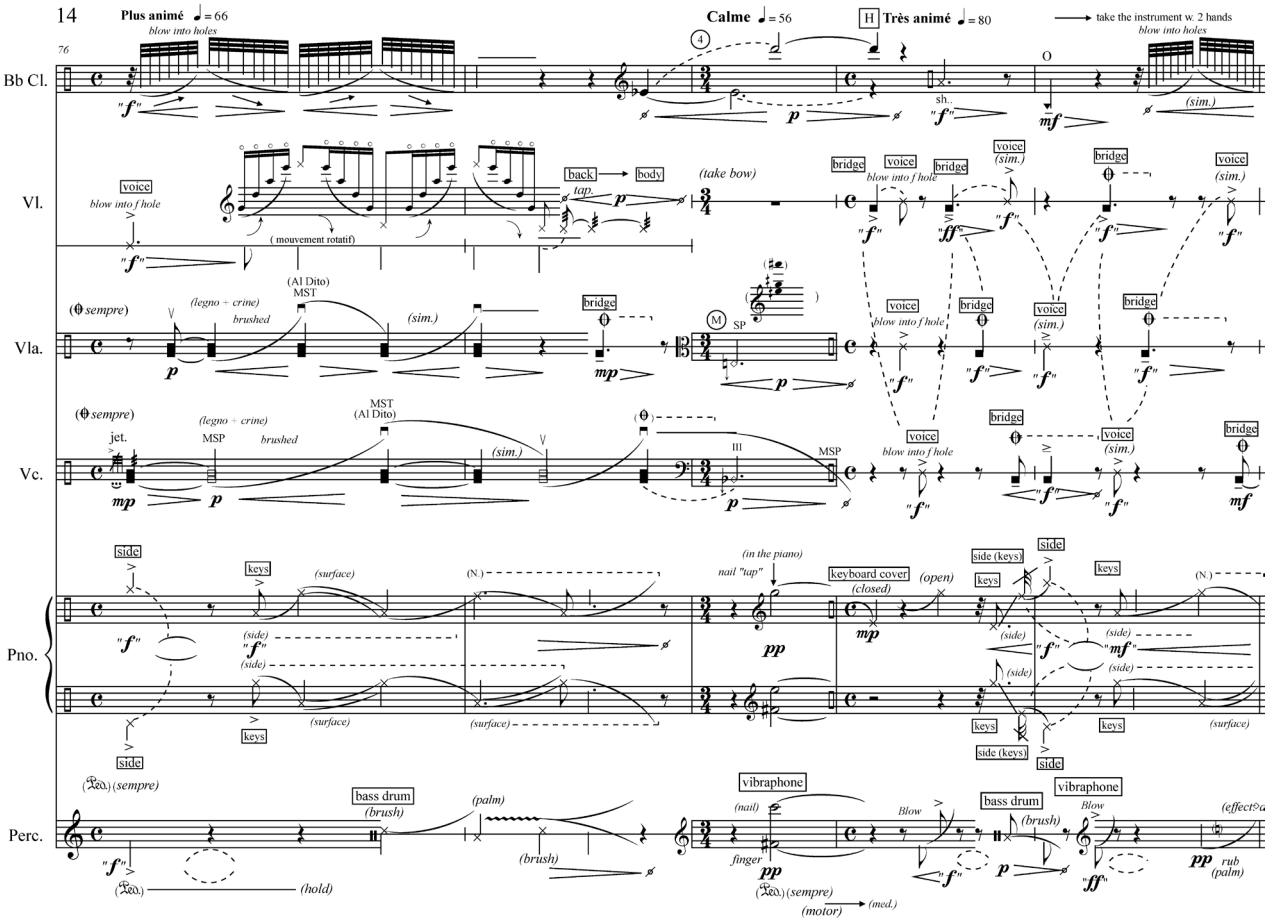


Fig.21 Peak utilisations. Friction and breath as two distinct respiration movements and principles

4) Air-impact-vibration: peak and decay, towards the human breath (IV)

The fourth movement develops in two sections (see fig.22). The first section (IVa, b.90-116) develops percussive impacts generating extended resonances and vibrations (piano, percussion, strings) put in perspective with air and 'residue' elements (such as the soft 'grain' of strings).[163] A gradual change in the performers' position and ensemble disposition creates two foreground-background resonance layers. The string trio remains unchanged while the three other performers 'polarize' around the piano.[164] The second section (IVb, b.116-129) builds from the strings' scordatura. The cellist – a frontal 'soloist' (see fig.23) – performs a bowless cadenza, executing various percussive actions directly (or indirectly) triggering the (scordatura-enhanced) strings' vibration.[165] The ensemble acts as a dual expansion. While the violin and viola extend the cello's scordatura timbre/vibration features by 'injecting' additional microtonal material into it, the piano-anchored trio (pianist, clarinettist, percussionist) create a second layer mirroring the cello, projecting its sounds in the (sonic/spatial) background. A 'raucous' transition (letter N) re-incorporates breath-based material emerging from the instruments' low vibrations.

Form movement IV

IVa impact/resonance, air/grain → IVb cello cadenza, dual expansion/projection → 'raucous' transition to V

Fig.22 form movement IV

The following paragraphs discuss both sections of this 'reversed' air/resonance balance/hybridization in which resonance-related phenomena and techniques predominate.

The IVa section develops saturation, percussion, grain and 'buzzing' techniques to generate and enhance resonance (see fig.25). Saturated friction techniques – scraping, overpressure on the instruments' surfaces, bodies and strings – and assimilated sounds (e.g. clarinet *sons fendus*, b.103) fill the musical space. Air is an omnipresent element, not only participating in and implementing the resonant impacts (e.g. percussion's skin or piano's strings 'blown' and vibrating through air, b.93, letter J), but also 'continuing' resonance and expanding vibration (e.g. violin/viola, b.98). As the movement unfolds, the clarinet's sound modifies through the position/directionality evolution, impacting resonance and timbre from 'blocked' bell muffling/pitch-lowering to fully resonating 'bell up' multiphonics (e.g. b.98).

Directionality evolution also includes lateral changes/movements (e.g. bell towards viola/cello, left/right side, letter K), introducing the core hybridization-extension parameter: spatialization. Spatialization movements impact the air and resonance interactions through changing instrumental configurations (see fig.23) developing air sound(s) and spreading textures in various directions. The principle of sound directed towards the vibrating strings/body of other instruments fully develops in the next section, utilising the piano's sympathetic resonance as a reservoir and 'anchor' for amplification and reverberation.[166]

[163] See *Holos* (3.1) for development of the 'residue' concept and utilization.
[164] The lid is removed for triple access.
[165] E.g. percussive actions on the body that trigger the strings' vibration; double 'non-adjacent' natural harmonic pizzicato creating specific 'beating' vibrations; breath on strings.
[166] Principle extended in 2.2.

The IVb section develops the string trio scordatura in a resonance-and-air orchestrated cello cadenza. The cellist utilises two types of processes and actions: *i)* the cello open strings (a complex vibrating object) 'react' to percussive impacts (hands/fingers) on the cello's body (in particular *sotto tasto* i.e. behind the fingerboard, a rich vibration-triggering zone) which generate their vibration *ii)* natural harmonics develop the scordatura microtonal features in systematic double-pizzicatos, creating a complex attack-vibration material.[167]

The resulting sound interactions (including beatings and timbral 'frictions') are extended by *i)* piano harmonics expanding the scordatura, adding microtonal 'friction' into it[168] *ii)* the violin and viola (bowed) harmonics, extending cello's pizzicatos resonance, increasing complexity by adding complementary microtonal material and *iii)* the rubbed, tapped and scratched piano strings and parts, here by two performers (pianist/percussionist) on complementary 'zones' on each side of the piano (see fig.24). Clarinet multiphonics and other sounds also 'project' into the piano. Amplified, they build sympathetic vibration expansions. Air-like frictions (pianist and percussionist) and air techniques (clarinet) also inject air 'residues' (inharmonic content, grain) in the piano's resonance, here a latent trace of air and shadow of a previously central material 'melted' within resonance (see fig.27).

The specific ensemble disposition at this stage of the piece 'polarises' three performers around the piano, which becomes a breath amplification and percussion and friction body. The clarinettist plays directly inside the piano (a position gradually reached in IVa), developing sympathetic vibration phenomena; the percussionist utilises the piano's metal frame, soundboard and lowest strings – more accessible in this *à la queue* position – as rich friction materials and breath resonators.

Spatialization builds *while* the cellist performs the cadenza. While the cellist's 'solo' actions attract attention, the ensemble foreground and background movements spread and 'confuse' overall perception. The intense level of gesture-visual actions 'splits' attention, creating a spatial/aural disconnection. For example, the clarinettist's position changes are firstly 'signalled' by movements of/with the instrument (bell between the legs to up in the air, left/right directionality changes), impacting timbre and sound. The player then slowly stands up to reach the piano 'anchor', thus playing partially back to the audience (Letter L). In parallel to this, the percussionist changes position reaching the back of the piano, while the cellist continues the cadenza expanded by the 'frontal' players (violin/viola).

As noted by colleagues and composers during the premiere, one of the characteristics of the piece is its intense, near-constant sonic and gestural activity. The canalization of this (possibly overwhelming) activity – intense both from the auditory and visual perspective – was indeed a challenge during the work's rehearsals. I realized that one of the keys for the effective rendering lay in the gestural work on stillness and movement – both from the conductor and performers (e.g. as part of unconducted sections, gesturally animated or 'frozen' phases, or breath-related movements and 'apnoea' sections). Working on such details gives more strength to the sound and action multiplication, creating coherency by magnifying 'peaks' of activity (e.g. hybridization peak in III, cello cadenza and double layer and activity in IVb) and building contrasts with more static phases. Put in

[167] Playing on the scordatura 'imperfect octaves' (II-IV and I-III). Beyond building rich microtonal/beating interactions, this non-adjacent string utilisation prevents 'accidental' dampening of the strings (cutting vibration) during performance.
[168] E.g. piano $11^{th}/14^{th}$ partial whose results are *near* the cello harmonics' micro-intervals, see fig.27.

perspective with tempo changes (another challenge of the piece[169]) and the work on spatialization and texture evolution, this allowed achieving an effective and much-appreciated performance, both from the performers and the audience.[170]

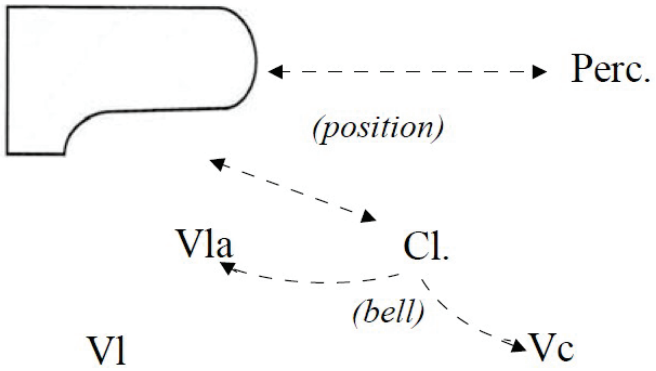


Fig.23 Spatialization development

Ending movement IV, a transition prepares the hybridization-reversion towards the first 'non-hybrid' developments (see fig.26) by re-injecting air and breath-based material within the texture and developing breath-related corporeal rhythms and sounds. This resonance-emerging breathing transition builds on the gesture and sound equivalences. Nose and mouth inhalations and exhalations mix with instrumentally-modified air sounds and 'vibrating' air – here low instrumental resonances and vibrations – through which the human breath becomes a *raucous* element. The clarinettist's air and percussionist's breath resonate and 'vibrate' inside the piano. Sounds of bowed frictions (bridge and waist parts) combine with the string trio's inhalations and exhalations, while the soft 'tapping' on the instruments' back softly implements the strings' vibration. This initiates the core process of movement V, extending the introduction's material through the breaths of the performers (previously absent or filtered) to develop new hybrid instrumental-human respiration textures.

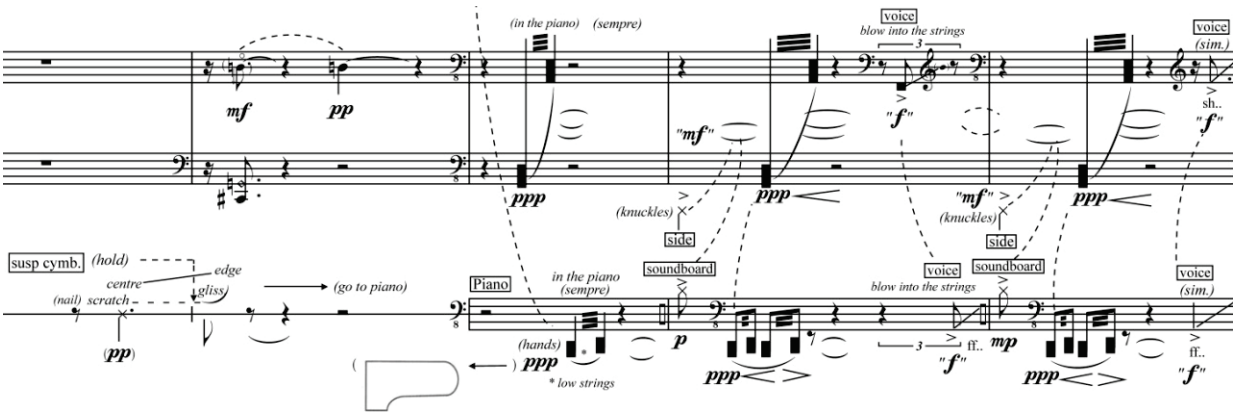


Fig.24 Piano and percussion parts: raucous resonance and blowing, front/back dialogue

[169] The good execution of tempo variations, which, written in indicative musical terms (*plus animé*, *plus calme* e.g. movement II), leave the constant micro-variations to the conductor's appreciation, is also key.

[170] The piece was premiered in the Kalv church (Kalv festival, Sweden) by ensemble Norrbotten Neo. While the work was not composed for this specific space/architecture, its rich resonance allowed effective implementation of the work's spatialization and resonance expansion, enhancing perception of 'moving' air layers, sound directionality and changes of position. The resonance and sympathetic vibration of the piano – a spatially 'polarising' expansion triggered and reworked through actions of three players (see below) – could fully expand through the rich reverberation.

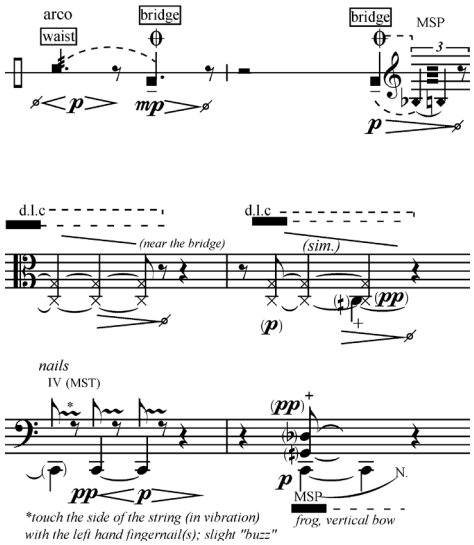


Fig. 25 Saturation, "buzzing" and air techniques (strings)

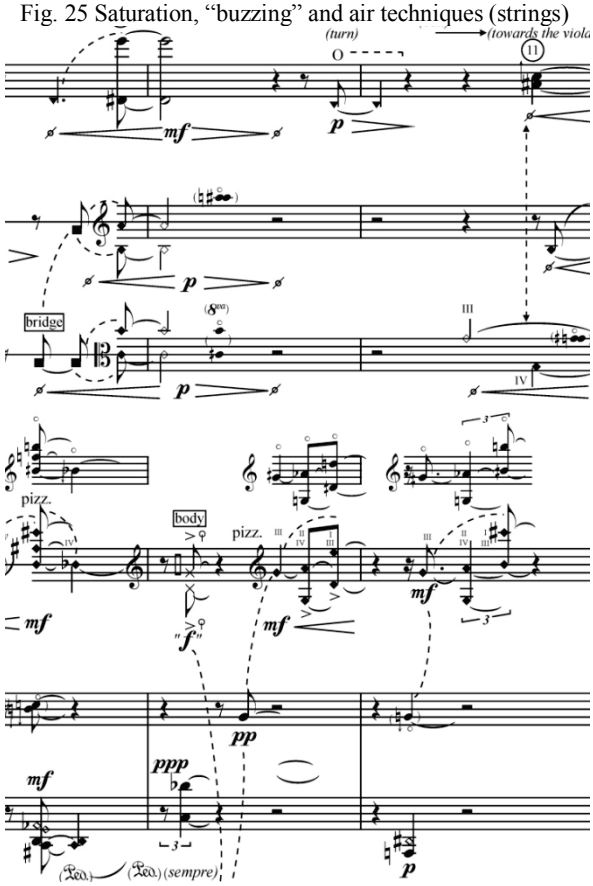


Fig.27 scordatura expansion

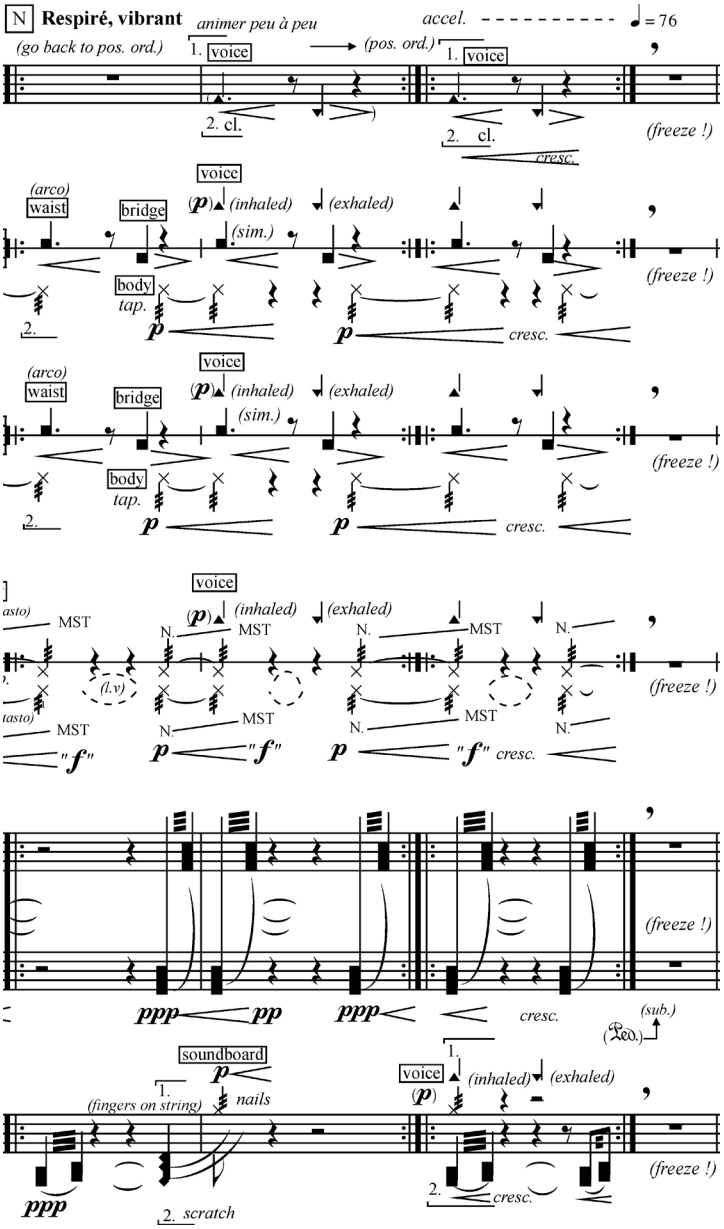


Fig.26 Low vibrations, breath raucously emerging from resonance

5) Vibration and resonances: human, instrument, ensemble (V)

If respiration irrigates the piece construction, it mainly acts as an underlying element until the end of movement IV. The last movement focuses on the corporeal-instrumental 'equivalence' and ambiguity of breath. Introduced in the 'raucous' transition and implicit in other sections, the process stems from three main breath gestures and 'forms': nose inhalation, mouth inhalation, mouth exhalation. These corporeal actions interact with instrumental 'equivalents' to which they are systematically associated (see below), colouring, extending or blurring the human breath.

The 'equivalents' are performed simultaneously (or in slight echo) to the corporeal actions, thus joining the instrumental gesture to the action of respiration. The corporeal forms find equivalences in specific instrumental forms, which, through the affiliations they create, 'merge' and extend breath and breath-like sounds towards

new hybridities. On the piano, they merge with black and white keys gueros (two dark and bright colours developed with speed/grain variations); on strings instruments, exhalations and inhalations transform into bridge and ribs (dark/bright) frictions; the piano-soundboard and frame rubbing (two wooden-dark and metallic-bright sounds) merges with and echoes the percussionist's respiration. The breaths are also amplified by the instruments' body or resonance. The percussionist (piano-tail position) directs exhalations on the piano's lowest strings, 'reacting' by creating a gentle 'halo' (fig.31). The string players blow/exhale into the f-holes, amplifying the breath. Transitions between corporeal and instrumentally-amplified breath also develop (see fig.30). The clarinettist's exhalations/inhalations are filtered through the clarinet and executed without filtration, developing transitions through mouth/mouthpiece distance variations (e.g. O).

While repeating these corporeal and gestural 'mirror actions', the performers naturally *adapt* them, merging their timbre and duration at the 'intra' and inter-individual scales. The choice and systematicity of the 'equivalents' allow action-complementarity creating trimbrally-efficient affiliation (see table 3 below).
These parameters – dual action, breath amplification, gesture/sound adaptation – generate textures in motion. Varied in echo and tempo, they are multiplied, accelerated. Stillness arises as a new function. In b.148 (see fig.28), the performers hold gesture and breath following a brief crescendo/acceleration, thus 'freezing' inhalations/gestures in a sudden corporeal and instrumental 'apnoea' in which breath emerges, again, through the subtle instrumental reverberation (e.g. end b.148), resurrected in a second life in resonance (see *apnoea and resonance,* 3.1).

As gesture/sound states, the human-instrumental 'equivalents' arise as rich processes: apnoeas 'freeze' instrumental gesture(s) and breathing action(s), echo/equivalence multiplicity increase texture complexity (e.g. fig.30), and breath-built resonance extends as a dialogue and 'trace' element (e.g. 148).[171] Here, slight echoes in individual actions and overall texture create complex expansions (see fig.30). The combination with other, complementary or contrasting elements and materials creates fruitful transformations. Starting from letter O, the human-instrumental equivalences 'cross-fade' with the 'air fermata-trace' approach in which apulsated asynchronous materials 'auto-generate' the texture (see above). The texture thus evolves from a breath-related temporality, marked (despite its complexity and echoes) by the constant alternation of inhalations and exhalations (and their short separating pauses), to a wider apulsated and blurred time and sound approach incorporating multiple elements. The cross-fading transforms respiration sounds and movements through the gradual incorporation of other *continuous* (air-like or air-related) techniques, such as the softly rubbed vibraphone bars (creating bright air-like sonorities) and the strings' 'blown' guero (rotating movements 'circularly' amplifying/modifying breath, creating gentle vibrations). These elements create new perspectives with the vanishing human-instrumental respirations. As they gradually take precedence over the breath-related time and sound approach, they further confuse it, creating, for a time, a second 'extended' breath-related temporality.

As in the previous 'air fermata' trace (III-IV transition), the texture expands through freely repeated, individual loops. Beyond improvisation and texture auto-generation through asynchronisation, a key parameter is added, spatialization. The clarinettist, violinist, and violist slowly move offstage, continuing their variations. The

[171] See 2.3 and 3.1 for electronic/spatial developments.

onstage trio – percussionist and pianist in the background and cellist in the foreground – gradually generate a silent, gestural and visual 'tension' slowly emerging from the ‘frozen’ instruments manipulation.

At the end of the process, the pianist, almost still, holds the piano fallboard in a nearly closed position, a desperate, almost trembling attempt to refrain it from completely closing. The cellist's hands remain ‘stuck’ under the fingerboard (a position utilised in the cadenza). Visually ‘disappearing’, the hands slightly tap the back of the fingerboard/cello's body, creating soft percussive sounds indirectly triggering the strings’ vibration until the very last action. The percussionist performs the ultimate, near-imperceptible sound movement. As the airflow of the vibraphone rotating motor decreases, reaching its slowest, near-silent speed, it continues the frozen (and spread/non-visible) musical action in another air form – a mechanical trace beyond the piece.

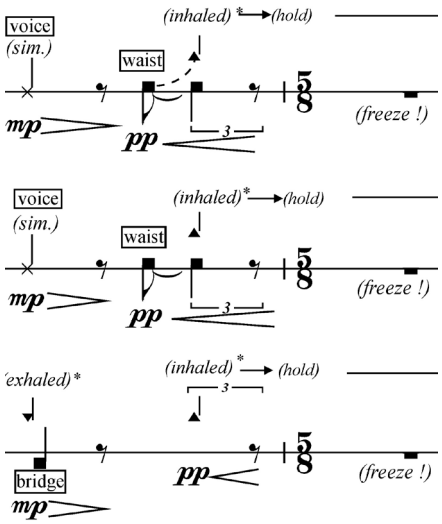


Fig.28 human-instrument equivalents: string trio

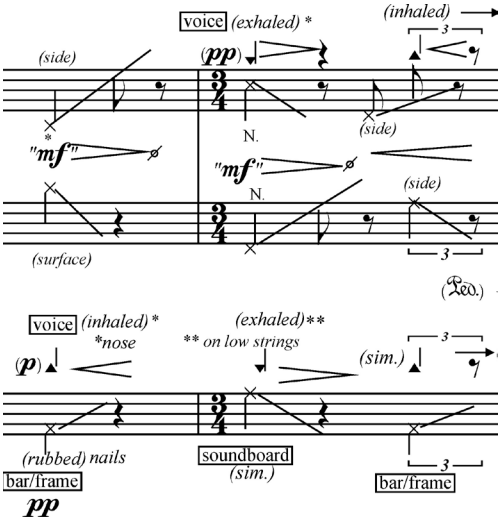


Fig.29 piano and percussion (in the piano)

	Percussion	Piano	Cello	Viola	Violin	Clarinet
Inhalation equivalent	Piano Frame Rubbed (nails)	White keys Guero (nails)	-	Waist (bowed)	Waist (bowed)	Filtered inhalation
Exhalation equivalent	Piano Soundboard Rubbed (nails)	Black keys Guero (fingertips)	Bridge (bowed)	-	-	Filtered exhalation
Resonance generation	Low Strings (Blown) Piano reverberation	Piano reverberation	Strings (Blow)	F-hole (Blow)	F-hole (Blow)	Piano reverberation

Table 3: equivalents

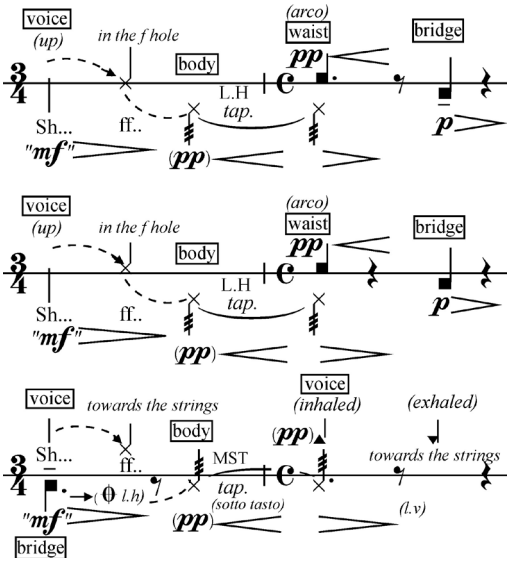


Fig.30 equivalent development: echoes, variations (string trio)

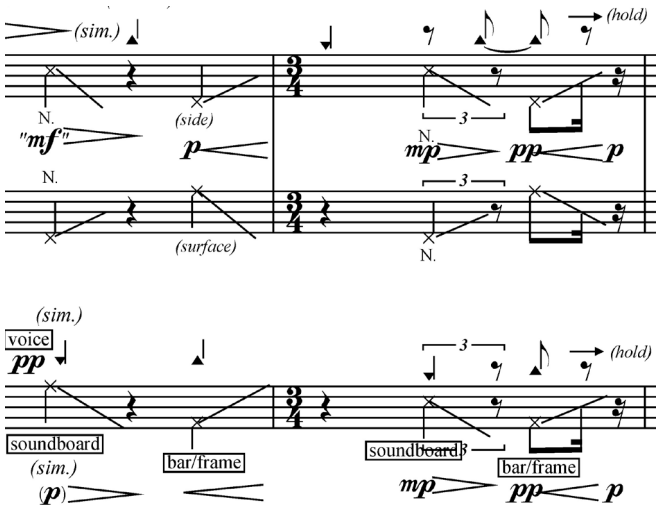


Fig.31 human-instrument equivalents: piano/percussion

2.2 Deepening resonance(s): *Un eco di soffio II* for clarinet and piano resonance. Breath catacoustics[172]

Un eco di soffio II explores sympathetic vibration and instrumental reverberation as versatile resonance forms. The piece incorporates an external resonating body, a prepared grand piano whose resonance functions are augmented by a novel pedal system. Sympathetic resonances and other forms of instrumental vibrations and filtrations generate the structure, built on an evolving musical and physical space exploiting various resonant polarities. Through this, the piece develops the air and resonance interactions typology.

The air and resonance continuities create new synergies. Triggering and impacting vibration through both direct (e.g. percussion) and indirect (sympathetic) actions, the performer/clarinettist creates a constantly evolving air and resonance dialogue utilising contact (intra-piano parts) and 'contactless' (wind/sympathetic) actions. Through sympathetic resonance, the various air (and air-containing) techniques of the clarinet (Bb/bass) emerge as a complex category of sounds whose forces and fragilities are reworked and revised through an overarching phenomenon and multifaceted element, 'reshaping' air timbres in all their forms. Clarinet-amplified corporeal actions (deep exhalations to thin air-filled whistles and 'asthma' effects) resonate through the second external body of the piano, modified in perception and extended in time, working on echoes that can link or obfuscate their combinations. The work extends the porosity concept to the air and resonance interactions – an 'air/resonance porosity'.[173] Explored as resonance-triggering sounds and forces, air and breath also develop as parts/forms of resonance, recomposing it as underlying reverberations or spectral expansions. The notion of trace (core aspect of 2.3) emerges, building further continuities during and beyond the piece.

A physical extension of the piano sustaining pedal, the *extended pedal* allows approaching resonance as a malleable object. The system controls the pedal/dampers action remotely (i.e. beyond the keyboard), bypassing the need and constraint to physically block the pedal or have an 'assistant' controlling it. The extension activates the pedal from both piano sides, opening new possibilities such as the exploration of 'polarized' resonances in various positions/configurations impacting sympathetic interactions. Piano preparations enhance this by filtering sympathetic responses (see below). The clarinettist's role extends in this context beyond that of a wind player, a 'manipulator' triggering/controlling sympathetic resonance through the new pedal system.

Context: piano and sympathetic resonance (André, Berio)

Works incorporating sympathetic resonance through the addition of an external instrumental body – generally piano or percussion(s) – can be categorised in two forms with two objectives: creating dialogue, achieving amplification-reverberation. If these functions naturally overlap, one aspect generally remains at the centre of compositional exploration. In the first case (dialogue), the intervention of a second performer is necessary, as in Berio's *Sequenza X,* 1984 (see below). While resonance becomes a malleable object, the work inevitably becomes a duo with an 'assistant'.[174] In the second case (amplification-reverberation), the pedal blocking in depressed position is the most common solution, as in André's *..In..*, 2001 (see below). While freeing up the (sonic/visual) space for solo actions, this drastically limits the scope for resonance exploration. The strings vibrate freely. The performer cannot implement any action on the (blocked) pedal mechanism that modifies

[172] *Catacoustics* is the branch of acoustics dealing with echoes/reflected sounds.
[173] The piece continues investigations of *Un eco di soffio* (air 'porosity' in 'contact-based' (string) techniques), developing aspects of *Atma(n)* (resonance polarization) in a 'solo' context.
[174] Usually with a limited number of actions, including simply maintaining the pedal depressed. See Cowell *The Banshee* (1925) often performed in this configuration.

this. Sympathetic resonances and variations are tied to their triggering material – pitch, noise or timbre-based, complex or with a specific register – and its time/dynamic articulation. Instrumental (sympathetic) resonance can hardly evolve beyond the mere reverberating function.

In André's *...in....* (clarinet and piano resonance, 2001), there is a stark contrast between the detailed approach to the 'solo' material (five graduated air and pitch states, phonetics variations, multiphonics and other techniques) and sympathetic vibration, a broadly unspecified yet key element. Though variously impacted by the clarinettist's sounds, the sympathetic response and evolution are simply beyond the performer's control. This lack of control over resonance *once it is created* is taken for granted[175] and overcomed through compositional means, creating variety. A key aspect of the piece's articulation is the alternation of soft or static phases and staccato, loud, even strident attacks creating, for a time, the means for a dialogue (through sympathetic extension) beyond the mere amplification/reverberation function.

Berio's *Sequenza X* (trumpet and piano resonance, 1984) includes a second 'shadow' part (an assistant) filtering sympathetic vibrations through pedals and keys, but also, and perhaps more importantly, by utilising a second parameter: directionality. The trumpet player alternates lateral playing towards the piano (generating sympathetic resonance), and ordinario frontal playing towards the audience (no/limited impact on vibration). If the resonance filtration is detailed in the score (e.g. silently depressed keys), it is not the performer *triggering* it that *controls* it. Actions are mediated, adapted by the assistant. Without direct control on his/her actions' sympathetic expansions, the soloist has a limited hold on their second 'life' in resonance – changing according to space and instrument.

Extended pedal, sympathetic resonance and sound directionality, piano body and filtration: new perspectives

Spatialization parameters, sound directionality and 'polarity' are prolific tools creating variations. Beyond the frontal/lateral playing (Berio), distance parameters (near/far, around/on the side(s) of the piano) create 'aimed' register-responses working on 'contact points' – position(s) reaching and impacting the lowest, medium or highest strings/reverberation 'zones'; direction(s) of the instrument's bell next to, inside, under (bass clarinet) and even stuck to the piano's body.

Aiming at extending the dialogue and amplification-reverberation functions and achieving *unmediated* control of sympathetic vibration, the 'extended pedal' is a double physical extension reachable from both piano sides (see fig.35).[176] The new resonance control possibilities this allows develop 'polarized' forms, from which the piece's structure germinates (see form and process).

[175] The pedal is blocked, and André even offers alternative solutions to achieve the 'external body' resonance-amplification function: using a tam (or large percussion), amplifying the resonator (grand piano) by placing microphones *under* it.
[176] Built and tested with Hugo Bonamin (visual artist) and Benjamin Maneyrol (clarinettist).

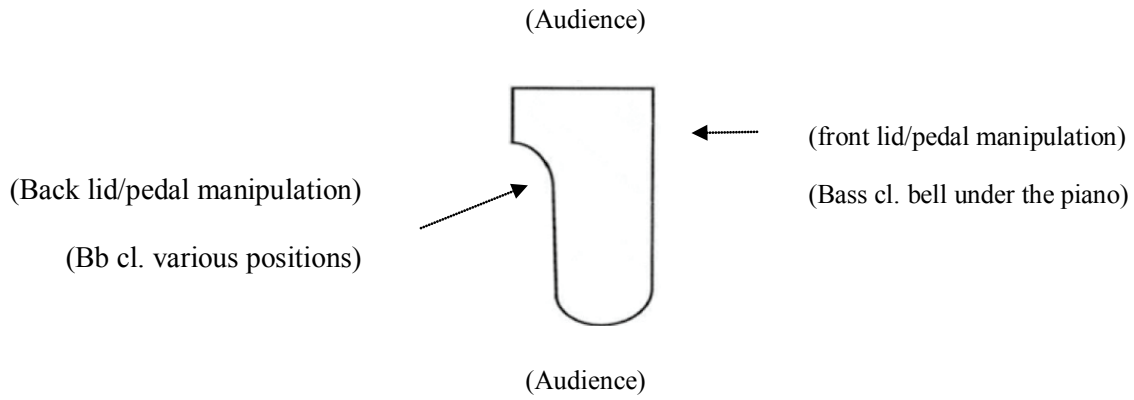


Fig.32 Polarizations

The first main polarization places the bass-clarinet's bell under the piano (left side), a zone/position impacting the lowest strings' vibration. The second main polarization utilises a wider 'open' zone (right side of the piano), exploiting the Bb clarinet's directionality and movement possibilities: straight/lateral (piano/audience) playing, movements under the lid, distance/contact with the piano strings/frame. In addition to these evolving resonance 'polarities' controllable through the extended pedal, a second filtration arises from the piano configurations.

The piano's body is an evolving amplification. Lid(s) act an external 'mutes' impacting timbre and projection of sympathetic sounds. Selected/gradual opening-closing the piano lid parts (front and back) creates three types of filtration-projection: closed lid (muffled resonance, filtration and limited projection), front lid open ('half' resonance and filtration-projection), and lid open (ordinary concert situation, full resonance/projection, little filtration). Beyond its evolving resonance-impact contributing to the piece's construction, this natural body and wood filtration develops as a technique per se. The first movement's actions revolve around the extended pedal and piano front lid manipulation. Gradually depressed/lifted and opened/closed, they filter, muffle or expand the vibration and 'trace' created through piano preparations (see below).

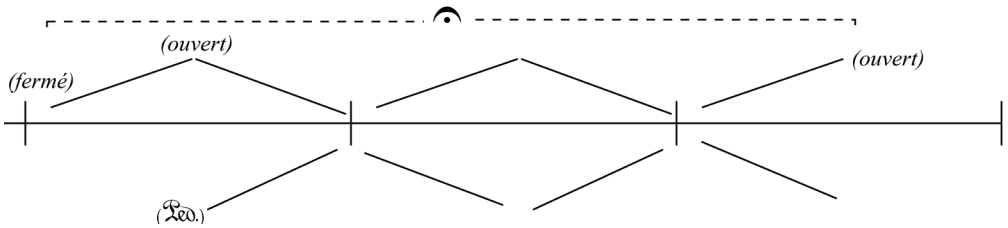


Fig.33 Front lid (open/closed) + extended pedal filtration

Fig.34 Initial performance configuration: extended pedal, piano keys blocked (visible), lid ‘closed’

Fig.35 *Extended pedal*: ‘grafting’ on lyre mechanism, double access/extension

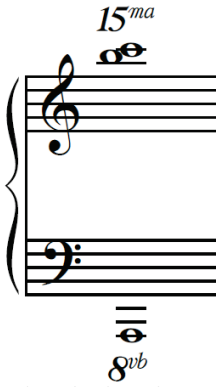


Fig.36 Piano keyboard preparation objects under the cover block selected keys

Fig.37 Bb clarinet preparation for dyads and one-hand playing (fingering diagram)

Vibration, traces, preparations: system of resonance filtration

Initial investigations pertained to the exploration of efficient ways to maintain audience attention during the possible sound 'gaps' movements/manipulations and in-performance preparations create: lid reconfigurations, instrument changes/modification, changing positions (see process and form). The piece was commissioned by an exhibition featuring eighteen international artists in a specific space (see fig.59). The solution came from the desire to keep a trace of the piece after the premiere (at exhibition opening), during the whole exhibition (seven days) until another performance in a 'mirror' version (exhibition closing).[177] If a first envisaged option was to include a recording in a headphone-angle playing the work and freely available to visitors after the premiere for full or intermittent listening, another path was explored, ultimately inspiring compositional developments: a trace of vibration expanding the piece.

If options such as e-bows were envisaged, a less 'pure', rich and evolving vibrating trace was selected: a vibrator creating changing contact points on string(s) and intra-piano part(s) (fig.38). Controllable by distance, the vibrator creates transitions, interacts with the performer's actions, participating in their resonance and vibration. Less 'sticking' to the string(s) and with a spectrally rich, 'imperfect' and 'moving' contact due to its shape,[178] this revealed an effective option to create vibration auto-variations in and beyond the piece. During performance, a second person 'hidden' in the audience controls the object's vibration using a remote (on/off, speed changes creating variations). These actions (detailed in the score) escape the audience attention, for which the vibration source is kept unknown, opening to the impression of an electronic expansion.

The vibrator/string contacts evolve. The dual string/frame contact creates constantly changing spectral expansions through slight movements of the vibrator on/along the string(s) and frame, subtly changing position and associated spectral filtration during the piece and trace. The slight 'bounces' on metal frame the vibration and vibration-speed changes create add an underlying percussive component to the sound and resonance/vibration – furthering the suspicion of an electronic expansion for the listener.[179]

Fig.38 Vibrator: 'imperfect' contact with lowest string(s)/metal frame

In addition to the extended pedal and piano/clarinet preparations (fig.36-37), these various processes/extensions create a complex system of resonance filtration (fig.39). The five movements focus on specific air, sound and resonance explorations that the system expands (see process and form).

[177] Movements V to I.
[178] Evolving part/harmonic node contact, see recording.
[179] In another performance (Brussels) the piece was presented as 'for clarinet and electronics' based on the recording.

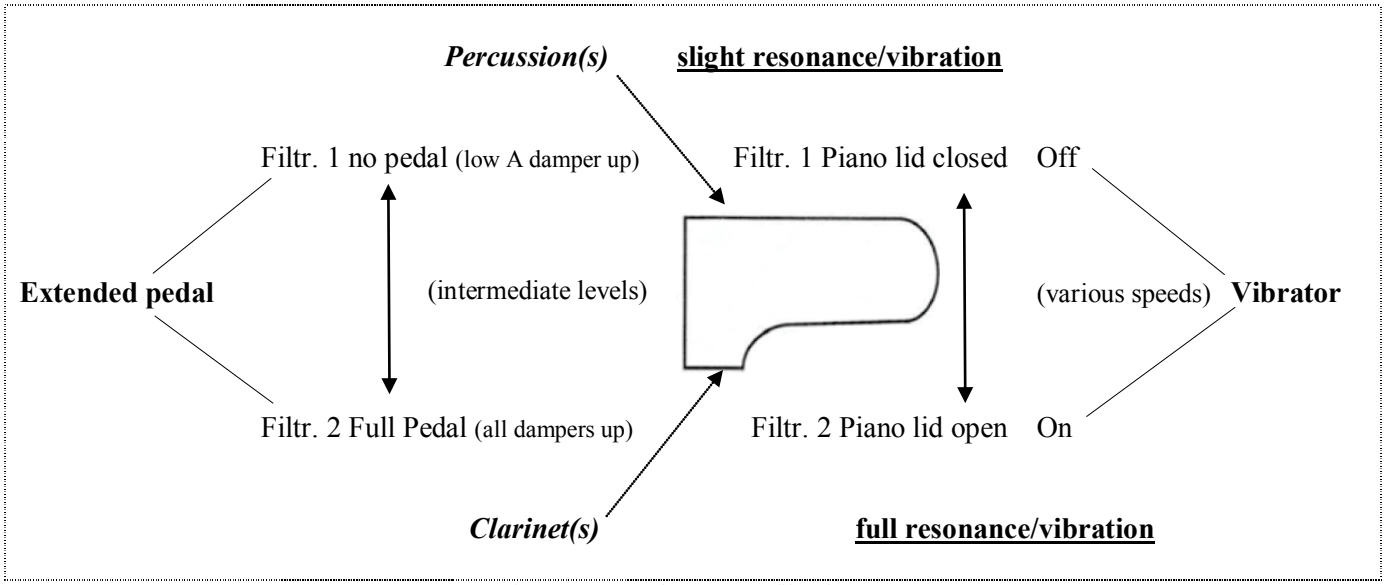


Fig.39 System of resonance filtration

Opening new resonances, revealing the score: the piano as compositional and physical reservoir

Throughout the piece, the gradual/selected opening/closing of the piano lid(s) *reveal* the score, making visible or hiding its page(s) which, following the polarizations, are placed on and underneath the lid (movements I-II), inside the piano (left side, III-IV) on the metal frame (I second part, V) and other parts. Beyond the score, the piano 'evolving body' creates new physical accesses revealing objects hidden/inaccessible both to the audience and performer. Placed inside the piano prior to (and at the end of) the performance, the Bb clarinet is invisible until the 'full' opening of the lid (IV-V transition). This 'hidden' instrument – and its 'hidden' score – is prepared: one hole filled with an earplug allowing feasibility of the dyad combinations in V (see fig.37).[180]

Other tools (plectrum, mallets) are also pre-positioned, taken from and ultimately left inside the piano. In the *end* section (see form), the Bb clarinet is put back inside the piano whose lid is again fully closed. As the *collection intérieure* of scores/objects (including the vibrator) visually disappears, 'permanently' inaccessible, its vibrating 'life' reappears. The vibrator, at its slowest speed, maintains a soft, continuous vibration the prepared keys allow to slightly resonate (see below), an 'infinite' halo and trace expanding beyond the piece (see traces and interactions).

The piano as a body/instrument: prepared keyboard, percussion

Keyboard preparations (light objects placed under the closed fallboard blocking three selected keys in depressed position, see fig.34-36) act as a first filtration (see resonance system). The lowest string's damper (A) is held up, guaranteeing a soft and constant vibrating 'trace' during/beyond the piece. Other blocked keys (highest B-C) have no impact on resonance.[181] Beyond balancing the fallboard suspension 'weight' in an even fashion, these extreme-registers 'blocking' creates means for unconventional percussive/filtration actions.

'Un-preparing/re-preparing' the blocked keys,[182] the fallboard opening-closing become a hand-controlled 'sostenuto pedal' interacting with the extended pedal's actions, creating new functions. The extended pedal activates/deactivates all the dampers besides the lowest A-string held up through preparation. An 'un-

[180] This preparation also serves for the 'one-hand' playing (V, see below).
[181] There is no damper in this register due to the string size/resonance.
[182] The closed fallboard pushes on the objects that, in turn, depress the keys. Fallboard-lifting lifts the objects/keys, 'un-preparing' them.

preparation', the fallboard-opening and associated key-lifting/damper-deactivating allows the *full* string damper-activation function to be passed to the extended pedal.

The combined pedal/fallboard manipulation achieves filtration variations. In movement I (piano-body 'filtration 1', vibrator on/speed variations, see form), filtrations range from full resonance (pedal/fallboard down) to 'harmonic' dampers-pressure on strings (minimal activation through extended pedal) to slight halo (pedal up/fallboard down) and 'dry' vibration (pedal up/fallboard up, vibrator sound only) (see fig.40).

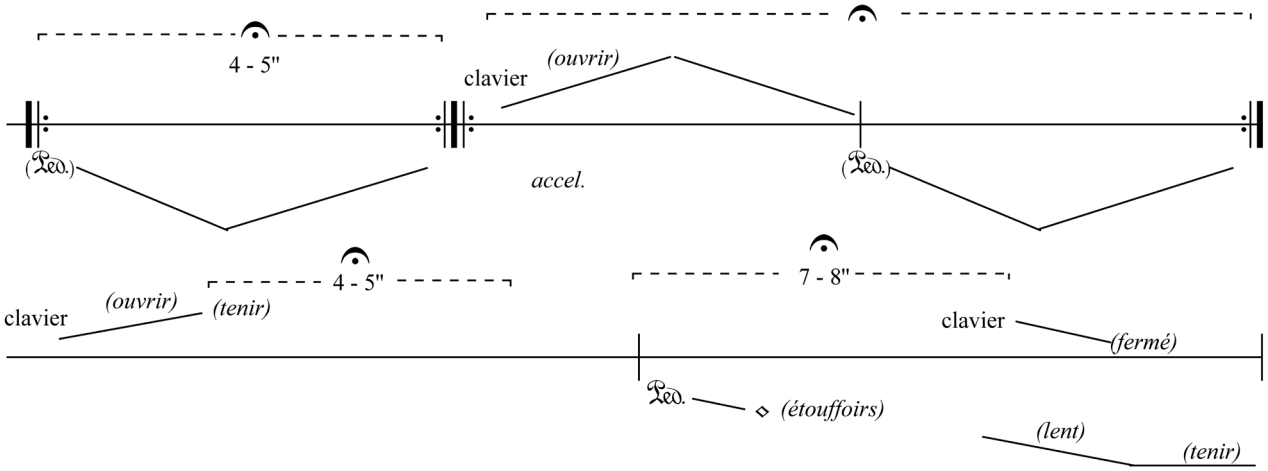


Fig.40 Vibration filtrations: pedal gradations including 'harmonic' pressure, fallboard open/closed variations (un/re-preparing)

Silently activating the keys/dampers action in movement I, the fallboard opening/closing technique also becomes a percussive gesture in V. In fig.41., the fallboard is lifted and let to fall, literally impacting the prepared objects/keys. The lowest and highest notes – which require a wide two-hand extension in ordinary 'piano' playing/position – activate through a spectacular, one-hand action. The other hand develops sound echoes using 'one-hand' clarinet fingering/playing (combined with voice) which softly emerges in this action's resonance. This dual clarinet and fallboard percussion action creates a spectacular visual and sonic 'peak', building a long resonance in which the final breaths of the piece (re)appear: the performer's respiration filtered through the clarinet (without mouthpiece).

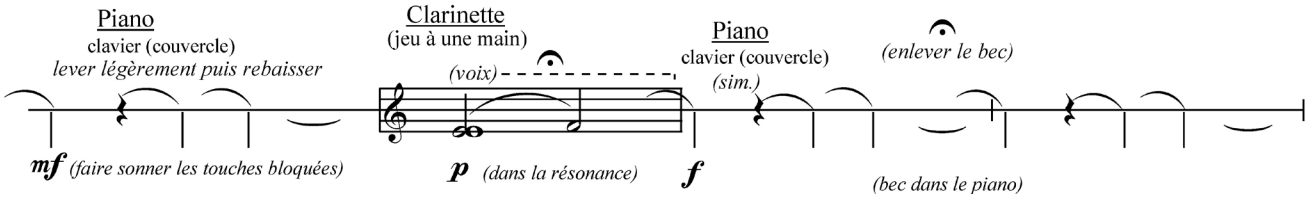


Fig.41 One-hand clarinet playing, fallboard percussion impact/resonance

While the performer 'definitively' closes the piano lid in the end section, a 'heartbeat' sound emerges through the slight asynchronization of the left/right front lid angles closing: a diastole/systole rhythm (fig.42).[183] As in the introduction, where this 'heartbeat' hesitatingly arises through the repeated lid opening/closing 'filtering' (see fig.42), it creates a soft percussive material briefly developed. But conversely to the introduction, it gradually unfolds here without resonance. As the pedal is slowly lifted, the 'heartbeat' becomes *dry*. It leaves no trace, creating tense suspensions interrupting and ultimately freezing the performer's actions. After a final suspension and tense silence, the vibration is put again 'on', thin but 'alive' (prepared A-string) as the performer silently leaves the performance space (see fig.43).

[183] This effect is achievable on most pianos when the front lid is slowly closed. It was highly effective on the 1923-Steinway of the first performance.

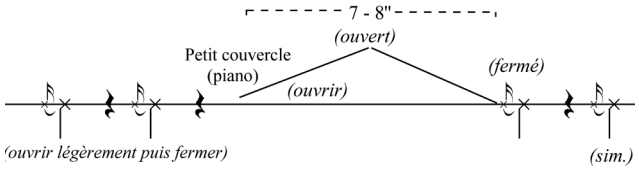
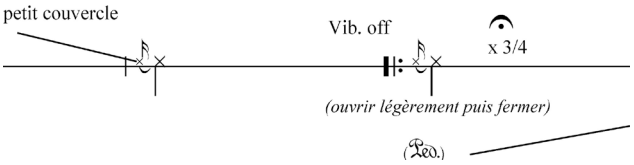


Fig.42 Introduction: opening/closing front lid: filtration, 'heartbeat'



End: 'heartbeat' (dry)

Traces and interactions: beyond the piece

After the first performance of the piece (opening the exhibition), the prepared vibration was left on as a 'trace' of the work for the duration of the exhibition, seven days. The exhibition included installations on several floors of a *Maison de maitre*, a space through which the trace could fully expand (see fig.59).

'Grafted' to the piano, the extended pedal took the new function of interactive object, an 'installation' part of the exhibition. Visitors were invited to manipulate it, thus activating/modifying the dampers' action (without seeing it), invited to play on (and be surprised by) the modification of the resonance/trace this creates – the prepared blocked keys (see above) guaranteeing the first continuous vibration 'trace' the extended pedal action filters, modifies and extends (the main process in the work introduction). After seven days, the piece was performed again and the vibration was ultimately (and definitely) stopped, vanishing as the exhibition ended.

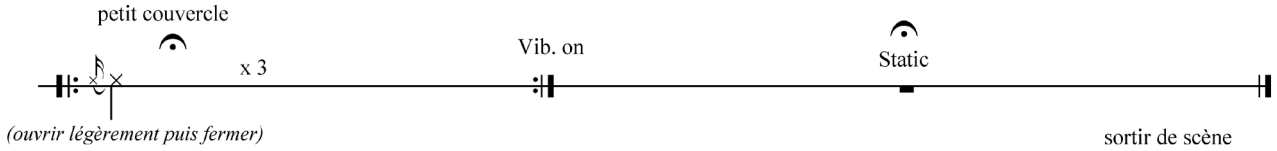


Fig.43 End heartbeat and silence/trace/performer exit

Process and form, typology and porosities: overview and specific examples.

The form builds through the parallel evolution of the 'augmented' piano and resonance filtration system and the performer's movements, changes of 'roles' and positions. The resonance filtration gradually evolves towards less 'resistance', from muffled vibration (I-II) to full sound projection (V).[184] The piano is an evolving amplification explored in various configurations and performance situations (see table 4): 'polarization' on the left/right sides, closed/open and semi-open lid(s) filtering resonance. Several sections focus on percussive intra-piano playing (I, transitions, end).

The transitions keep a sound/vibration 'activity' during changes of position/configuration (lid(s), instruments, preparations, etc.). For example, the IV-V transition (fig.44) exploits the rich resonance of the metal frame percussion which, merged with the vibrator activity, builds an effective sonic transition during the performer's movements/preparations. While the frame resonance (bright) and the vibration (dark) 'open' a wide resonant space (also modified through vibrator speed changes), the performer moves, puts down the bass clarinet, changes position (left to right piano side), modifies the lid opening and takes the Bb clarinet inside the piano.

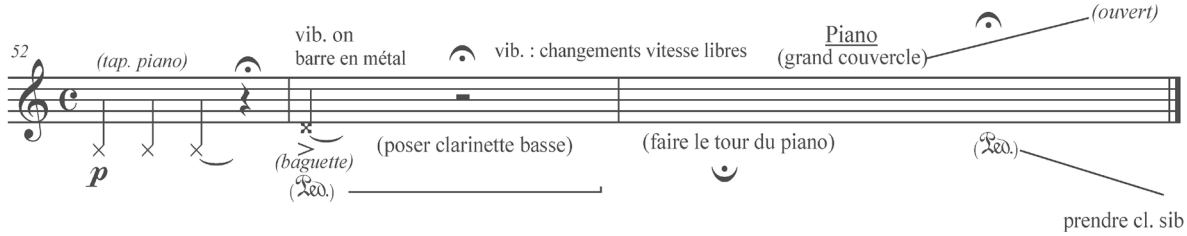


Fig.44 IV-V transition: frame percussion, instrument/position/lid modification, vibration (w. speed changes)

[184] The filtration is ultimately put back to its original filtered form (muffled resonance) in the *end* section.

	I Vibration-resonance	II Air-resonance	*Transition*	III Impact-resonance-air	*Transition*	IV Fragile (air-containing)	*Transition*	V-a 'face' the air	V-b Fragile (air-containing)	*End* Resonance filtration	*After end*
Instrument (objects)	Piano Hands, plectrum mallet	Bass clarinet (no mouthpiece) Piano (Hands)	Piano plectrum mallet	Bass clarinet (mouthpiece)	Piano mallet	Bass clarinet (mouthpiece)	Piano mallet No action	Bb clarinet (prepared) Piano surface (frame)	Bb clarinet (prepared) ↓ (no mouthpiece)	Piano Hands	extended pedal free access visitors
Investigation Main Process techniques	Vibration expansion Resonance filtration Front lid opening/closing Pedal variations Piano manipulation percussion	Resonance as air amplification/extension Air/breath → Resonance ↺ Breath filtration (voice, whistle tech.)	Vibration Resonance percussion	Air as resonance amplification/extension sound impact → Resonance → Air/breath Resonance-triggering (teeth-on-reed, slap, air..)	Vibration Resonance percussion	Resonance as legato Sustain/enhancement air/sound fragility/porosity hybrid techniques	Vibration Resonance decay	Resonance as 'obstacle' extended echoes resistance → Resonance → Air improvisation air directionality	resonance as 'legato' (echo) fragile (dyad) ↺ → Resonance Dyads "choral"	Vibration decay	
Performer position	(position 1a) (position 1b)							(position 2)		(position 1a) → (offstage)	
Piano lid	closed /variations (front lid) (Closed) → (half-open)	(front lid open)						(lid fully open)		(front lid half-open) ↓ (closed)	(closed)
Type of resonance filtration	Variations: Filtration 1 (muffled resonance) Filtration 2 (half-resonance)	Filtration 2 (half-resonance)						Filtration 3 (full resonance) Echo		Filtration 2 Filtration 1	Filtr. 1
Vibrator	On → Off (Speed Variations)		On → Off	On		Off	On	Off		On (On/off variations)	Off On

Table 4: Form, process and typology development (overview)

Typology development, specific examples

Throughout the piece, the vibration of the external sounding body (a grand piano) is triggered by utilizing air as a *sound* and as a *force*. In the first case, the sound of air, i.e. its spectral characteristics, creates the sympathetic vibration phenomenon.[185] In the second case, the force of air, i.e. the physical movement in space, triggers vibration, generating resonance.[186] The characteristics of the air/air-containing sounds (timbral share/complexity) and development in space (directionality, distance/position to external body) create variations. The two forms develop individually and combine as a dual function.

The time articulation between the *triggering* (air/other sounds) and *extending* (resonance) steps and actions develops combinations impacting the air-resonance interactions. For example, in movements III and V, short temporalities create 'mirrors' echoes – air (re)appearing shortly after/within resonances (triggered through air or other sounds/actions) – evolving time expansions (crescendos gradually building resonance) and extended reverberations until 'obstruction' (V). From isolated/spread elements creating specific resonances to accumulation of sound materials generating denser forms, the succession of action is key to developing a wide range of specific and 'clear', or conversely mixed or 'blurred' sympathetic responses (e.g. 'enveloping' mixtures through multiple actions, II). Evolving interactions (e.g. isolated/combined triggering action(s), resonances through combination of air and other techniques) build *resonating textures* and a typology of *energies* and *functions* impacting the work construction.

Typology 1: resonance as amplification/extension, movement II [187]

The second movement explores the dialogue between corporeal breath and sympathetic resonance, focussing on accumulation/multiplication processes. Breath and air are 'passed' through the dual clarinet-piano instrumental and resonant filter. Breath expands in a 'raw' form: without mouthpiece,[188] the bass clarinet amplifies and 'projects' corporeal sounds towards the second 'filter', the piano.[189]

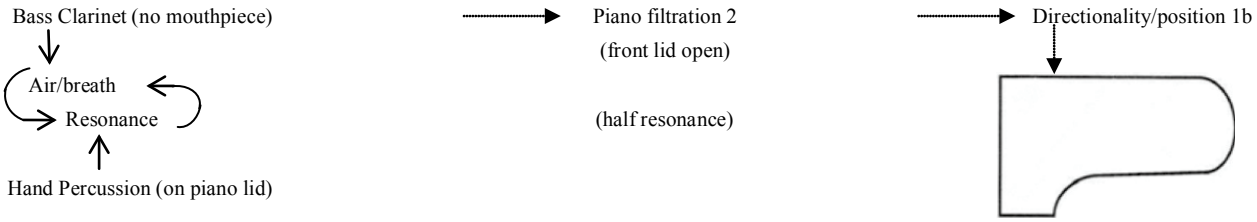


Fig.45 *Action-Filtration/type of exploration: movement II*

Through their various dynamics and articulations, corporeal sounds act as rich vibration-generating materials. Radical actions trigger resonance and extend filtration: repeated 'gasping', near-percussive *ala tromba* and softly inhaled 'asthma' effects,[190] slow and deep to fast 'hyperventilated' inhalation/exhalations. The mouth articulations extend these sounds (and their resonances) through flutter and 'rolled' tongue techniques, throat articulations and growls. Phonetics, fingerings and instrumentally filtered voice and whistling build the air-

[185] Air sounds (variously filtered/modified) impacting vibration.
[186] Approached in 2.1, this aspect is central to the souffle-based orchestration system (chap.3) activating various vibration/filtrations.
[187] Movement I, an ongoing resonance/vibration modified trough pedal/lib manipulations (see above), serves as an introduction to the 'echoes of breath' (*eco di soffio*) starting in II.
[188] Mouthpieceless clarinet voice-filtration has been notably explored in Globokar's *Voix Instrumentalisée* (1973). Beyond breath amplification/filtration, the interested lies here in investigating the (mouthpieceless) sounds 'after-life' in resonance.
[189] Bass-clarinet bell under the piano left side, a more direct/effective impact on lowest strings' vibration.
[190] 'Respiratory difficulty' simulation – see utilisation in Mark André *...in....* (2001).

resonance interactions, nourishing mutual expansions. Percussion on the lid of the piano (hand) also generate resonances combining with air – also emerging from (and extending) resonance.[191]

The dual instrumental filtration of the techniques creates various resonances triggering specific (or less defined) vibrations. Combined, air and resonance create processes. Air/breath actions and sympathetic resonance responses overlap, transforming each other.

For example, in the *calme, récité* sections, whistling techniques generate 'clear' resonances 'enveloping' breath through their reverberation.[192] In b.11-14, the whistlings extend (in) a specific 'vibrating tessitura' of the piano resonance. Low, deep inhalations through clarinet then emerge in a 'blurred' resonance 'zone' contrasting the relatively defined sympathetic response(s) the whistles create. These deep inhalations generate more complex sympathetic vibrations (enhanced here through instrument bell position) in which the next filtered whistling then takes place until, again, the whistling and inhalation *enveloping process* repetition (fig.46).

As the process develops, a broader sympathetic vibration 'tessitura' expands, enveloping the inhalations in a reverberation space. The process develops with variations – voice and spectral modifications,[193] voice/whistling combination through clarinet (e.g. b.47), 'unfiltered' whistling directly on piano strings (e.g. b. 14) generating other resonances and vibrations.

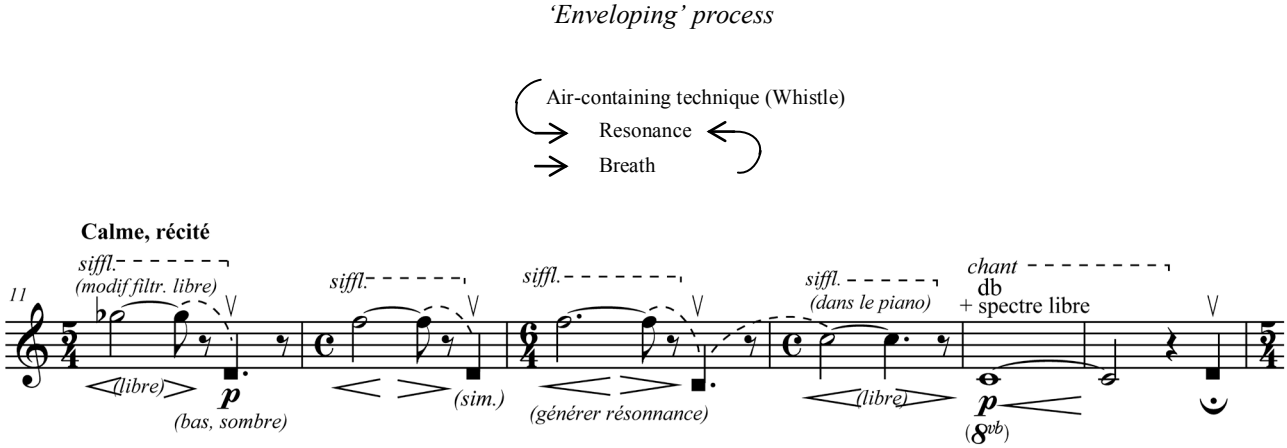


Fig.46 *calme, récité* enveloping process: clarinet-filtered/unfiltered whistles and inhalations, voice/spectral modification

Conversely to the *calme, recité* 'envelopment' in which sympathetic phenomena *take the time* to emerge, filling specific 'zones' of the resonant space, the *haletant* ('gasping') sections (see fig.47) do not develop 'clear' or focused sympathetic responses. In its various bass clarinet-amplified forms, breath accumulates, creating dense resonant extensions. Corporeal actions form complex sympathetic results. Unstable tempos and phonetically modified inhalations/exhalations form 'hyperventilated' articulations; flutter-tongue, raucous growled sounds become attack/resonance actions. These combinations generate various piano 'responses' through *accumulation*, and the variety of the attack/resonance material and articulations in time builds an otherwise unreachable dense and complex resonating space.[194]

[191] Three piano lid impacts/clarinet-amplified exhalation is a recurrent action (reminiscent of I) throughout the movement/piece, e.g. b.7.
[192] Clarinet-amplified whistles incorporate free mouth/instrument distance-movements changing air share and timbre, see recording.
[193] Free changes of fingering and voice-filtering impacting timbre – a resonance-triggering 'didgeridoo-effect', e.g.b.15.
[194] E.g. through softer, isolated air-sounds.

Accumulation process

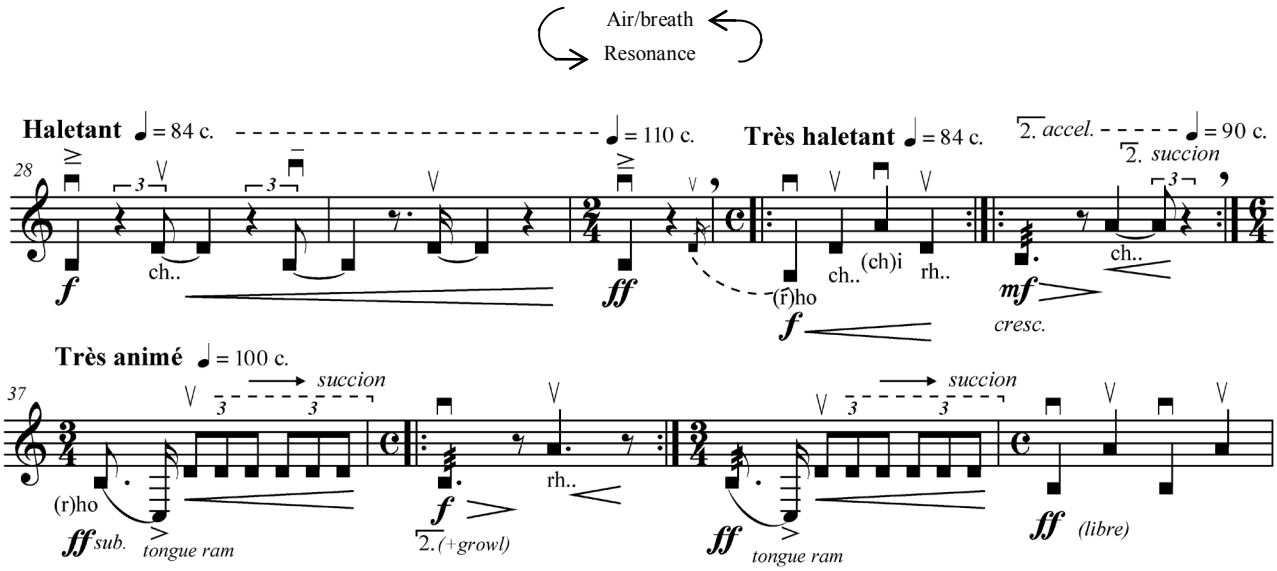


Fig.47 Accumulation process, corporeal techniques: 'gasping', inhalations/sucking, tempo changes, articulated/modified breath

Reaching a climax (b.32, fig.47 sys.1), the accumulated 'gasping' resonance briefly extends to the previous *calme, recité* approach (b.33-34) until yet another accumulation and explosion (b.35-40, fig.47 sys.2). The latter section reworks the 'gasping' material with variations, extending and ultimately 'stretching' it in *declining echoes* (see below) reaching, again, the soft whistled and 'inhaled' resonances of the *calme, recité.*

The *declining echoes* (fig.48) combine both approaches and soundworlds: whistle resonance, gasping breath in (and out of) the clarinet. Inhalations gradually 'freeze' and expand towards softer 'asthma' effects.[195] As the other end of the dynamic spectrum develops, the previous profusion of corporeal techniques dilutes, creating softer echoes, ultimately barely triggering sympathetic vibrations. Performed *p-pp*, breath sounds emerge here from the resonance of other equally soft yet more resonance-effective techniques (hand-percussion on piano lid, filtered whistles and voice). Breath appears in and develops inside resonance – a process at the heart of the next movement and second main typology development.

Declining echoes

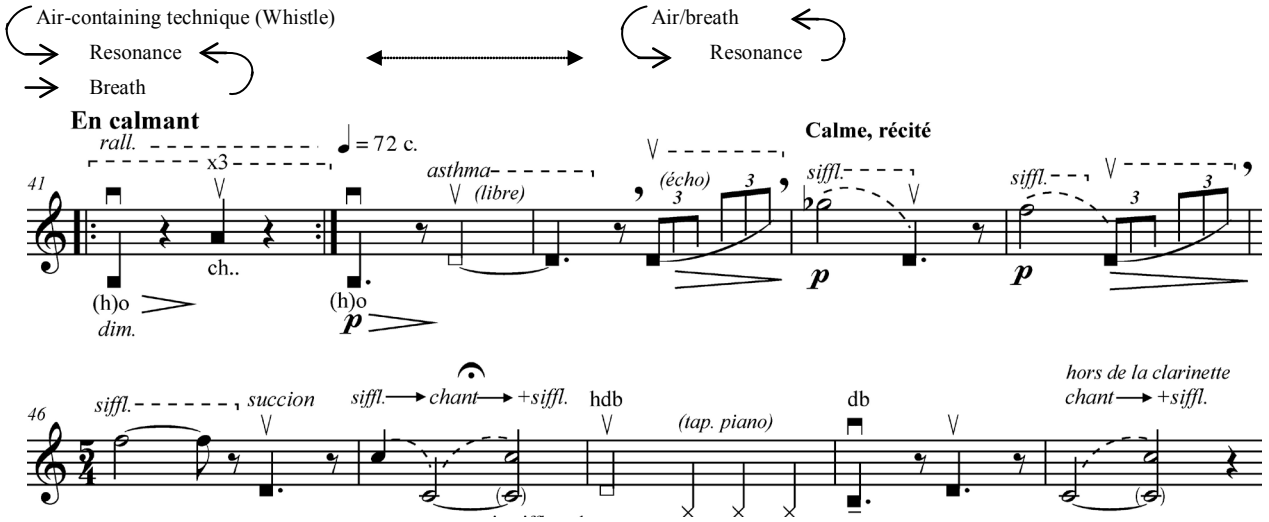


Fig.48 Declining echoes: whistle/breath, voice in/out of the clarinet, extended' inhalation, suction/asthma

[195] See footnote 190.

Typology 2: air as a resonance extension (dialogues/echoes in movement III)

In movement III, air sounds and air-containing techniques develop as resonance extensions. The mouthpiece (put on in the transition) transforms the bass clarinet's function from breath-filter to percussive implement. A three-step impact-resonance-air process utilising the extreme registers triggers resonances, merged with air echoes. The process unfolds as follows: *i)* non-air/non-breath resonance-triggering attack (open slap, teeth-on-reed, multiphonic) or process (mixed techniques, crescendo, beatings through voice incorporation), *ii)* strong sympathetic resonance (possible rest and) *iii)* air into resonance, dialoguing or mixing with it.

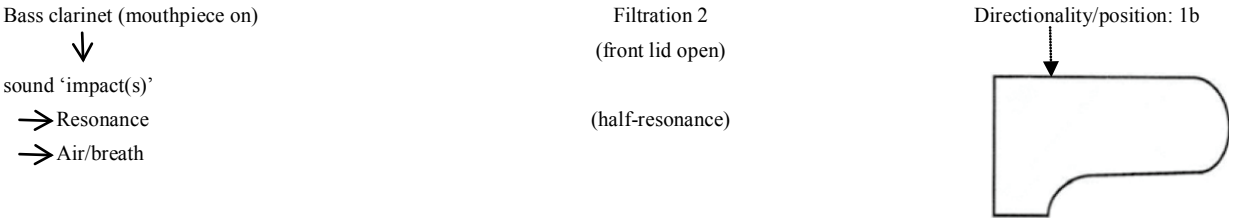


Fig.49 Action-Filtration/type of exploration: movement III

Fig.50 shows the process unfolding with a multiplication of resonance-triggering actions – dry and percussive (open slap, teeth-on-reed) and fruits of accumulations (crescendo, voice/beatings). Air-sounds are here *in* resonance, emerging from and extending it. Using the blow-at-the-mouthpiece technique (repeated with free mouth/reed distance variations), air expands from resonance-emerging element (e.g. b.29) to resonance extension overriding resonance as the movement develops.

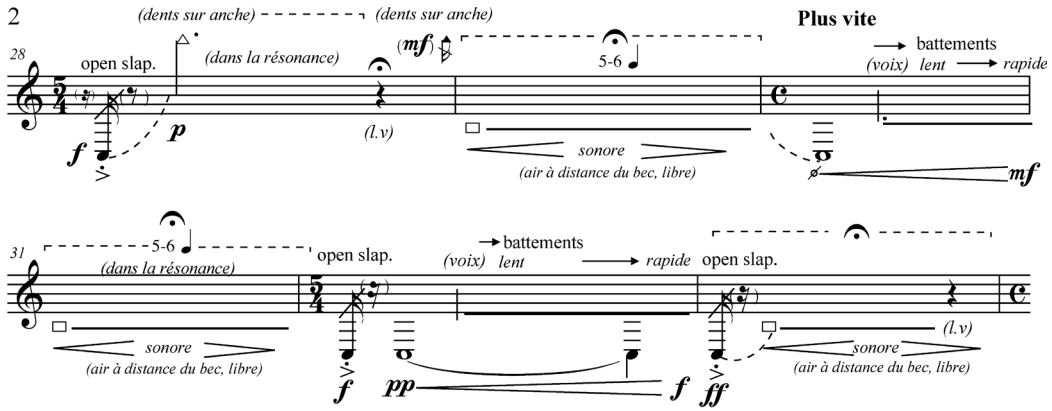
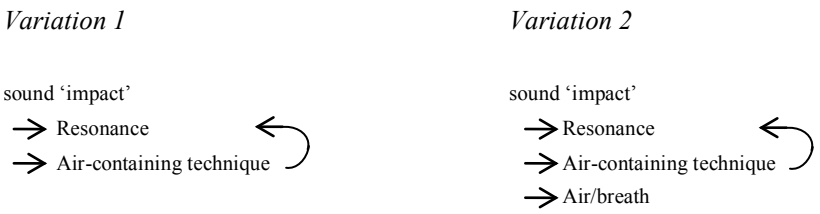


Fig.50 Resonance-triggering actions multiplication (open slap, teeth-on-reed, voice/beatings), air in/extending resonance

This core process varies. A first variation (*variation 1*) replaces step *iii*'s air-based extension/echo by an air-containing technique, emerging into and mixing with resonance, playing on harmonic affiliations to develop spectral expansions. The alternation of the core process and variation 1 creates a second variation. *Variation 2* develops/alternates processes of both previous steps *iii*: extension/echo through air and air-containing techniques.



Variation 1

In the example below (b.10-14, fig.51), the low-Bb polarisation (written C, held through circular breathing) and crescendo incorporating voice and spectral multiphonic (*Z*) expand towards sympathetic resonance ultimately *saturating* the Bb spectrum (b.11). The strong sympathetic response this creates extends through and transforms into softer fragile sounds gradually incorporating air (b.12). Still exploiting the Bb position/spectrum, *pp* harmonics create echoes *in* and *of* the piano resonance. The merging of sympathetic vibration – the result of the Bb 'saturation' – with the clarinet's highest harmonic partials creates spectral fusions 'inside' resonance.

As the harmonics expand towards the highest altissimo-register zones, air and sound instability become full components, 'recomposing' the decaying resonance. Hardly controllable in these registers/dynamics, clarinet harmonics appear as increasingly fragile as they reach their maximal extension. They form a second gentle reverberation 'trace', mixing the piano strings' vibration and the unstable air-filled 'zones' of the bass clarinet's extreme register and associated playing technique (e.g. air escaping from the mouth/mouthpiece).

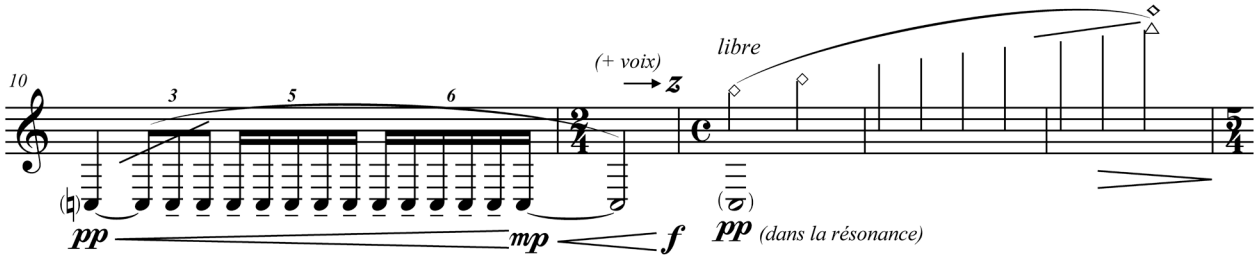


Fig.51 Var.1: gradual resonance-generation, extreme registers: Bb spectrum, harmonics as expansion in/of resonance, altissimo air

Variation 2

The example below (b.22-27, fig.52) shows the alternation of percussive resonance-triggering actions (here open slap), harmonics (extending resonance) and clarinet-amplified air (using mouth/mouthpiece distance). Altissimo utilisations act again as expansions, 'fragilized' even more through their 'direct' emergence within the other actions (e.g. highest reachable harmonic *pp* immediately after *f* open slap and air, b.25/27). The direct alternation of the lowest/highest reachable registers (*f* and *p*) creates unstable responses and fragile, air-filled 'resonating' textures. This process opens the next typology development, resonance utilising the sound/texture of air-containing techniques, and resonance as a link and reinforcement in fragile, unstable contexts.

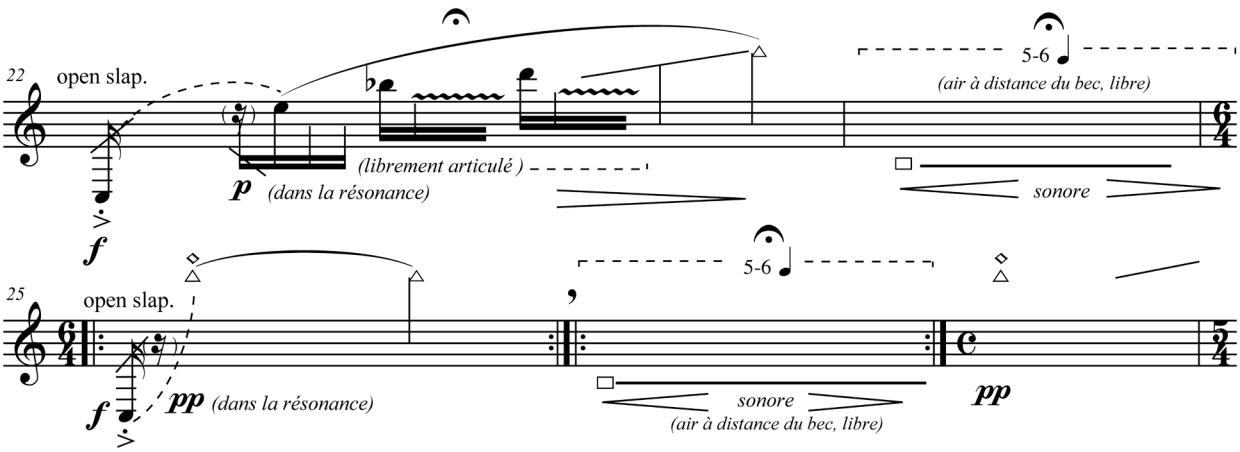


Fig.52 Var.2: alternation: resonance-triggering action (open-slap), 'air containing' harmonics/altissimo expansion, clarinet-amplified air

Typology 3: Resonance and fragile air-containing techniques. Enhancement, legato (movements IV and V)

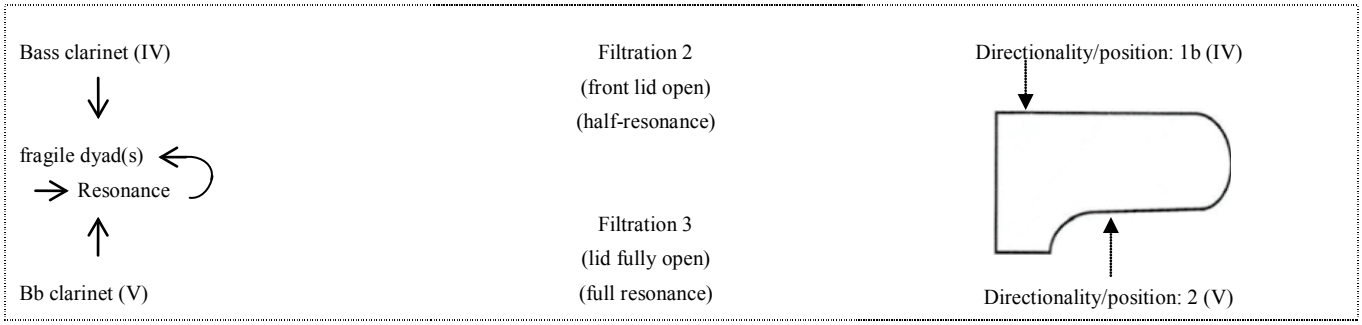


Fig.53 Action-Filtration/type of exploration: movement IV

In movements IV (b.38-50 section) and V (dyad 'choral' p.1-2), resonance takes on a *legato* function facilitating combination of fragile/unstable sounds and techniques – here dyads – which are linked and sustained. Resonance acts as a legato element 'enveloping' the dyads as they slowly evolve in 'choral' sequences. Air is in this context a background element 'escaping' from the instrument, reed and mouth.[196] The resonance-created legato allows seamless emergence/succession of these complex air-containing sounds, which, in many cases, need 'time' to emerge individually/as a sequence.

The 'choral' writing develops through the sympathetic resonance extension. The short pauses, silences or fermatas (written in the score or free) give way to a soft vibrating sustain creating a continuum, extending and enhancing the dyads (in their decay/emergences) as the clarinettist takes the time to change or adapt fingering, mouth position and breathing to the next sound – thus seamlessly arising in the resonance expansion and 'halo'.

Dyads create another form of air/resonance dialogue. Based on specific, selected fingerings/positions (that the preparations allow achieving in V), they form a complex air-filled 'choral' (fig.55). Extended through the piano resonance, the dyads constant air-filled fragility 'vibrates' in renewed fashions. Oscillating and incorporating emerging elements, the dyads evolve – beatings, timbre and air, 'shadow' presence of a third sound (fig.54) – impacting sympathetic 'responses' and sustain. In IV, dyads are 'interrupted' through external elements (fingered note, voice.) which purposely 'break' or fragilise their sound/expansion.

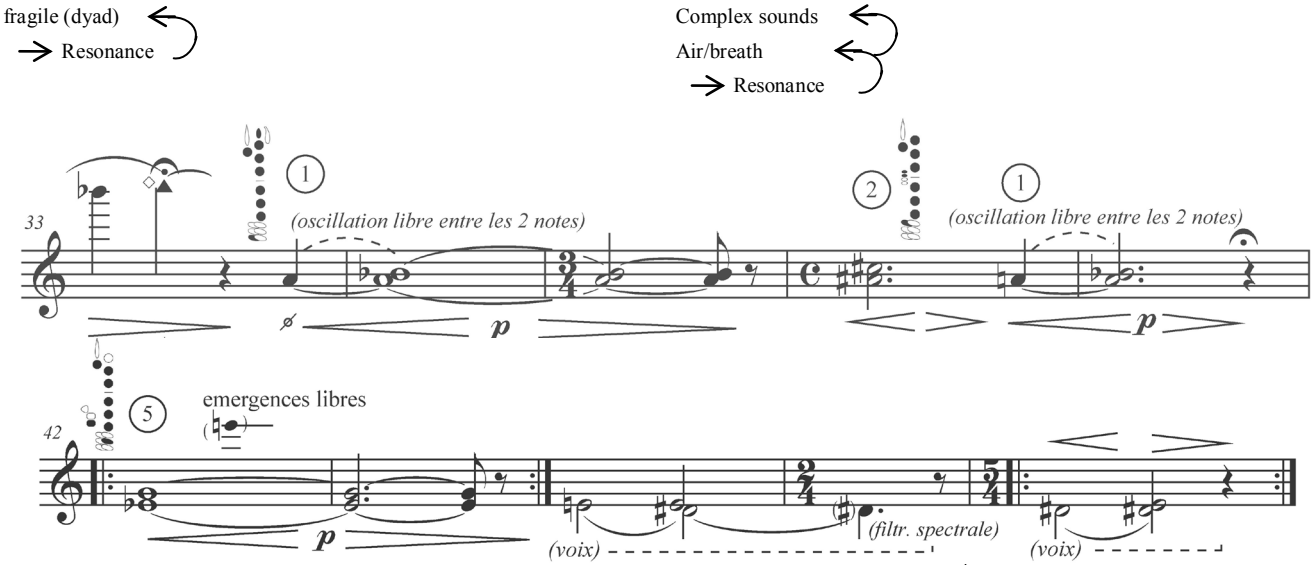


Fig.54 Dyad fragility (IV): legato, enhancement, resonance envelopment; emergences (3rd sound), external elements

[196] Most dyads have a medium/strong air presence/component.

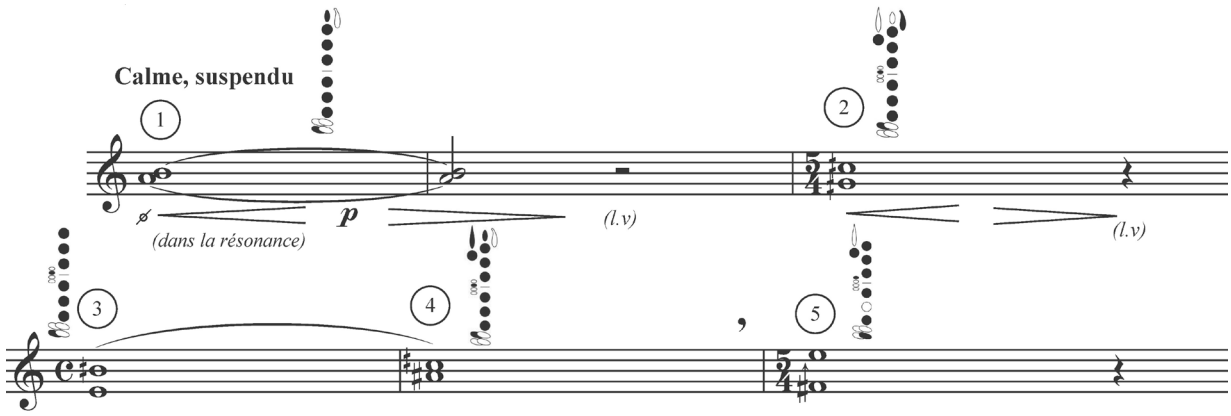


Fig.55 Dyad 'choral' (V): vibrating rests/pauses, dyad/resonance 'legato', slow emergence/decay

Fragility/resistance. Resonance as echo and obstacle (V)

In Movement V, air and air-containing techniques evolve within wider sympathetic echoes – invading, even obstructing resonances.

sound 'impact' resistance
→ Resonance echo
→ Air/Air-containing technique ↩

Resonance accumulates. Spread over a long crescendo (sys.1 fig.56), the main resonance-generating material builds an extended echo. The clarinet's bell is stuck against the piano metal frame (see fig.58). The player utilises the lowest E-fingering (sounding D) filling clarinet holes, directing the sound/airflow towards the piano frame. This dual 'blocking' (frame/fingering) acts as a filter and physical obstacle 'resisting' to the sound and airstream. Unable to 'flow' properly, air escapes from the instrument (reed, holes) and mouth. Slight 'blocking variations'– controlled or accidental bell movements within the bell/frame contacts – impact the sound and airflow, letting the air component 'escape' from the bell or flow normally for a time. The acoustic and physical vibrations in the piano strings/frame build a dense echo, grown through other techniques (including blocking-created microtonal differences). 'Applied' directly on the metal frame, multiphonics (on equally 'blocked' D-fingering/bell-stuck position) strongly impact vibration. The complexity of the sound (including the escaping air) 'resonates' *against* and *through* the metal frame, creating a 'metallic' air timbre (see recording). The extended echo is then used as a background, a resonance 'soundscape' to work on air (sys.2 fig.56).

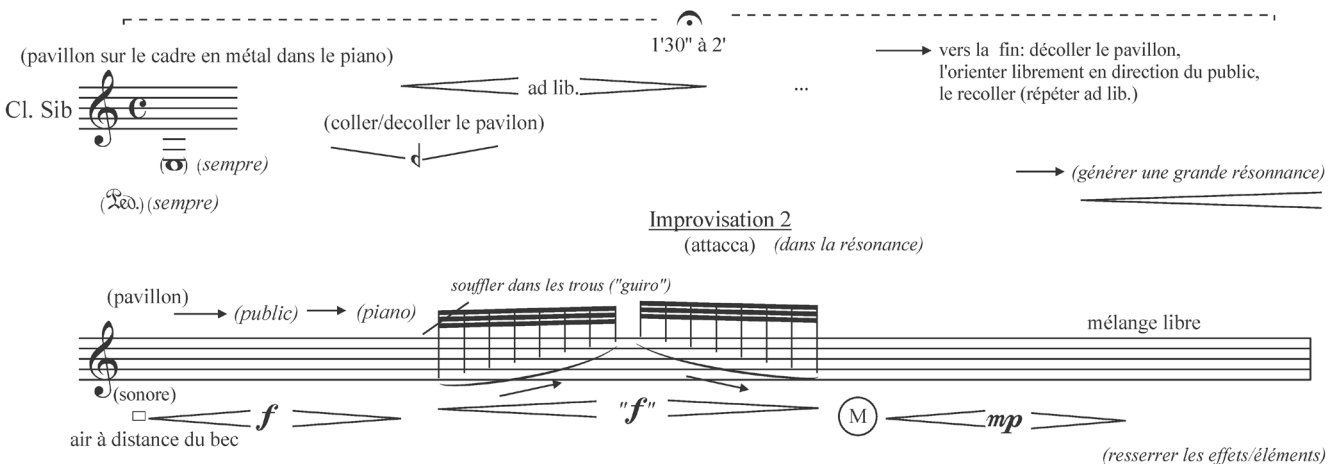


Fig.56 Bell on frame echo generation (sys.1), improvisation (3 elements, sys.2)

Utilising the dense echo and resonance, air sounds expand through directionality changes and improvisation on three given elements (sys.2 fig.56). The performer alternates wide left and right audience/piano-directed air-sounds, freely utilizing the mouth-mouthpiece distance (*element 1*). Blown ‘guiros’ on clarinet holes (*element 2*) expand this first continuous, wide gesture through a second discontinuous, ‘localized’ gesture (it is the instrument that is moved through fast left-right hand movements; the sound stems here from the hand/breath gesture of the performer). In both techniques/elements, the performer’s mouth *is not in contact* with the instrument: it is the flow of air and its distance from the instrument (mouthpiece/parts) that create and impact the sound, a 'contactless' development in stark contrast with the previously ‘blocked’ bell/metal frame development. Complementarily to the first two ‘air’ elements, free multiphonics (*element 3*) briefly nourish the sympathetic echoes and ongoing resonance ‘soundscape’. The three elements are mixed freely. As they get closer (end sys.2), they build a free articulation of moving air and spectral echoes.

The whole echo generation through 'resistance' process repeats (sys.3), extended this time in a dyad ‘choral’ section (previously discussed) emerging within the resonance echo/soundscape. As it slowly unfolds, the dyad 'choral' (more than 3 minutes) gently develops the echo, nourishing resonances through softer, complex sounds.

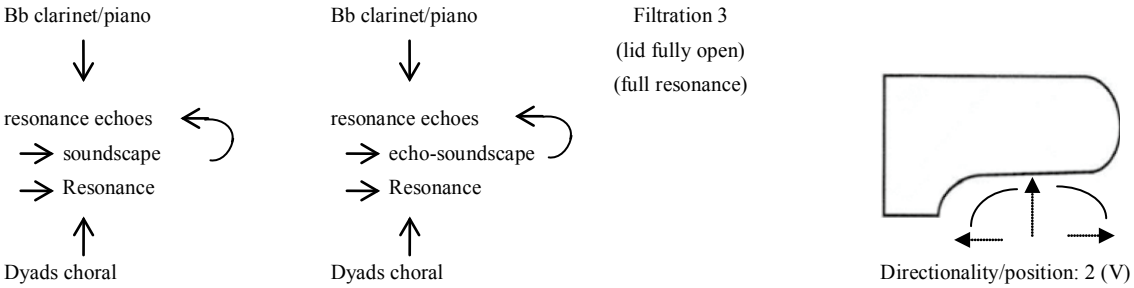


Fig.57 Movement V (details)

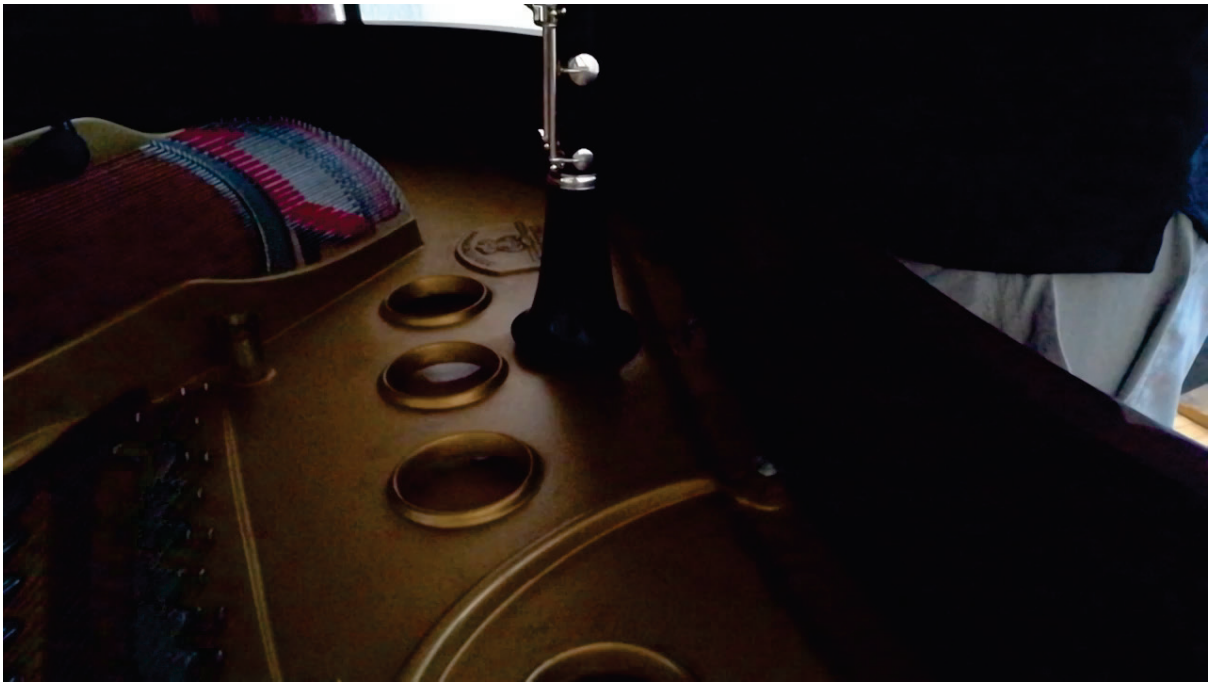


Fig.58 Bell on frame ‘metal’ Filtration /clarinet sound/airflow ‘obstruction’

Fig.59 Space for the performance and exhibition of the work/trace of the work (room n° 6, ground floor)

2.3 Tracer le souffle for accordion and pedals: composing (with) the traces

Tracer le souffle explores air as a trace – its own, ambiguous trace, or a trace in combination with other reverberating traces – opening and revealing the porous borders (and possible confusions) between air and resonance. The work explores the limits of the air-breath-friction-resonance continuum by incorporating an additional layer: a combination of effects processors. The triple human-machine-technology resonance 'mirror' expands the traces multiplicity and extreme extensions – until white noise and saturation.

The air and resonance echoes and reverberation 'illusions' are extended by the augmented accordion configuration. Human breath and mechanical air, frictions on an elastic instrumental body and new sounds and actions of the setup configuration (accessibility of the microphones to the hands/breath of the performer, stereo projection and amplification-diffusion of the accordion's techniques and effects) are reworked through an overarching (performer controlled) effects layer. This complex intertwinement between the machine, the electronic, the human and 'tactile' forms of air (souffle) allow a multifaceted expansion, an 'orchestral' medium for the air and resonance development in a single instrumental setup.

The piece is at the intersection of the first two research axes (air tactility/resonance), opening to the third axis (multiplicity/energy). The accordion is one of the only instruments in which the dual physical/expelled and contact/tactile *souffle* action is achievable. The complexity of the white noise, air, breath, friction and resonance interactions creates the piece's development. These interactions expand in the next chapter towards multiple energies and time and sound forms.

A reflection on the human and the 'artificial' (and finite and non-finite) forms of air and breath – until white noise – opens through this. Such 'hybridities' extend beyond corporeality. As a specific instrumental body and 'air machine', the accordion opens-up even more the complex ambiguity between the respiration (inhalation/exhalation of the human and/or of the machine), the friction (the rubbing/scraping of the instrument and/or of its amplification means, here the two microphones), and the traces of air and their augmentation (amplification/diffusion and effects creating modifications).

Human, instrumental and electronic modes of sound production: a triple reserve and pneumatic energy

The piece's main mode of sound production is a triple action. The left hand reworks the accordion's air (playing on pressure, occasionally adding other sound materials) while the right hand constantly rubs and scrapes the bellows (in various discontinuous 'granulated' or continuous 'air-like' fashions); the right foot controls the effects and their variations, expanding this dual air and friction mode of sound production. The performer's breath – reworked through phonetics and effects/amplification – creates an additional layer in specific sections. Pedal effects reverberate air, de-compose and re-compose it, generating otherwise impossible resonance traces.

The quadruple ambiguity of the modes of sound production (breath, air, friction, electronics/pedals) is key to exploring and even re-evaluating the air multiplicity. The piece lies on a constant air and friction and sound and gesture intertwinement, incorporating 'grain' to the textures and their traces. Variations unfold through parallel expansion, e.g. friction speed and air pressure changes, which, in turn, create reverberating traces 'mirroring'

these actions. Beyond electronics, traces are also reworked *from the inside* by air/breath and friction, acting as triggering actions and forms of resonance (see typology 2.2).

Air accumulates in a triple reserve – human, instrumental and electronic – and develops through corporeal, gestural and pneumatic energy (the bellows 'lungs'). To this human-mechanical prism, a latent energy is added. The loop effects create additional air/breath 'reserves'. Controllable through hand-delay and foot pedals, loops build complex textures *grown* as the piece unfolds. Two loops ultimately generate ongoing traces fruits of the accumulated air and breath textures, blurring the frontier towards infinite white noise traces.

Technology and breath: enhancement and transformation. Air as accumulation, the mechanical aspect of air: anthropologic memories, breath of the machine

'What I have discovered for myself is that the accordion can breathe [...]. Everything vanishes, and what is left is the breath of the machine.' (Sciarrino)[197]

In the previous subchapters, resonance achieves hybrid extensions through acoustic/instrumental means. The movements and sounds of air/breath create dialogues with (and generate) resonance/vibration, which, in turn, act as augmentations. Here, the body-instrument ambiguity and 'resonances' of air and breath extend through electronics. The denser forms technology creates develop the *equivalences* (2.1), 'augmenting' the instrumental/human continuum beyond human and instrumental breaths. The air/breath and resonance pathways arise as complex, blurred entities.

Through the constant investigation of the inner-life of the air-friction-resonance continuum and electronic/pneumatic (con)fusion, the piece aims to reflect on background and machine noise(s) as forms of *souffle*. The mechanical air of the accordion 'speaks' with its specific grain; the breath of the machine that is 'left' (Sciarrino, [epigraph]) develops, building on saturated human, mechanical and electronic air. What are the interactions and pathways between white noise and breath[198] and to what extent are these two forms distinct and non-communicating, associated with the human/the machine? [199] Are they porous and what are their borders –and when (or where) does the transformation occur?

Electronic, human and instrumental/pneumatic forms interrelate in many respects. The sonic-corporeal duality, the perception complexity and porosity of air and breath permeate technology. The first developments indeed focus on the sound and not the body, exploiting the mechanical aspect of air, e.g. in Russolo's *Inorumatori* (1913)[200] and in the *Heliophone*[201] orchestral incorporations. In the first post-war compositional experiments, recorded/concrete mediums tend to predominate over instrumental/vocal mediums as in Henry's *Le voyage* (1962, see chapter introduction) or Stockhausen's *Hymnen* (1966-67). Far from modifying the human sound,

[197] Sciarrino, quoted in Wilson, P.N. (1999) *The breath of the machine in search of the quintessence of the accordion.* Preface to CD Push Pull by Teodoro Anzellotti. Available at: http://www.anzellotti.de/seiten/extras-articles-wilson.html (Accessed 30/03/2022).
[198] A question developed in chap.3 (large forces) through the breath-human/friction-white noise association.
[199] Can we also speak of a *bruissement* ('rustle') in the sense that Barthes evoked the 'rustle of language'? Barthes, R., *Le Bruissement de la langue*, Paris, Seuil, 1993.
[200] Whose instruments include the *whistler* ('a noise like the whistling or howling of the wind') and the *rustler* ('a noise resembling the rustling of leaves or of silk'). Brown, B. (1981). The Noise Instruments of Luigi Russolo. *Perspectives of New Music*, *20*(1/2), 31–48.
[201] See Wind machines, chap.1.

these works take it for what it is: a corporeal element whose evocative power, enhanced through close recording, seems self-sufficient and requires no reworking or extension.[202]

Interestingly, the traditional undesirability (yet omnipresence) of air (souffle) in the sounds/techniques of instruments (see *porosity*, 1.2) equally applies to electronic/concrete explorations. As the background noise and accumulation result of successive copies of the magnetic tape (which cause loss of definition), air (souffle) is a defect, but also, for Chion, an element of life in the works of the 1970s-80s. 'It was a hygienist obsession […] to hunt down the souffle of magnetic tape as if one wanted at all costs to forget that sound in musique concrète is not produced live, but rests on a support.'[203] Chion sees these 'electronic' forms of air (souffle) as elements building the pieces inner life[204] – even in musique concrète where they are the fruits of accumulation on a specific, imperfect yet 'alive' support. [205]

Breath-related sounds are specific and powerful. Disconnecting (or extending) air and breath from (and beyond) their corporeality/physicality, i.e. expanding the result in sound and not the production means, can shed new light on respiration as a fundamental process and mechanism made of memories and presences (see below) which, reshaped, develop in a new form. Beyond magnetic white noise, air (souffle) as a form of *accumulation* opens fruitful pathways that the electronic/acoustic combination (re)builds here through various means – close amplification, loop recording, human and mechanical air – to create a complex 'whole'. Such developments expand beyond human-instrumental forms through multiple reworking, leading to an accumulation questioning the merging, interaction (or lack thereof) between human and non-human (or perhaps disconnected from the human) forms such as white noise. This questions the association and 'equivalences' of instrumental air-like, unpitched or noise-based materials, techniques and sounds as forms of 'human' breath (see 2.1), playing on and blurring even more their perception. Does this phenomenon extend to complex, perhaps dehumanised or saturated forms such as white noise? Can we achieve such dense or complex forms through the accumulation of human breath(s) and instrumental/pneumatic air through electronic augmentation?

For Nono, the resonance merging through electronics can 'negate' the 'mechanical strangeness'. In *...sofferte onde serene...* (1976) for piano and tape, the tape part is 'like a gigantic resonance composed in the form of a mirror, from reworked piano recordings.' The result is two acoustic planes that often merge, 'frequently negating the mechanical strangeness of the tape'. Between these two planes, the utilisation of the vibrations of pedal strokes, 'which are perhaps particular resonances from the depths of our being,' act as 'memories' and 'presences' that are superimposed and 'merge with the *onde serene*.'[206]
Developed through the pneumatic and electronic energy and reworked through the instrumental and human air, the mechanical grain and 'rustle' expands throughout the piece, investigating the 'anthropology' inherent to the

[202] Even in 'acoustic' works, forms of technology remain key elements. In *Cardiophonie* (1971), Holliger utilises an amplified stethoscope attached to the oboe player to add the player's respiration/cardiac pulse to the music – accelerating as the work unfolds. In Grisey's *Jour, contre-jour* (1978) the souffle sounds and noises spring from the tape.
[203] Chion, M. (2015) "La venue du souffle, sur trios sens de ce mot". In Joubert M. & le Touzé, D. (eds.) *Le souffle en musique*, Lyon, Presses universitaires de Lyon, pp.13-23.
[204] 'When the first editions of musique concrète on CD arrived, certain composers had their works remastered, by digitising them [...] to filter out any background noise (souffle).' 'This unfortunate netoyage has caused some of these pieces to lose a great deal of their life, that it has distorted them, dried them up.' *Ibid.*
[205] See Chion's similar considerations on the instrumental support (taking example of a Guitar Prelude by Sor), discussed as part of the 'metalanguage' of souffle in 3.2.
[206] Nono, L., *ibid,* p. 661.

accordion's workings (Sciarrino).[207] The mechanical rustle expands towards 'anthropologic memories' negating the 'strangeness' of electronics through constant accumulation and reworking of air (souffle) in its pneumatic, mechanical, human and technological forms. 'Left' and accumulated along with that of the human, the breath of the machine acts as another presence and memory, a resonance that perhaps equally belongs to (and emerges from) 'the depth of our being', merging with (and as) resonance traces.

Air and friction: a double mode of sound production. Articulation, grain and 'speaking air'

The accordion acts as a sonic and physical fusion 'block' between the 'tactile' possibilities (chap.1) and the human-instrument resonance extension (current chapter). Unfolding at relatively similar (soft/medium) dynamics requiring the same volume of amplification, the accordion pneumatic and 'tactile' (air and air-like) techniques interact efficiently. Their constant intertwinement is at the heart of the piece. Bellows frictions range from bright/continuous rubbing to dark, granulated scraping. 'Expelled' and 'touched' air interactions develop in terms of the accordion 'elasticity', until 'cracking', maximal stretching of the bellows (see 'end of breath' stammering phases, mixing the accordion vanishing air and the equally stammering granulated frictions on bellows surface). Such parallel movements develop the parlando 'speaking air' idea, in which friction grain on the rough bellows surface 'speak' along with articulated air through tremolo techniques and effects (see below). This gesture combination develops the central choreography of the piece, a double layering that rests upon two gestures approached as equal forces, the first stemming from the physical pressure of air, and the second utilising contact actions to expand or obfuscate the result by sounding 'like' air. [208]

This dual development through air and friction springs from and utilises the accordion's mechanisms and workings. Air colours inextricably link to pressure.[209] The accordion's air systematically goes by waves, with slight variations between the push and pull (bellows closing/opening) actions. If pressure-increase achieves higher dynamics, it creates brighter sounds. Loud and dark (or soft and bright) air sounds are thus impossible, and each *dynamic change* (e.g. crescendo) creates a *colour change* (e.g. dark to bright). This inherent aspect is a fruitful element reworked through the exacerbating functions of electronics/amplification. Tremolos and reverberations enhance or 'freeze' the waves in their decay or expansion, creating new articulations and developments.

The constant air/friction and amplification/effects combination creates a malleable tool for exploring the 'rustle' of the accordion. Those developments are systematic; combinations evolve from stammering breath building from air and grain, until 'raucous' forms (e.g. whammy/clusters addition, b.58) and denser energies fruits of the airwave expansion (e.g. b.87). The 'speaking air' (parlando) phases develop this wave quality (movement I, see below). Tremolos 'chop' the waves using speed variations (expression pedal) to create 'spoken' effects. The outcome is a dual layer including the amplified-processed sound – the 'speaking' transformation – and the unamplified-acoustic sound – the continuous airwave, audible in most situations (see recording), a simultaneous continuous-discontinuous effect to which the (equally continuous-discontinuous)

[207] 'The instrument inhales and exhales. [...].This is not an effect, but a very different, anthropologic conception of musical language.' Sciarrino, quoted in Wilson, *The breath of the machine in search of the quintessence of the accordion.*

[208] The conventional playing zones of the accordion are bypassed. Besides extreme registers clusters, the keyboards are barely used, and when such utilisations occur (e.g. mov.II) they germinate from noise-based or percussion-based developments or extend other actions, such as the percussive microphone utilisation.

[209] An aspect rarely mentioned in technical handbooks and often overlooked by composers.

rubbing and grain of the scraped bellows is paralleled. Friction techniques utilise the *roughness* and *elasticity* of the bellows. Rubbings, frictions and granulations are modifiable, extendable from 'air-like' to 'cracking' sounds, stemming from the bellows' evolving elasticity and striation.

In addition to pedal effects and controlled pressure (and associated dynamic/colour variations), air articulates and 'speaks' through three main gestures. Through short tapped impulses on the instrument's right side, the right-hand (fist) gently 'chops' the airflow, adding a slight percussive component to the sound. The left-knee 'trembling' – a key articulation and physical/sonic 'state' throughout the piece – achieves a similar effect, impacting the airflow in a more random fashion. Left-hand impulses (brief air pressure increase/decrease) build more sonorous articulations, expanding possibilities.[210] Combining with or expanding through electronics/amplification, these three gestures form a versatile tool for the air articulation, e.g. from soft tapped hand/knee 'trembling' to sonorous air impulses (see *form and discussion*).

Amplified/processed and acoustic duality, setup/stage configuration. Pedals/effects description

The developments of effects and traces create processes incorporating the dual acoustic and amplified layer, working on their fragile intersection. A constant search for the point of junction between the two worlds – acoustic and amplified – leads to questioning the origins of breath, and therefore the place of the body. 'The fact that we simultaneously hear ourselves interiorly [...] creates a continuum between "hearing oneself from the inside" (through internal vibrations) and "hearing oneself from the outside" (through the ears, by reflections off the walls, through a loudspeaker, etc.), and this continuum binds the one to the other,' notes Chion.[211] Throughout the piece, the double amplified-processed and acoustic-unamplified layer creates an underlying continuum and a link binding the hearing from the 'inside' – the unprocessed accordion and its mechanisms – and from the 'outside' – the amplified and processed soundworld.

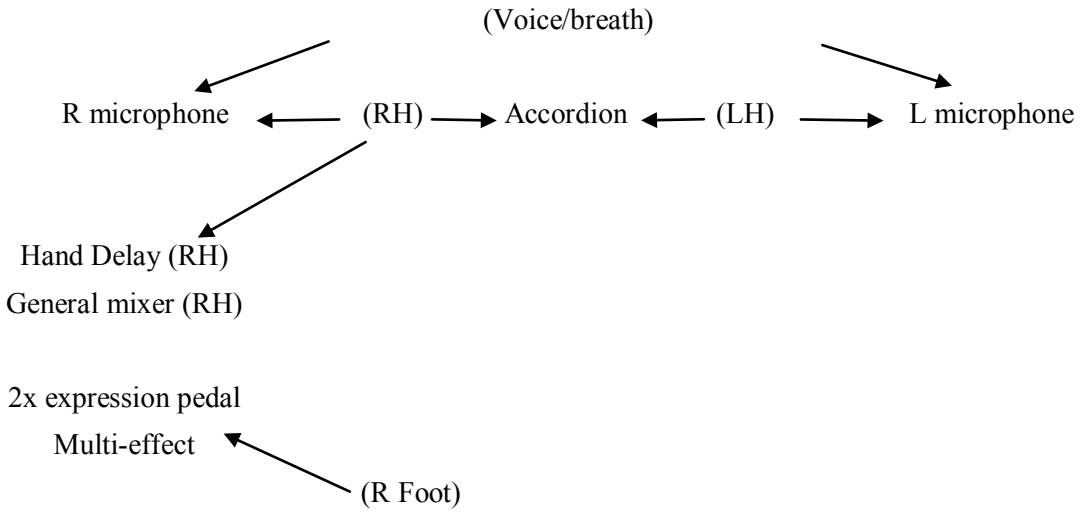
The effects configuration, a complex system borrowed from those of electric guitar pedals, allows processing the sound in various fashions. Applied for the first time to the accordion, this specific combination is rich and even surprising. New interactions emerge. Extended reverberation traces act as forms of air reworked through the reverb/whammy system (see below). The ring modulation results in specific effects (complex, unpredictable high register results). The interaction between microtonal beatings and tremolo effect gives rich results (third sound 'vibrating', last movement). The loops become fluctuating elements stemming from the piece's accumulated memories. The physical disposition of the effects and performer/accordion position (fig.60) are key for the acoustic (transformation/expansion) and physical (microphones friction/breath projection) exploration, creating means to work on the acoustic-amplified/processed continuum, enhancement, liminality and 'imperfection'. The configuration includes two expression pedals (controlling details of selected effects), an electric guitar-type pedalboard (with hundreds of effects, most of them untested on the accordion[212]) as well as a hand-delay/looper and a mixing table – both right-hand controlled.

This setting serves as a basis to modify the amplified sound by processing it (sometimes imperfectly), and as a possibility to generate loops that 'store' material/textures. Controlled by the feet and hands in a fully written

[210] The left-hand thumb also needs to maintain the air-button depressed (this extends as a percussive action throughout the piece).
[211] Chion, *Sound*, p.93.
[212] Luca Piovesan (who commissioned the piece) is the first accordionist to extend the instrument in such a way.

choreography (see below), these tools are also used for improvisation.[213] Manipulation noises (e.g. pedal 'clicks') incorporate in the score as full sonic/gestural parts of the work. Two effects banks are utilised: setup 1 (movement I-II) and setup 2 (movement III) (table 5). Main differences are the ring modulation incorporation (setup 2), effect-position changes and whammy utilisation.

Concert configuration



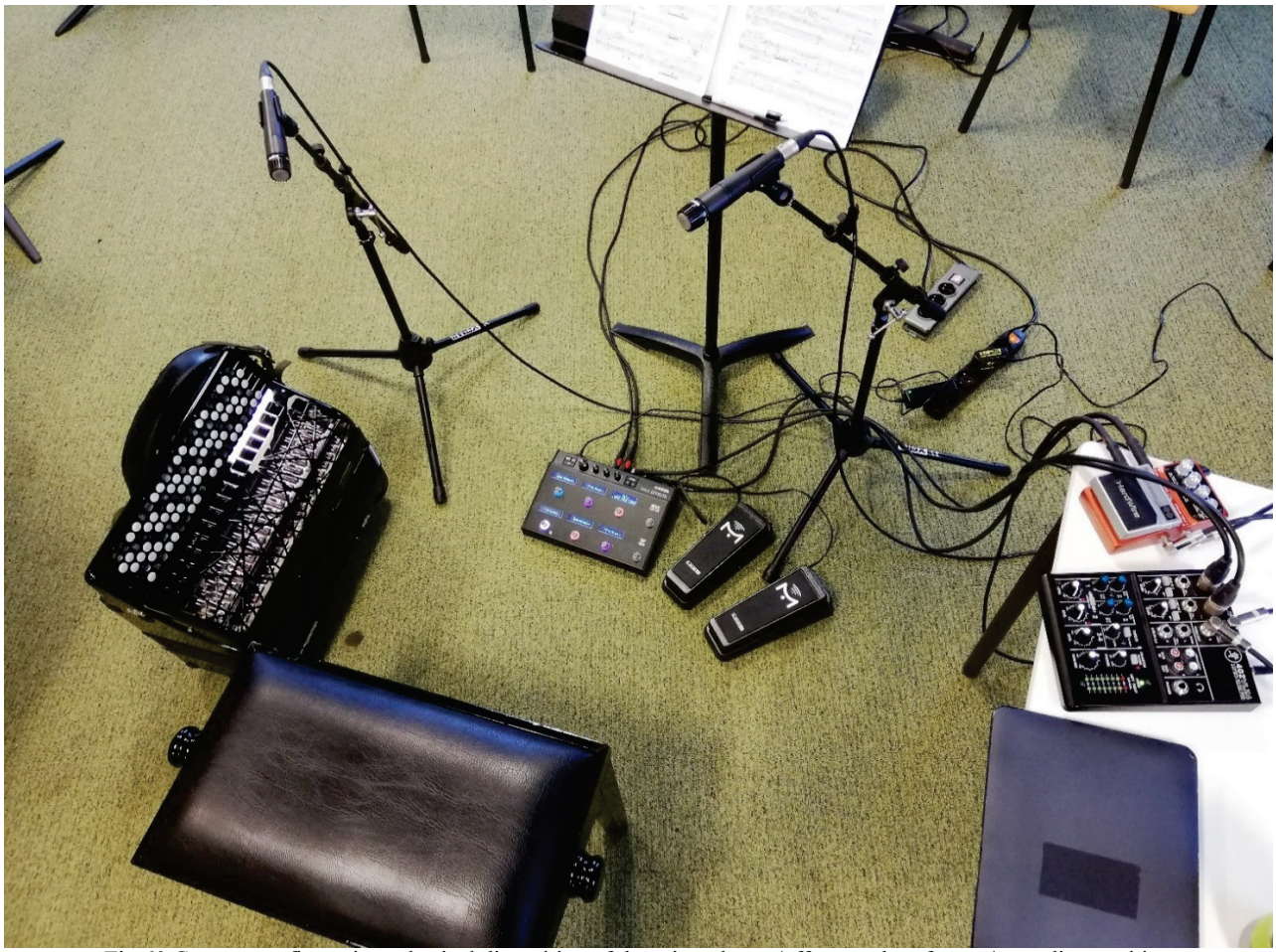


Fig.60 Concert configuration, physical disposition of the microphones/effects and performer/accordion position

[213] Predominantly right foot and right hand (also in combination) and in one specific case by the two feet (double pedal-control end I).

Effect setup 1

Tremolo	Whammy 1 (+ 2 8*va* / - 1 8*va*)	Rev 1
Looper	Rev 2	Whammy 2 (+ aug. 4^{th} / - aug. 4^{th})

Effect setup 2

Ring modulation	Tremolo	Rev 1
Looper	Rev 2	Whammy 1 (+ 2 8*va* / - 1 8*va*)

Table 5: effect setup 1 and 2

The double whammy system reworks sounds and traces. Two whammies have different, complementary functions, utilised independently or in combination. Whammy1 has a wider range (see fig.61) allowing expanding/deepening the colour and 'depth' of the material, acting as a pitch/timbre augmentation. Whammy2 reworks the reverberating traces and, due to its end of the chain position (setup 1), affects the other effects' development, including loops and reverberation trails. The whammies are also utilised in 'stuck' position(s)/setting(s), creating an overarching colour expansion widening or impacting (for a time) the material in a specific timbre direction.

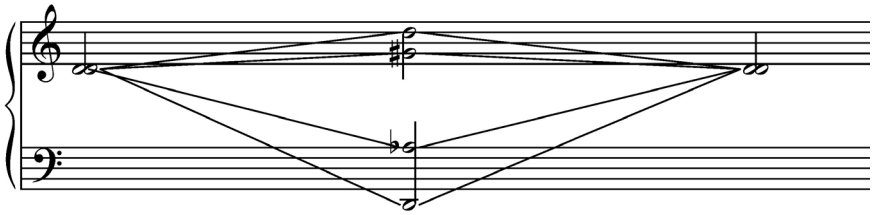


Fig.61 double whammy system

The loop effects extend breath and friction towards white noise, building fruitful paths from air to air 'saturation'. Reworked through whammy and reverberation, loop-effects 'store' materials, re-utilised as traces and texture augmentations. The reverberation is an important part of the loop(s) giving more 'space' and impacting texture/trace quality. The dual whammy system and disposition – 'internal' whammy 1 working directly on the performed/recorded sound, 'external' whammy 2 reworking reverberated/processed sounds – build sound and colour variations, including on the recorded and accumulated white noise elements.

Microphones: from amplification to wind instruments and percussion. Volume control, pedals clicks: a gestural incorporation

Beyond amplification, the microphones develop as full instruments. The inherent, but for Solomos yet to be elucidated 'contradiction' of the microphone (as an 'auditory prosthesis' or a 'new (musical) instrument' which, 'without producing the sound, transforms it and ends up making a different sound'), leads to discussing its incorporation beyond the Shaefferian heritages. Indeed, 'this hesitation, this duality, is at the heart of musique concrète; it even constitutes its main characteristic as both a new way of listening and a new musical (compositional) practice.'[214] The microphone, as its name suggests, has a magnifying power. It can 'confer the

[214] Solomos, *From Music to Sound* p.93.

same importance and, if it pushes the magnification further, the same dimension of strangeness to a whisper, to the heartbeat, to the ticking of a watch.' 'It becomes possible to create arbitrary relationships, to reverse the proportions, to contradict everyday experience.' [215]

Here, the microphones produce sounds as *concrete instruments* in a Lachenmannian understanding,[216] through the 'confrontation' with their own, specific (physical and acoustic) 'matter'. In phases of the piece, the conventional hierarchy – the instrument as a sound source and the microphone as its amplification – is reversed. The accordion becomes an extension of the microphones, extending the sounds obtained by rubbing, tapping, striking, or 'blowing' the microphones' capsule, diaphragm, edges, surfaces and other parts. Vertical, circular, horizontal, slow and fast rubbings/frictions of the microphones, utilised as full instrumental bodies with their specific zones/fingerings, create variations (see movement II). The microphones emerge as complementary bellows. The overarching effects layer enhances the instrument/microphone (con)fusion by working on the application of similar effects (e.g. whammy/reverberation) to the scraped, struck and air-amplifying bellows and microphones building a new, intertwined energy (see *movement II: microphone as instruments)*.

The piece constantly plays on gain changes that the right-hand controls through the mixing table. This direct access allows fully developing contrasting, volume-diverse actions. For example, the loud, widely reverberated sounds (microphone percussion, sys.1) of the introduction extend to parlando 'speaking air' sections developing softer materials (air, tremolo, friction, sys.2). The volume and pedal changes required to develop these contrasting ideas incorporate as full gestures and elements within the instrumental choreography (fig.62). The pedal clicks (created by activating/deactivating effects) and volume changes are approached as parts of the musical action, not only to allow their feasibility (e.g. in a given time or frame), but also to create a 'gestural navigation' between the instrument, sounds and effects, and their audible (or silent yet visible) technical changes. Throughout the piece, pedal clicks (unavoidable as part of the pedalboard control) are incorporated in the musical and gestural flow, dialoguing with the other techniques (fig.62). They also emerge as gentle percussion and reverberation-generating elements expanding the work on air and traces.

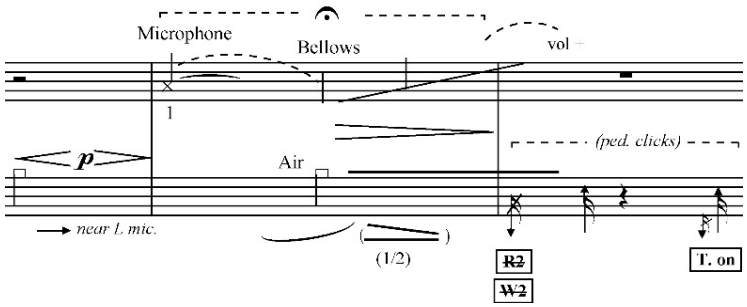


Fig.62 Introduction, choreography: microphone percussion, bellows friction, air, volume change/pedal clicks

[215] Schaeffer, P. (2002) "Notes sur l'expression radiophonique (1946)". In *De la musique concrète à la musique même*, Paris, Mémoire du Livre, p. 82-84.
[216] See chap.1. Lachenmann's *musique concrete instrumentale* is extrapolated from Shaeffer's *musique concrete* theory and reflection.

Voice and breath, body and gestures

The performer's breath is a key material in specific sections (see below). Closely amplified, breath expands through phonetics, utilising respiration (inhalation/exhalation) as a sound and time process. Reverberated, merged with the 'other' breaths and developed towards tempo and dynamic expansions (e.g. the end of movement II), the human breath, in its explicit but also more elusive forms expands and creates traces accumulated. Its agglomeration, along with the other 'air' elements of the piece (instrumental, mechanical, gestural, electronic) makes it a complex, dense material whose corporeality either exacerbates or vanishes through accumulation (e.g. end I). The human breath also acts as a 'signal' and form anchor in specific sections, climaxes or rests (e.g. peaks in II, exhaled/inhaled phonetic glissando in contrast with the softness of sound and fragility of the effect processing in III). These utilisations are complemented by (or incorporated within) other breath-related forms and 'states', e.g. focus on *end of breath* 'residues' of frictional-mechanical 'exhalations' (I), inhalation and exhalation counterpoints building a timbral polyphony evolving from relative clarity (three distinct human/instrumental/electronic forms) to complex white noise entity blurring sonic borders and energies (end II).

Parts of the piece develop the performer's contacts and movements on and with the instrument as processes impacting the sound, and more specifically the *processed* sound. The accordion's playing position involves multiple contacts – the belly, chest, legs, hands, and even the chin are in close contact with the instrument and its various parts – generating a specific situation in performance, which becomes even more central through amplification: the slightest movement (including the breathing action) is (or can be) 'transmitted' to and translated into the accordion mechanisms and sound.[217] Movement III expands this phenomenon by incorporating parameters such as microphone/instrument distance. Movements with the instrument create 'panoramic' effects through evolving left and right (and near/far-away) instrument-microphone positions, impacting amplification and processing. Body contacts change the efficiency of the effects (e.g. trembling), 'revisiting' them as fragile tools building imperfect results developed in liminal situations (e.g. half-processing, extreme distance, altissimo register and very soft dynamics). Through this approach, the effects creating rich, unexpected results beyond their primary function(s) (see *Movement III*)

Form and discussion

The three movements develop various processes, performance situations and technical configurations expanding the chapter investigations (Table 6). The following sections discuss such applications, illustrating the compositional reflection through specific examples.

I - *Traces and processes*	II - *friction and breathing white noise*	III - *body/electronic fragilities*
Speaking air (parlando)	microphones as instruments	processing imperfection
mechanical rustle, grain and wave	air and blown percussion	Body/sound liminality
Traces compression/dilution	dual trace expansion	expanded memories
Texture-traces	white noise/respiration	

Table 6: Tracer le souffle, form

[217] Piovesan, L. (2021) *Accordion4Composers.* Version 1.0 (self-published). Available at: http://www.lucapiovesan.it/wp-content/uploads/2015/09/ACCORDION4COMPOSERS-v1.0.pdf (Accessed 30/03/2022).

Movement I: Traces and processes

Throughout the first ascending arch in movement I (b.1-77), the traces (see table 7) evolve, increasing in complexity. The trace-generating material – initially air and friction – enriches through corporeal breath, accordion (and microphone) percussion and other materials (e.g. low clusters). Traces with different qualities (short/long, dark/bright) emerge, reworked through the pedals (reverberation/delay, whammy variations, loops), and left 'untouched' to their 'natural' expansion.

The traces generation and processing unfold as follows: air/breath sounds and/or other actions (e.g. percussion) create dark, bright, or medium traces reworked through the system (e.g. whammy 'colour' variation of/in reverberation) and other instrumental actions *in* the traces (e.g. *pp* air or friction). Traces, in their various shapes, are put in perspective and ultimately 'competition' with each other but also with their 'triggering' actions. Long, dense and even 'invading' traces and shorter resonances dialogue with friction, percussion and air, utilising various 'levels' of granulation. Granulation is a key element of (and in) the traces and acts as a complementary 'fragmentation' of the sound, through the physical and mechanical 'roughness' of air and friction. The first trace (introduction) exemplifies this: the microphone percussion creates a widely reverberated element (rev1/rev2) whose colour is reworked through the whammy's position evolution (half-pedal, foot), expanded 'from the inside' by pneumatic air and frictions on/with the bellows (left and right hand) (see Table 7 triple exemplification).

The traces are of a triple nature:

- *Electronic traces* build through the double reverberation system (rev1, rev2), whose brightness or darkness is reworked by the whammy system (whammy2). The hand-delay (right-hand controlled) creates short-medium traces. Two loopers (right-hand and foot) create recorded, accumulated traces.
- *Gestural traces* range from striated to continuous rubbing and friction creating dark, medium or bright granulations and air-like sounds within the traces. They are executed horizontally and vertically over the (elastic) surface of the bellows (and to a lesser extent of the keyboards), which have different (and evolving) 'roughness'qualities according to their zones and opening.
- *Air traces*: air also develops as a trace (including its own trace), a complementary element combined with rubbing/friction and electronic traces.

Electronic traces	*Gestural traces*	*Air traces*
Double-reverberation (medium-long)	Rubbing and friction	Air as a trace
Hand-delay (short-medium)	(elastic) bellows surface	
Whammy 2 (colour-timbre)	Horizontally/vertically	
Two loopers (accumulation)	Roughness qualities	

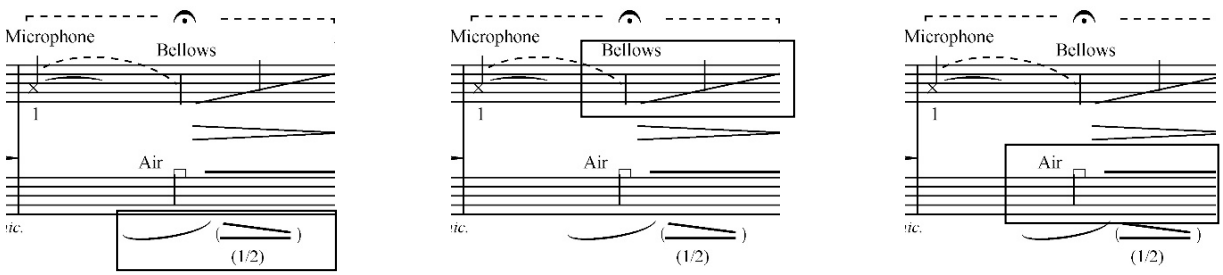


Table7 Typology of traces (with example)

Loop traces: texture expansion, first accumulation, physical-instrumental limits

This section discusses the first trace accumulation through the loop-effect (b.29, repeated). The accumulation extends to the physical limits of the accordion, building near-silent, 'breathless' expansions (b.30 fermata) (fig.63). Utilised for the first time, the loop effect is here primarily a texture expansion accumulating breathing movements. Bellows frictions and pneumatic inhalations/exhalations accumulate as a dense material creating the first 'memorised' texture. While initially subtly expanding the (perceived) complexity of the (performed) actions, the loop overdubbing creates a sound density increase and crescendo. This accumulated breath is stored in the system as a trace designed to grow towards white noise as the piece develops.

The recorded material acts as an expansion of the granulated sound of respiration – an air and friction mixture developing characteristic arsis-thesis respiration movements – superimposing changing reiterations. The loop firstly merges with the performed material, barely distinguishable from it. Gradual overdubbing increases texture complexity, building 'imperfect' superposition as the performer accelerates/contracts the movement. Grown through several overdubbing, enriched through reverberation (rev2, expanding/confusing the performed-accumulated materials furthermore), the resulting loop accumulated is played (4th repetition) as the performer continues acceleration and sound modification (whammy2, whose subtle colour variations impact the overall performed, recorded and reverberated material, see whammy system).

The loop sudden interruption (b.30) brings back the first unexpanded breathing movement,[218] slowed down and 'stretched' to reach the accordion's sonic and physical limits. Starting from end b.30, the sound emerges from the physical limits of the bellows, which cannot open or stretch further here. The maximum bellows-opening (and consequent performer and instrument disposition) 'freezes' the action in a *near-silent* fermata. More than 1.2 metres separate the two ends of the accordion. The player and instrument remain, for a time, almost 'frozen' in this uncommon position. Stretched up to its limits and even forced to open further, the instrument can no longer 'play': it can only crack. [219] The accordion's bellows resist. Their resulting cracks (*full opening bellows residues*) mix with the equally sporadic crackling obtained through the right hand's slow bellows scraping (*slow grain residues*) creating a breathless combination of air and friction (pneumatic and gestural) 'residues'.

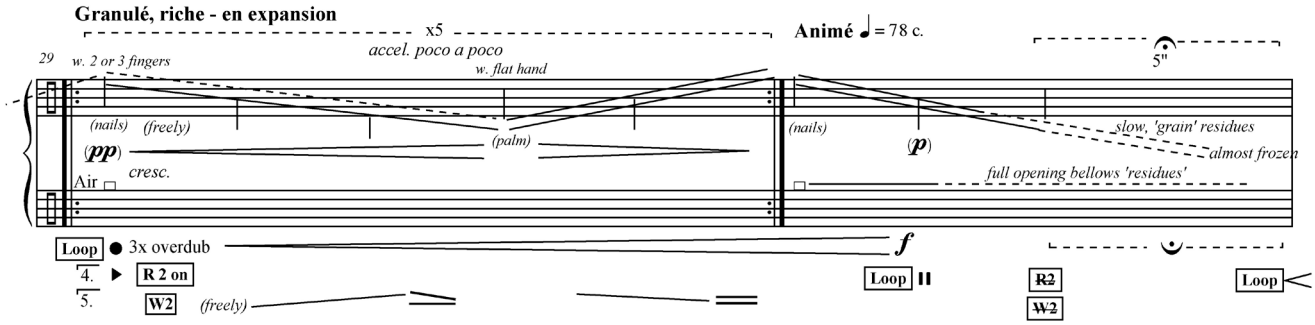


Fig.63 Breathing air/friction, loop accumulation/reworking. Loop interruption, bellows cracking-fermata

[218] The rev2 and whammy2 effects are equally cut.

[219] Cracking of the stretched bellows varies according to humidity and weather conditions (no undesirable impact on the instrument).

Elasticity and friction: a 'cadenza'

These sonic/physical extremities serve as bases for the next section. Starting from the 'crackling fermata', the accordion's body is fully extended and friction surface maximised. Utilizing this stretched instrumental body, the performer gradually develops a spinning 'cadenza' – a 'spiral' of friction on and over the whole instrument's surface,[220] 'kneading' the bellows as if rediscovering them under a new configuration.

The instrument seems to resist at first. The extreme opening and consequent bellows striation prevent any continuity within the friction gesture/sound, as when attempting to rub a surface regularly spaced by a vacuum: the accordion becomes an 'oversized' guiro. The saving action – slow bellows closing by the left hand (hitherto frozen) – offers some relief through gradual compression of the spaces of (and for) friction and evolution of their 'playability' and striation (fig.64). The instrument's body compresses silently at first through the left-hand action, gradually adding air to the 'spinning' friction. The mixture of this growing air 'energy' and that of the gradually less discontinuous/striated friction sounds and spaces builds a crescendo and accelerando, fruits of the mutually impacting spinning/closing actions. Other elements (trembling 'knee' tremolos, bellows tapping) emerge, developing until a peak (fig.65) – the outcome of the friction/compression/acceleration process relentlessly pursued until full compression (the end is improvised, maximizing energy). The noises and sounds of this newly reduced,[221] 'non-fractionable and 'non-frictionable' instrumental body briefly extend to 'trembling-knee' tremolos (b.37, fig.65), a transition to the next section.

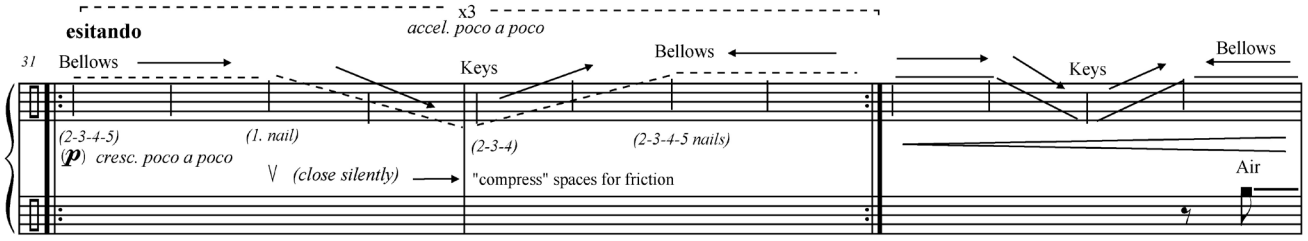


Fig.64 Friction 'spiral' on stretched accordion, silent compression

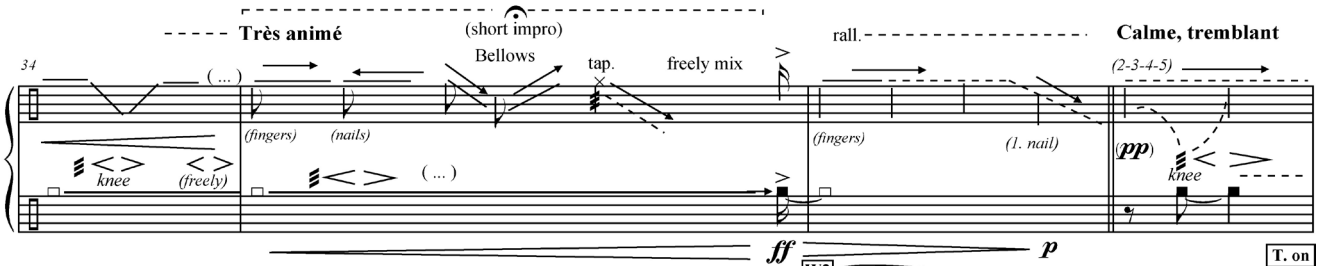


Fig.65 compression/acceleration, 'peak' expansion. Knee 'trembling' transition

Air traces: expansion, saturation, climax (b.46-77)

The omnipresence of traces 'saturates' the sonic space until the movement's climax (b.73-77). Traces are created and reworked by three effects (delay, reverberations, loop), incorporated gradually in a four-step intensification process (see below). The traces time/texture (length, brightness-darkness) are modified via the expression pedals. Reverberations and delay, as expansions 'returning' the sound and re-sounding the actions, are put in perspective with their sonic and gestural triggers. Air, percussion, friction and grain create traces, but also act as elements within the traces and *as* traces.

[220] See also circulation of/between sound/gesture/zones in *Circle(s)* (1.1). The accordion condensates the explorations of chap.1 and 2.
[221] During the phase and section, the accordion's body evolves from 1.20 meters to 40 centimetres.

The effects incorporation *order* achieves a gradual expansion. The hand-delay creates short/medium traces developed through the 'time' button/parameter (step 1, fig.66),[222] whereas reverberations extend traces (steps 2 and 3). The dual reverberation (rev1/rev2) allows gradual modification. The first setting (rev1) is relatively 'natural' with a short pre-delay and long fade time, expanding traces length (step 2), whereas the second (rev2) is 'deeper' with a larger pre-delay but shorter fade time, enhancing overall sound impact and 'space' (step 3). This trace-expanding combination (hand-delay/dual reverb) is reshaped through whammy2, reworking overall brightness/darkness of the traces – whether generated through air, breath, friction, noise or percussion (fig.67 sys.2). The loop effect (step 4) extends traces beyond reverberation, 'absorbing' materials (air, grain, reverberation) 'augmenting' the previous version (see above) towards white noise. The expression pedal controls the loop's volume, making it a versatile tool fading in the material, expanding/reworking reverberations traces in a seamless fashion (fig.67). The loop position in the effect-chain also makes it modifiable through rev2/whammy2 (see above) changing its reverberation and colour (see pedal 'solo', ending the movement).

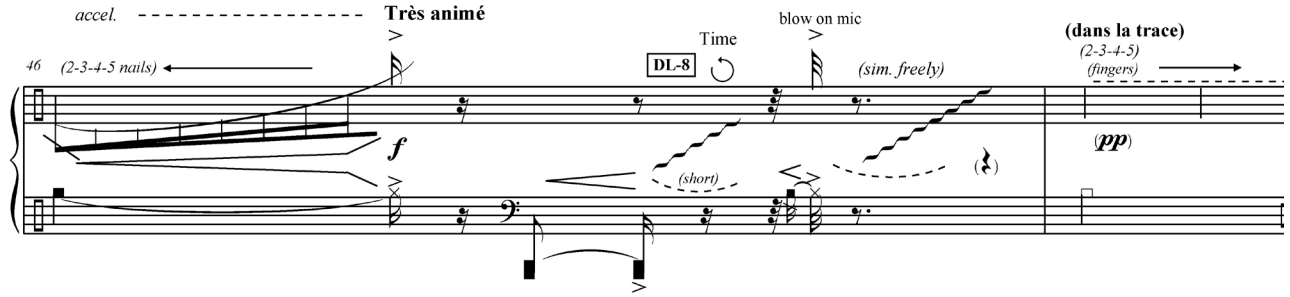


Fig.66 Trace-intensification process (step 1-2) hand-delay/rev1

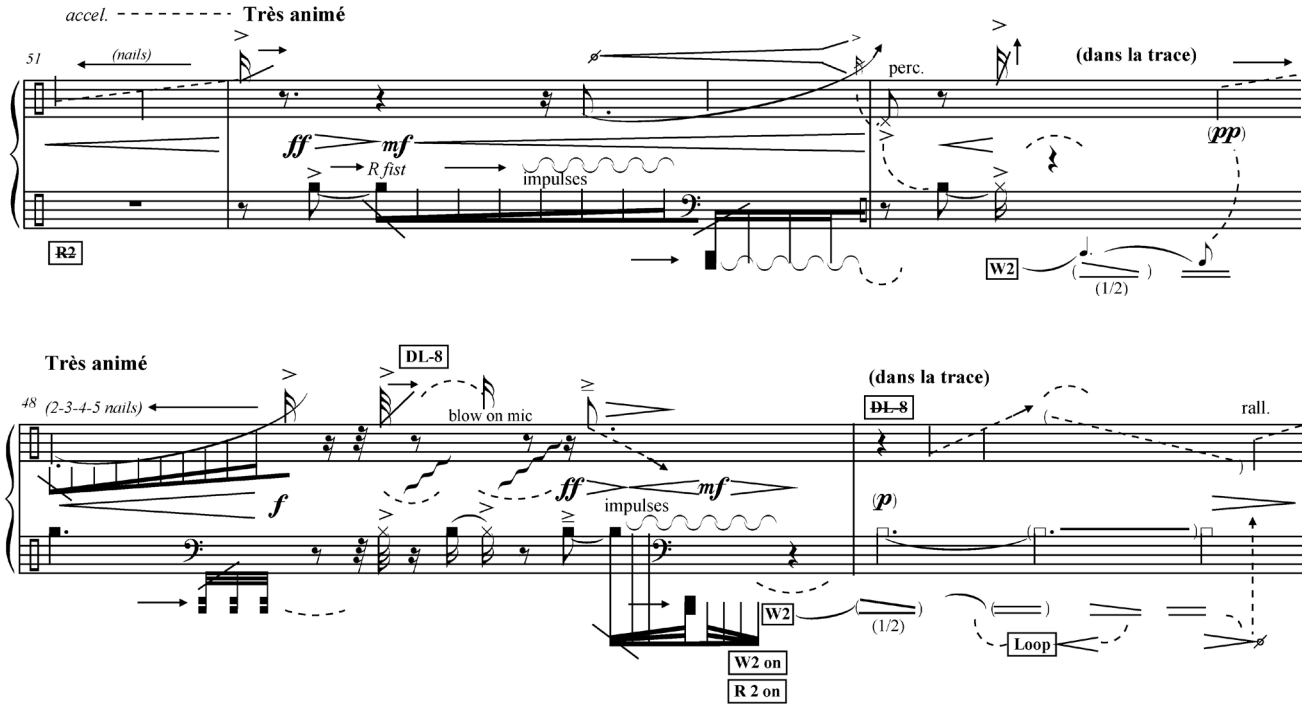


Fig.67 Trace-intensification process (step 2-3-4) hand-delay/rev1/rev2/loop (+whammy2)

[222] Fast increases and decreases of the 'time' setting (right-hand) creating short/medium echoes.

The *parlando* idea interrupts the traces-intensification process. However, here, the breath does not 'speak' but transforms into a deeper growl at the border of breathlessness. Densely reverberated *stammering* utilising low-register clusters – lowered here even more through whammy2 – generates deep traces exploiting the lowest reverberation 'zones', that extend through the loop-effect's white noise emergences (see fig.68).

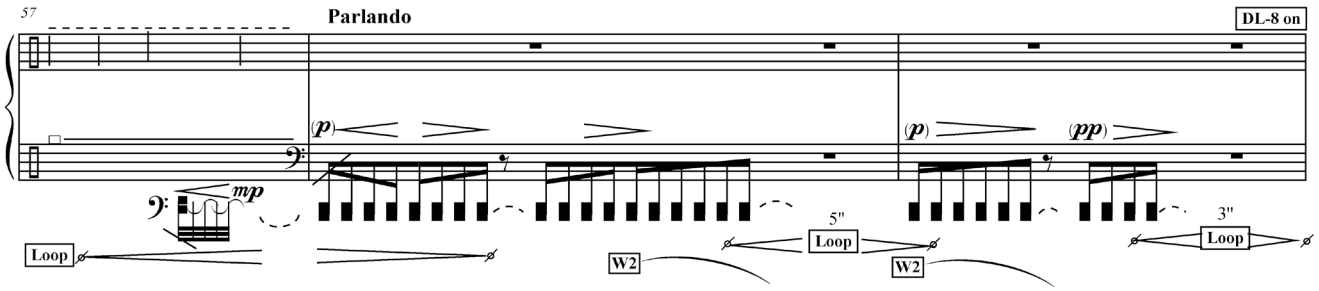


Fig.68 low clusters 'growl' parlando, dark traces and loop-traces dialogue and 'interventions'

Creating various reverberations (e.g. bellows friction with fingertips/nails generating bright traces b.54-55), the trace-generating materials densely combine, ultimately barely interrupted by *dans la trace* resonances in which their reverberations are briefly reworked (or left to natural expansion), until omnipresence and saturation. These shorter traces merge in constant dialogue with their generating actions. The variety, overall acceleration/compression of the material (whistling rubbings, growled clusters, blown microphones, struck bellows, see fig.66-67) creates animation/stasis phases alternating triggering actions, traces and work on the traces 'inner-life'. Increasingly complex, accumulated traces invade and ultimately saturate the musical space.

A brief suspended section interrupts again the process (b.68, fig.69), exploring this time the dialogue between the accumulated white noise traces (loop) and the altissimo register (here an unstable, effect-reworked element) – a reversed echo to the previous 'raucous' interruption.

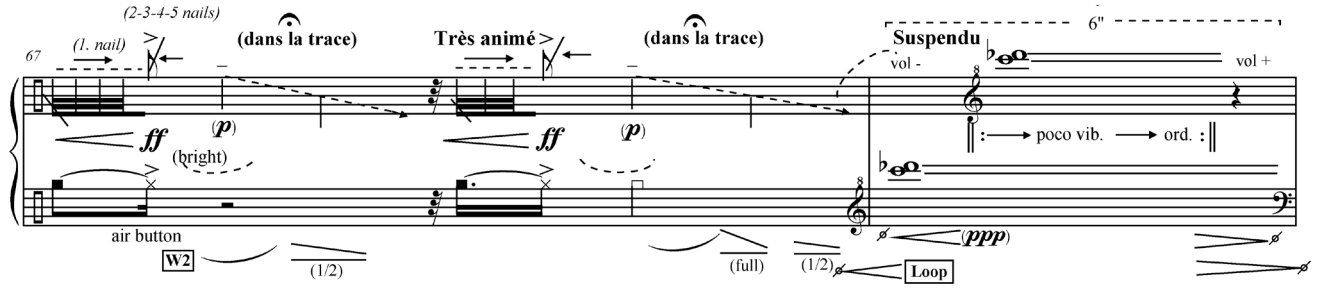


Fig.69 Trace-generating actions/trace combination, high register suspension

The traces peak (fig.70) builds complex resonances and reverberations saturating the sonic space. The expanded resonances reappear as foreground elements in which 'non-trace' actions evolve as backgrounds elements. The fusion (and confusion) between air and reverberation expands through the whammy-pedal gradual action acting on the air and reverberating trail colours, creating wind-like variations on accumulated reverberations (b.74). The trails combine with the instrument's air and friction 'grain', here evolving *inside* reverberation.

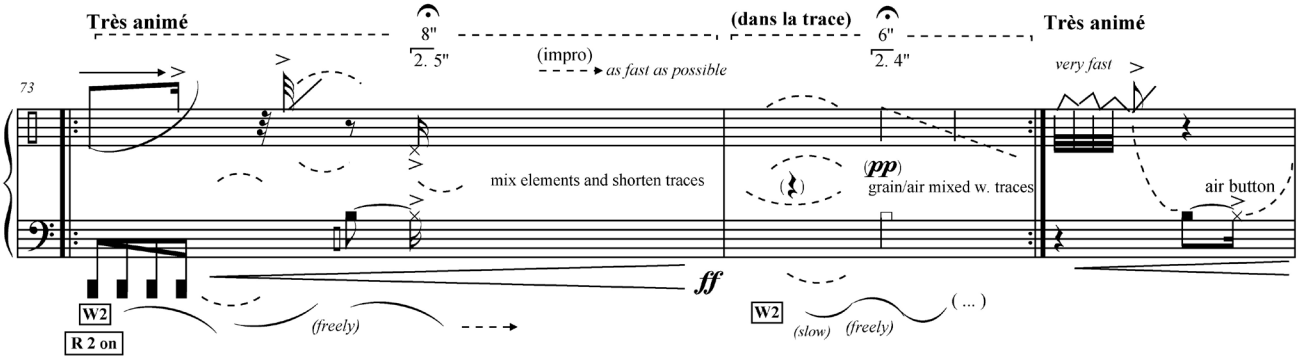


Fig.70 Mixed traces/peak expansion, wind-like textures, trails of reverberations, air-friction 'grain' in reverberation

The dynamic expansion is at this stage 'only' possible in one sonic and physical direction: the direct striking of the microphone. A spectacular, sonorous action (introduced *mf* in the introduction), the microphone percussion signals the end of the first ascending phase and the start of the second decaying phase of the movement (b.77-end) (fig.71). As the long resulting reverberation trace disappears, again, into air, friction and (here) corporeal breath, it creates a 'whole', an evanescent, human and reverberating element (fig.72). The corporeal sounds of breathing and their traces (here a soft exhalation blown directly on the microphone in dialogue with the instrument's air) are reworked, enriched, put in perspective with the loop and briefly interrupted by elusive waves of air, grain and low clusters, until, once again, the trembling sound/action of the knee and body – here already 'out of breath' – and the work on the movement's final texture and trace 'memory' (fig.73).

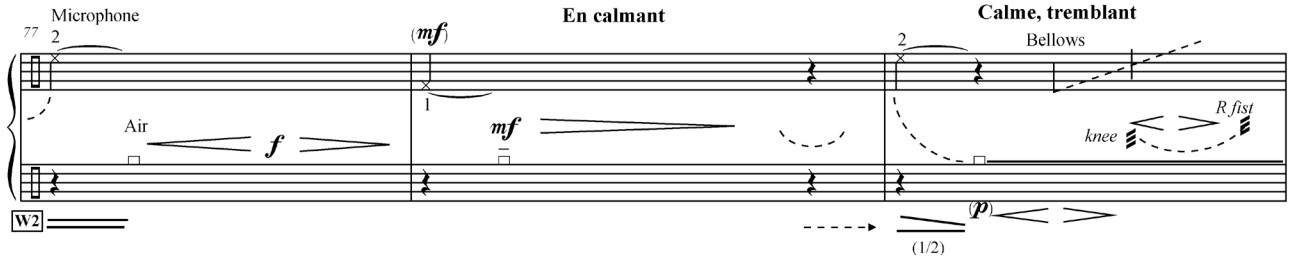


Fig.71 Microphone striking/peak, vanishing trace in air-friction

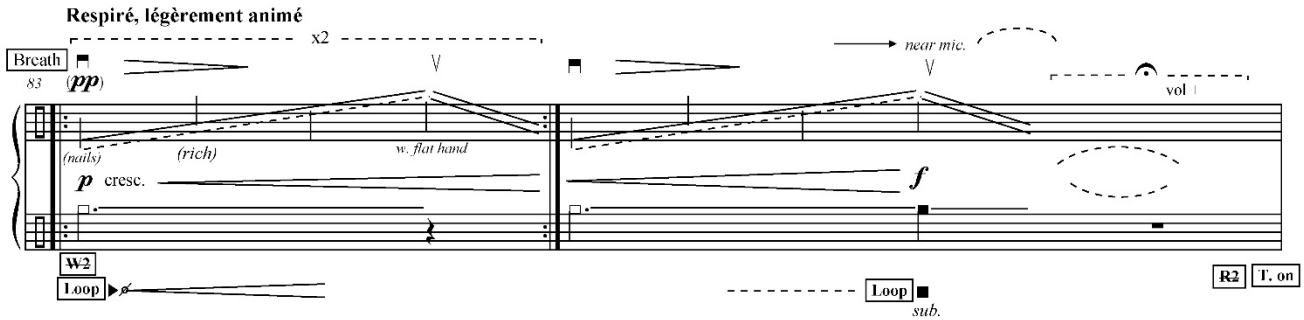


Fig.72 Corporeal breath, loop utilization after peak

Enriching the previously recorded/modified version, the loop is finally slowly reworked, storing again material as a growing yet contained energy in dialogue with the pneumatic one of the accordion – until white noise. Grown and developed, the sound finally disappears in an evanescent, gradually brighter air and white noise trace. Here, two expression pedals control the brightness and volume of the trace using the two feet (loop volume decrease/whammy brightness increase) – a 'pedal solo' ending the movement (fig.73).

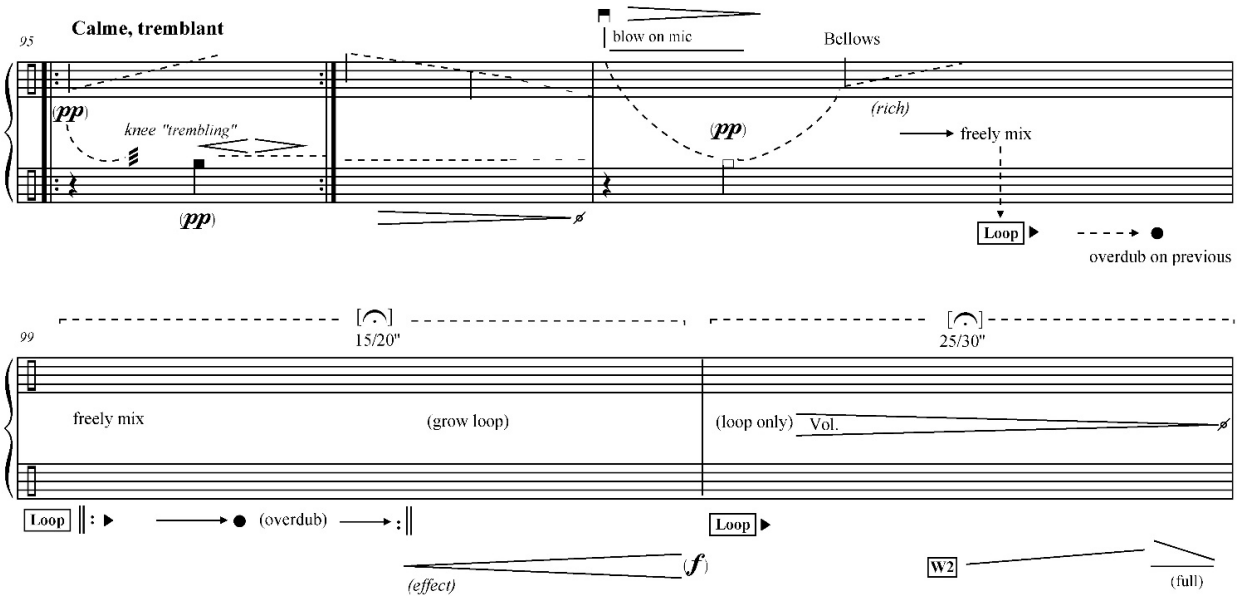


Fig.73 breath, final '2-feet' loop

Movement II: microphone as instruments, accordion as a microphone extension

The second movement extends the microphones' function beyond their mere use as 'prosthesis' (see subchapter introduction). Reworked through the double whammy system, microphones become 'synthesizers' of the percussive, friction or blown gestures and actions, becoming full 'wind' and percussion instruments. Taping, breath and percussion initially create short-medium traces through rev1. Initially barely used (until b.115), the accordion then arises as a microphone extension. Keyboard and button parts are struck, scraped and 'frictioned' in the very continuity of the microphones percussion, acting as their sonic and gestural extension. At this stage, the bellows are immobile, blocked; no sound comes out of the accordion's reed: it is purely a percussive implement.

The accordion gradually becomes a noise-based, inharmonic percussion. By slightly bending the instrument, the performer triggers the slow bellows opening, opening 'by themselves' and activating the pneumatic mechanism. Struck keys create clusters of notes in dialogue with (and response to) the microphones' percussion (fig.74). The dialogue is enriched and controlled by the overarching layer-action of the 'effects-colour' and 'effect-traces': single and double whammy system, single and double reverberation. The accordion's percussed keyboard and the struck microphones 'mimic' and respond to each other, reproducing their respective effects and actions. Pulsated clusters and percussive 'waves' echo each other through this double mode of sound production reworked through the overall 'synthesis' the double whammy/reverberation system creates.

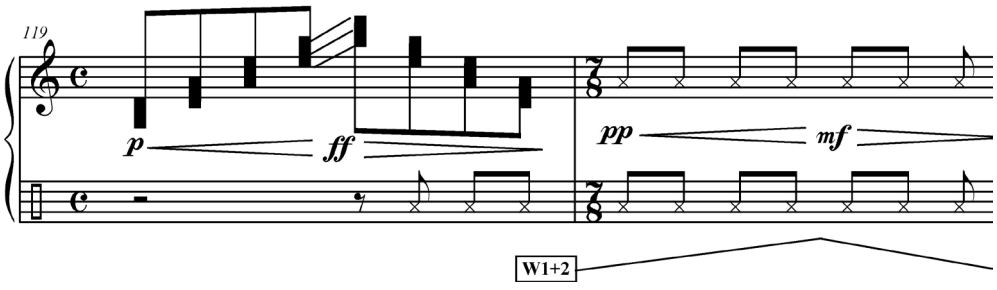


Fig.74 Pulsated clusters and percussive 'waves' echo

Raucous blowing: extending traces

The force of air creates the sequence's climax.[223] The performer's breath, literally projected on the right microphone, combines with the left-hand's low *ff* cluster directed towards the left microphone (see fig.75). Initially brief, emerging from the accordion-microphone-whammy percussive continuum, this double 'raucous blowing' repeats, extends and freezes in on itself. As this stereophonic 'groan' evolves, its wide, complex traces are reworked by the performer, stretched, compressed, modified. A brief 'burst' of struck microphones and accordion clusters reappears (b.132), inevitably bringing back the double blown groan and its extended trail. Traces are, here again, expanded towards a reverberating 'saturation' beyond percussion. The ultimate *ff* 'blowing attack' on the right microphone acts as the dynamic and reverberation peak (b.137-138) overriding the other gestures and actions: low clusters, microphone percussion.

The 'growling' cluster emerges again, 'frozen' for a time. The left-hand impulses 'chop' the low cluster – lowered and further 'growling' through the whammy position (- *8va*). This 'growled' sound (fig.76, developed in softer dynamics and 'parlando' fashions in movement I) evolves towards a new type of trace: the microphones as 'breathing' instruments whose frictions dialogue with the performer's phonetically modified breath.

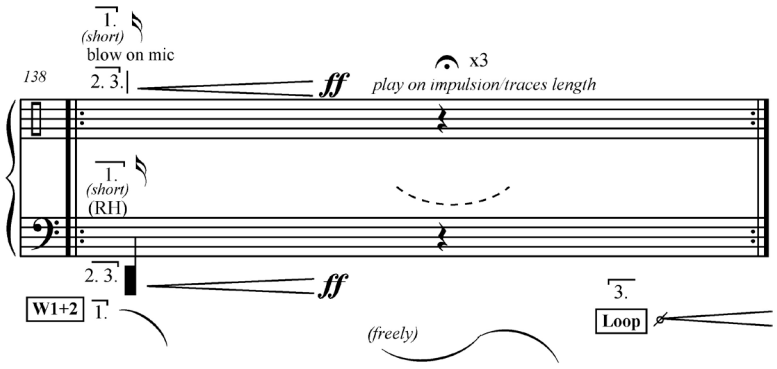


Fig.75 Raucous blowing, extended traces

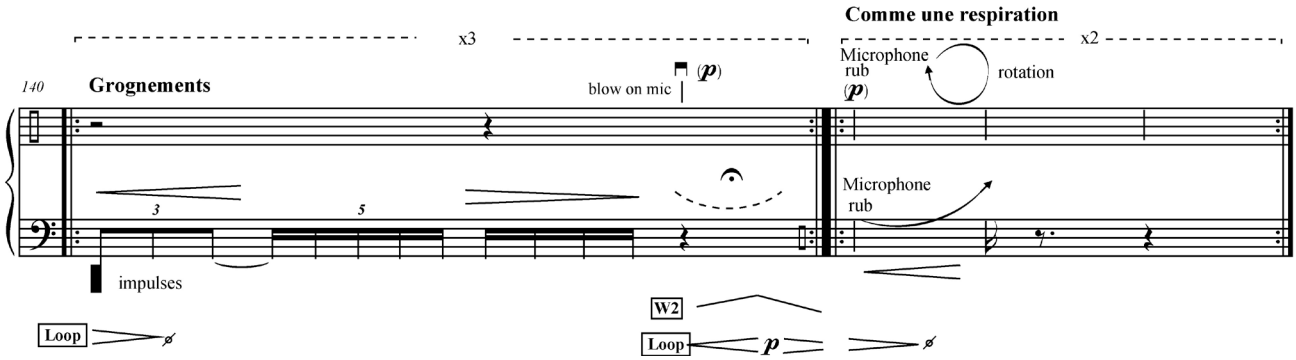


Fig.76 'growling' cluster, rubbing on the microphones' diaphragms

Human, instrumental breath and microphone friction

The combination of the thumb circular action and rubbing on the microphones' diaphragms (upward/downward, in slight acceleration/deceleration) recreate deep sounds of breathing – a granulated 'white noise' expanding towards the *arsis* and *thesis* of human breath through the gestural action (fig.76-77). Recorded and overdubbed

[223] Partly improvised to foster an energy that the writing might not, in this context, be able to achieve.

(hand-delay's loop, fig.77), this dense granulated breathing paves the way to the next section, a parallel expansion of the human-instrumental-electronic forms of respiration.

Almost in contact with the microphone, the performer's breath creates four systematically alternated, phonetically modified 'colours' (medium inhalation, dark exhalation, bright inhalation, dark exhalation) over-amplified by the effects and reshaped by electronic/instrumental echoes. The two previously stored loops (hand/foot controlled) enrich the corporeal breathing, emerging as two distinct white noise textures, fruits of accumulated microphone rubbings (hand-delay loop, see above) and expanded friction and air traces (foot pedal loop). As the accordion's mechanical air and bellows friction emerge in this triple white noise and breath interaction, they create further air colours and 'counterpoints' (see fig.78). A multiple breathing develops, combining all the 'air' forms of the setup: pneumatic, frictional, corporeal and electronic. This hybrid breathing expands in echoes, building a saturated breathing white noise (b.150-152). As this increasingly troubled breathing object grows and advances (tempo gradually increases), it transforms. The boundaries of the combined, actual and 'mimicked' forms of air and breath are blurred and open to infinite, moving-static forms.

The performer re-modifies and enriches the already complex breathing counterpoint, 'feeding it' with additional sound materials: scraping, tremolo cracklings. It is finally this last element that will become the subject and object for and of the next (and final) development in movement III, in which the crackling noise becomes again the one of a 'dual' physical and sonic tremor: that of the musician's body (impacting that of the instrument) and that of a rich, previously unused effect applied to the high register and air of the accordion: the ring modulation.

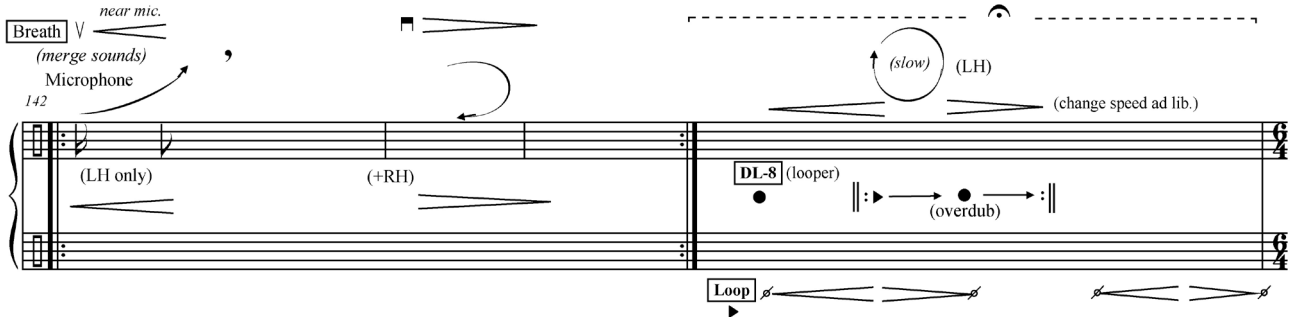


Fig.77 Microphone friction recorded and overdubbed

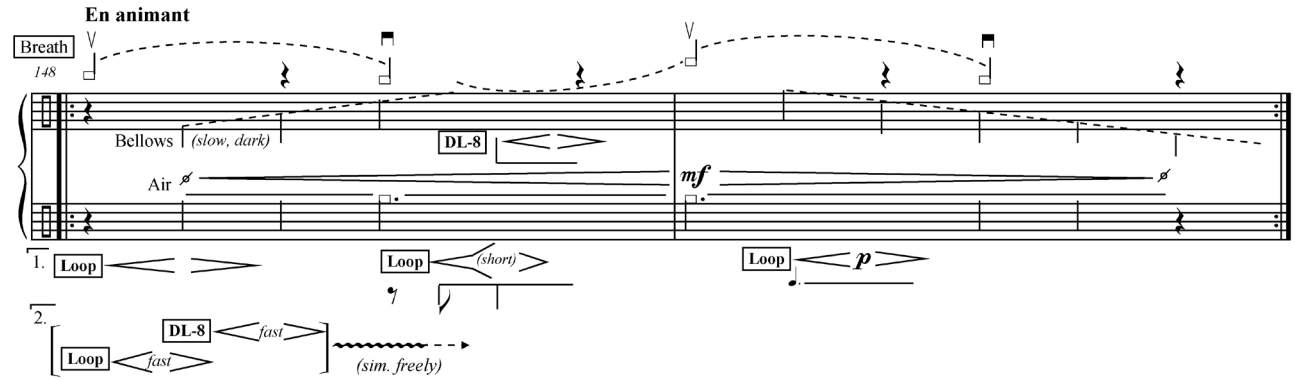


Fig.78 Hybrid breathing/saturated white noise

Movement III: trembling body, cracklings and beatings: body/electronic fragilities in combination

If the ring modulation and whammy effects produce the 'expected' results over most of the accordion register(s), these effects may not work *as expected* in specific cases, such as the extreme high register (see fig.79-81). The electric guitar-intended pedalboard setup does not include the instability of this tessitura, let alone its extended use in the softest dynamics.[224] The intrinsically changing distance and directionality between the left and right hands (bellows opening/closing movements) and keyboards (with two distinct frontal and lateral sound directionalities), and the distance with the microphones are among parameters impacting the effects' efficiency.[225] Results include changing, unpredictable sound 'cracklings' of varying intensity.

The slightest vibration of the sound/instrument (such as a simple vibrato) partially or temporarily 'cancels' this complex crackling sound state. The slow evolutions (or rapid changes) from one in-motion to motionless 'state' by virtually any action or movement (or lack thereof) of the body (e.g. breathing, minimal gesture or slight trembling – an aspect and 'state' introduced in movement I) create here a double gesture and sound exploration. The white noise from the previous movement's loops acts here as a 'counterweight' and 'counterpoint-trace' to these trembling actions and effects (traces of the reverberating crackling sounds-gestures), merging with them or interfering with their traces.

Though visually minimal, the performance unfolds intensely on the visual level since the slightest action of the performer's body affects the sound effects. The performer, holding selected notes in the highest register, triggers the ring modulation effect and 'stops' (or influences) it by a gesture or body action (trembling vibrato or tremolo, breathing in and out, left/right 'dancing' stereo movements near/far from the microphones, see fig.81). The instrumental surface in contact with the performer is, in the case of the accordion, at its paroxysm: legs, belly, torso, arms, hands and even chin are in contact with the instrument. It is here a pretext for a 'minimal' choreography and a means for a gestural and sonic 'trembling' expansion of the various techniques and actions, each of which has an impact on electronic/processed sound modification.

The dynamics (e.g. *dal niente* to *ppp* or *pp*) change the actual impact of effect processing. For example, the effect doesn't 'react' immediately to the accordion's sound (if too *pp*) and can come out either partially or gradually. It can even be 'stuck' at an 'intermediate 'half-working' state, giving complex, unpredictable results (e.g. emerging whammy half-processing and fragile changes b.172, see fig.81 and recording)

A second 'imperfect' effect (and associated unexpected result) is obtained by combining the accordion's microtonal beatings[226] and the tremolo effect (fig.80). Applied to double tones and frequency differential (here two pitches in the middle register of the instrument creating evolving beats), the tremolo sampling/repetition at various speeds/degrees of velocity generates a third 'part', a natural result of the tremolo/beats combination. A fluctuating beat in a differentiated register emerges which the performer *can control* through slight pressure action/variation on the microtonal glissando at the origin of the beats. In the continuity of the modulated body

[224] It is the first time this setup is applied to the accordion, and this novel application is rich and, in some cases, surprising.
[225] The Left Hand (and keyboard) is less bright than the Right Hand, which is brighter and has a more immediate impact on effects (due to sound directionality/projection towards the microphone – the left keyboard projection is more central).
[226] Obtained by sliding a note while holding another, creating microtonal interferences between the left and right keyboards' sound.

'tremors' and gesture tremblings, this sound effect and result presents in an unexpected way the (so far unused) medium register of the instrument.[227]

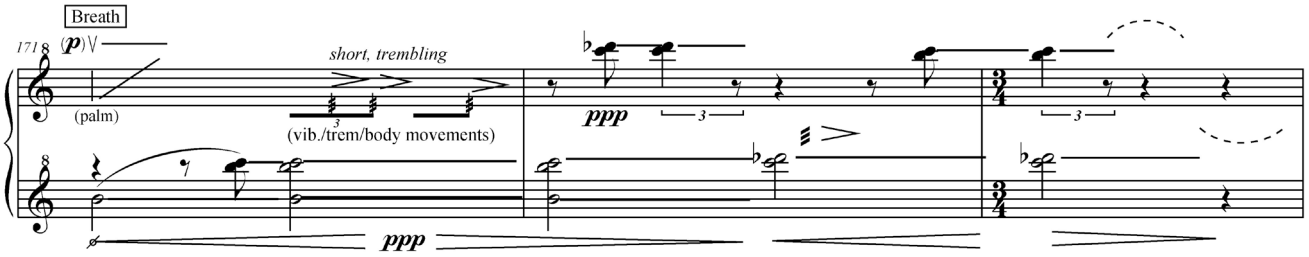


Fig.79 Imperfect processing: action of the performer's body affecting sound effects (ring modulation)

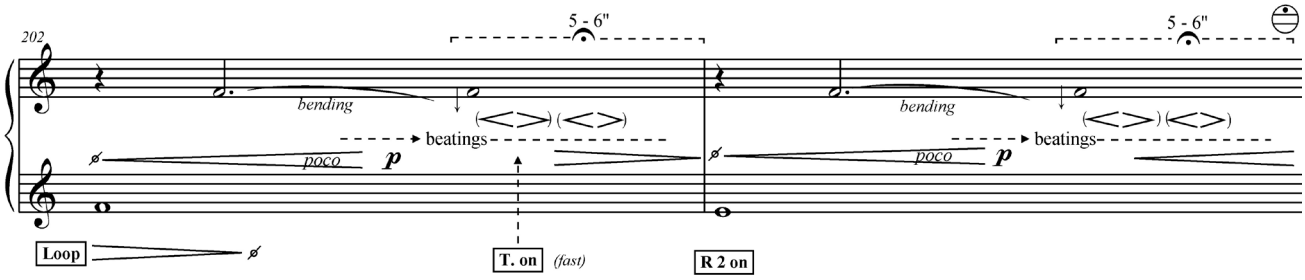


Fig. 80 Imperfect processing: tremolo/microtonality/beatings

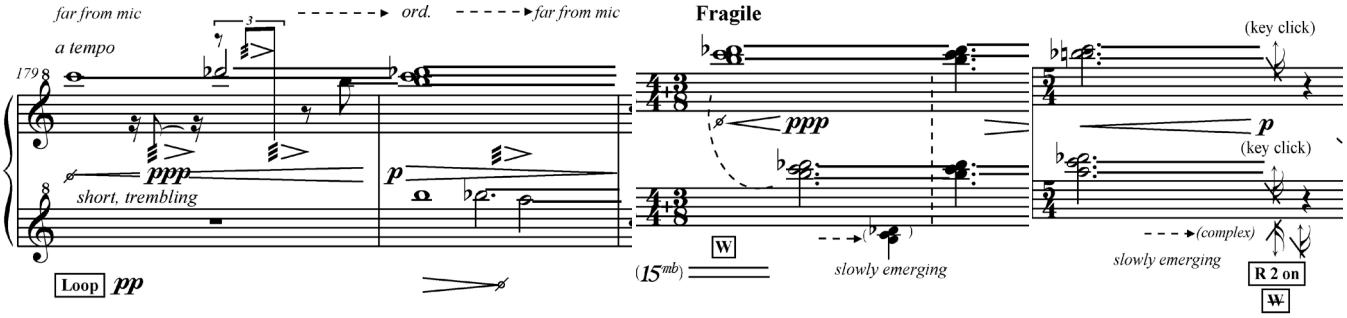


Fig. 81 Imperfect processing: microphone distance; whammy half-processing; manipulation sounds

Silent cadenza and perforated white noise

The various traces left by these different hissing, trembling, crackling and 'beating' elements are for a time objects of development in a specific, suspended temporality, between high-pitch, instrument cracklings and traces of sound in which pedals clicks and manipulations create further noise-based reverberations (fig.81) . It is finally the confrontation of the crackling sounds with air and granulation that brings us back to the reworking of the (already densely expanded) loop (b.211-213), whose static sound/white noise is 'perforated' and vanishes. As the overall loop volume slowly reduces, the visual, trembling action takes over. The near-silent actions, always visually sporadic, complete this journey towards a final silent extension. The loop, still perforated through the microphones' granulation, fades away as the performer gradually freezes and slowly cuts off the loop – the sound of his accumulated actions and sounds, memorised by the system.

[227] Or used only in an unidentifiable form: double octave whammy (e.g. b.183), percussive playing and short clusters in the preceding movements (e.g. b.115).

III 'Multiplier le souffle' – energy, flux and multiplicity in large forces

The overarching aim of the chapter is to explore air (souffle) as a complex force, movement and energy, and question its perception in large forces applications. The chapter explores how possible solutions to overcome the acoustic weaknesses of air (souffle) may arise from the development of an orchestration system using the previous developments of the research (air-friction-resonance continuum/extension), and how working on perception may allow to reinforce and transform this implementation. Using examples in existing works, the introduction puts in perspective two contrasting aspects: the sonic weakness and possible lack of timbre diversity of air (as a sound material), as opposed to its associated multiplicity and energy in arts, philosophy and religion.

The compositions investigate paths through which large forces applications may go beyond an essentially contrapuntal approach and towards a more 'vertical' or harmonic perspective, and how reinforcements may be put in place through composition and orchestration. The subchapters discuss applications in three different instrumentations. *Hólo(s)* for ensemble (3.1) builds the orchestration system, exploring its development in several directions (spatialization, texture and 'mass' expansion). *Concerto pour piano et ensemble* (3.2) applies it to a specific concerto form, exploring the solo-ensemble (and air-timbre) porosities as part of traditional and 'extended' forms of virtuosity. *Sha'aph* for orchestra (3.3) extends the system towards radical applications in which orchestral density allows expanded texture possibilities.

The new perspectives arising from the investigation of multiplicity and perception as part of the extended air-friction-resonance continuum are a key step towards the (further) (re)definition of the souffle paradigm: not only a complex category of timbre-sound and transversal tool encompassing several gestures and modes of sound production with a specific temporality, but also as a physical and acoustic force and complex energy. The compositions attempt to communicate and illustrate the possible developments of these principles in three different contexts, building a system applied and extended through (and towards) other parameters (spatialization, porosity/virtuosity, extreme utilisation) to create a second 'extended' version incorporating radical forms and energies, flux and 'residues'.

Acoustic weaknesses vs. Energy

Air is a force. Both figuratively and literally, air can convey and project the whole gamut of energies (from breeze to tempest, hurricane and blast). The assimilation of breath with energy is present in most religions, cultures and philosophies, from Chinese 'Qi'[228] to Sufism[229] and Hindu Prâna to Stoicism.[230] Bachelard notes that physical manifestations of air are often associated in arts and poetry with feelings and emotions, including energy and anger.[231] Air is characterized by its *plasticity* and moves through space with *directionality*. As seen in 2.3, it can be *accumulated* (e.g. as in the accordion bellows) and *triggered* (e.g. pneumatic energy). To some extent, the human breath can be controlled, modified, held – until apnoea. Loss of control leads to instability

[228] 'Qi' translates as 'air', 'material energy', 'life force', or 'energy flow'.
[229] In the 'Dhikr' ritual ceremony, repeated breathing is designed to induce hyperventilation and trance.
[230] In Stoicism, 'the "pneumatic" [pneuma] breath becomes subtle energy, under three aspects: hectic, ensuring the internal cohesion of each living being; physical, creative fire communicating life and movement; psychic, principle of thought and feeling.' Viret J. (2014) Le *souffle et l'esprit* : pour une anthropologie de la voix, in Joubert, M. and Le Touzé, D. (eds.) *Le souffle en musique*, Lyon: Presses Universitaires de Lyon, pp.13-23.
[231] Bachelard, G., (1943), *l'air et les songes: essai sur l'imagination du mouvement*, Paris : José Corti.

(actual or perceived) and may translate physical effort as well as suffering. Air/breath is also a stream, a flux,[232] a cycle and mechanism irrigating any form of life: it is both the *separation* and the *link* between the material and the immaterial.[233] Bachelard observes that this cycle is itself considered within a broader continuity and cyclic time in oriental thinking: 'in Indian thought, the wind, for the world, the breath, for man, manifest the expansion of infinite things. They carry away the intimate being and make it participate in all the forces of the universe.'[234]

However, air (souffle) is a specific sound material. Most instruments are not designed to produce air-sounds. Two simultaneous air-sounds do not necessarily reinforce each other nor create a greater timbral richness or open a 'wider' musical space (as, for example, two different notes would).[235] If, when amplified or developed in specific conditions,[236] air and 'porous' techniques reveal a great timbral richness (as seen in chamber applications of chap.1 and 2), the compositional development of air (souffle) at a large instrumental scale face challenges that are intrinsically related to its core acoustic and technical characteristics: specific dynamic range and register (hardly more than a 'real' *mp*/*mf*), acoustic weakness (thinness of the sound) and lack of sound projection and timbre diversity.[237] In large ensemble or orchestral contexts, microphone amplification is generally not a viable solution,[238] and the enhancement has to come from the instrumental extensions and combinations, i.e. from the composition/orchestration process.

In existing large ensemble or orchestral applications, the most common solution to compensate these potential limitations is to create more texture density through combinations of dynamic articulations and/or rhythmic animations, and by exploring the enhancements or amplifications the instruments may individually provide.[239] As a result, and despite past and present developments of extended techniques, an overall 'contrapuntal' approach tends to predominate when it comes to developing air as a wider textural or orchestral element in large ensemble contexts. Air sounds are in many cases wind-instrument focused (i.e. arising from wind techniques/possibilities). The interaction between *individual*, possibly relatively *similar* timbres tends to predominate over the investigation of possible ways create more sound diversity, or the further exploration of the texture(s) the timbre combinations may achieve when envisaged in a more mediated, 'harmonic' way. An approach through the *instrumental mass* and broader *textural thinking* which goes beyond conceiving air timbre(s) as isolated entities to develop air in a purely 'spectral' or 'harmonic' direction are prolific composition paths.

Extensions may arise from orchestration, using both technical and perception parameters (further investigation of techniques including but not limited to wind instruments possibilities, actual and perceived dynamics and

[232] This aspect is present in the Spanish word "Chorro" (stream, jet, blast) - a translation of 'souffle'.
[233] E.g. inhalation and life ('breath of life'), exhalation and death ('last breath'); the Greek Pneuma refers both to breath and spirit.
[234] *Ibid.*
[235] And, to some extent, other types of noise-based sound materials.
[236] E.g. adapted acoustics/space, resonance/instrumental developments (see chap.1-2).
[237] These aspects are pointed out by most (strings or winds) handbooks, e.g. Buchmann, B., *the Techniques of Accordion Playing* (2010), Gallois, P. *The techniques of bassoon playing* (2009), Strange P. and Strange A., *The contemporary violin, extended performance techniques* (2001), Weiss, M. and Netti, G. *The techniques of saxophone playing* (2010).
[238] Complex implementation, undesirable impact on overall sound/balance. Large ensembles specializing in amplified performance are rare (e.g. *Ensemble le Balcon* Paris, which includes a team of sound engineers).
[239] Including filtration modifications, e.g. an external filter (such as a mute) to create more sound diversity, removing/changing a part (e.g. reed/mouthpiece) to allow more projection. See for ex. Hummel, et al. *The techniques of oboe playing* (2014).

'illusions' arising when developing elements such as air and respiration). As a complex sound matter, air (souffle) is a prolific tool and material. Synergies between its multiple aspects – acoustic to physical (actual or perceived) force – can be deployed in large forces composition.[240] As seen in chap.2, both *movements* and *sounds* of air (souffle) can create complex dialogues with resonance and vibration that can be developed in large forces applications. Assimilations and associations of breath-related sounds are powerful. Respiration, as a universal cycle and mechanism, may influence several levels of perception (dynamics, energies, movements). Throughout the applications of this chapter, both technical and perception influencing parameters serve to develop an orchestration system based on the souffle energy and multiplicity.

The challenge of large forces applications: counterpoint, improvisation, micro-variations (Holliger)

As mentioned previously, two main challenges may arise in large forces applications. The first challenge is to achieve enough timbre variation so that the combination of individual parts may result in increased richness, not only in terms of mass, thickness or density but also in terms of texture diversity. The second challenge is to address the overall thinness and lack of sound projection of air-related techniques. Large forces works in which air is *thoroughly* the main material are rare, i.e. compositions focusing on the development of air (souffle)-based textures using air (souffle) as a *primary* sound material in a *sustained* development beyond isolated sections.[241] If air, as a timbre component or texture aspect reveals an important element in ensemble works of several contemporary composers,[242] most post-1960s large-forces applications stem from punctual or 'porous' utilizations – air as a *part of* the textures – and rarely focus on 'pure' or complex textural developments – air as generating *a multiplicity* of textures.

Improvisation (or relative freedom of execution) has been envisaged as a key aspect since the first post-1960s orchestral applications. It is, for example, a path explored by Xenakis in *Cendrées* (1973) for choir and orchestra. While not on the subject of air or developing air as primary sound material (as Holliger does in his orchestral works, see below), *Cendrées* includes specific sections using air exclusively. During these sections, and in contrast with the rest of the score, the instructions as to the performance of air-sounds are very general, and techniques are to be done freely by the performers.[243] In *Pneuma* (1970) and *Atembogen* (1975), Heinz Holliger (one of the most prolific composers in terms of large forces applications)[244] expands the textures through complex air counterpoints. The textures are the result of complex combinations of instrumental lines – up to 45 individual parts in *Atembogen*. In this context, the individualities (performers) cannot be controlled, and the textures are, to some extent, the results of aleatory combinations. Holliger utilises this as a process. In several sections of these works, the score instructions give a great freedom of execution to the performers, including 'auto-variation' parameters (free tempo, repetition/improvisation on given materials) creating aleatory changes within the overall orchestral texture. Parts of the works are free and unconducted.

[240] Some of these aspects expand to other arts: e.g. use of air projection/force by painters such as Jean-Marie Torque to project colour on the canvas (e.g, *Souffles*, 2007-2014), respiration sound/perception utilisation by filmmakers such as Kubrick (see below) and writers such as Beckett (e.g. *Breath*, 1969).

[241] Most major post-1960s developments emerged in chamber contexts (e.g. Berio, Globokar, Levinas). In large forces, sustained or extensively developed air utilisations generally occur in specific sections and rarely at the scale of a full work/movement, e.g. Ligeti *Aventures* (1963) introduction, Xenakis *Cendrées* (1973) punctual sections, Staud *Violent Incidents* (2005) introduction.

[242] For ex. Sciarrino (b. 1947, see 2.2), Pesson (b.1958), André (b.1964), Bedrossian (b. 1971), Filidei (b.1973), Adamek (b. 1979).

[243] 'Blowing without producing a sound while the fingers play all sorts of notes' (winds), 'rubbing the hair of the bow on the bridge' (strings). Xenakis, *Cendrées* (1973) score.

[244] Large forces applications (discussed here) include *Pneuma* (1970) and *Atembogen* (1975); chamber works include several pieces composed between 1968-1975, e.g. *h* (1968), *Cardiophonie* (1971), *Psalm* (1971), *String Quartet n°1* (1973), *lied* (1974).

In both examples, the compositional postulate is that the individual parts reinforce each other (and reinforce the whole) when performed in soloistic and even free or non-synchronised fashions and that an essentially 'horizontal' (or contrapuntal) perspective is effective to develop air (as a sound-texture material) in large forces.

If the use of air in *Cendrées* is anecdotal at the scale of Xenakis' full body of works[245] and was little commented by the composer, Holliger, on several occasions, expressed his dissatisfaction in terms of the textural results. *Pneuma* was revised. Holliger highlighted ways in which the approach to the orchestra as a *soliste multiple*[246] impacted the result in terms of energy and dynamics. The revised version includes a sensibly reduced instrumentation (24 players instead of 39) and a second revision (with the first instrumentation) with 'more doublings' and 'slower changes of embouchures, sounds and techniques' is still envisaged. Holliger highlighted other problems, such as the lack of sound impact of instrumental combinations,[247] despite utilising multiple techniques (mostly on wind instruments) as can be seen in both *Pneuma* and *Atemboben* score introductions.[248] In both works – including *Atemboben* which includes a large string section – the predominance of air (wind) techniques over friction (and non-wind) techniques is indeed one of the reasons for the lack of impact. Beyond the investigations of ways to create more richness and variety in terms of wind instrument air-timbres and sounds (an extension on which Holliger, a renowned oboist, understandably focused),[249] their almost exclusive utilisation inevitably results in fewer possibilities for creating timbral *mediations* allowing increasing texture and dynamic possibilities and approaching air from a more 'harmonic' or 'spectral' perspective.[250] Other possible enhancements (resonance, 'unfiltered' breath of the performers) are unexplored. Only a few 'porous' air/timbre mixtures or other types of noise/unpitched elements – that would allow enriching textures or creating variations – are included.[251]

To overcome these potential issues and limitations, Holliger developed rich counterpoint-based processes and a specific approach to gesture. Textures are the results of micro-polyphonies[252] and include non-synchronised and/or improvised elements (on given materials) developed at the orchestra scale and within instrumental groups. Developments include free choices of tempo by *each* performer (e.g. *Atembogen* coda) and different tempi between the groups.[253] In *Atembogen*, the bow-breath[254] gesture (inter)action is a key element designed to create 'accidental' changes in sound. For example, the work's opening consists of a silent gesture: an up-bow (without touching strings) and 'silent' inhalation (winds). Then, the first section is to be executed in one bow-

[245] Other significant utilisations of air (in chamber works) include for example *N' shima* (1976), for 5 instruments and 2 voices.
[246] A 'multiple soloist'. Holliger, H., (2007) *Textes, entretiens, écrits sur son oeuvre*. Genève: Éditions Contrechamps.
[247] 'Where I imagined dramatic explosions, there was only a little 'puff of air'! Holliger (2007) *ibid.*
[248] At least 14 different types of air-creating/modifying techniques, including inhaled and exhaled sounds with or without fingerings; embouchure, reeds and mute combinations (e.g. bassoons with trumpet embouchure, trombones with plunger mutes).
[249] As a performer and composer, Holliger contributed to the advancement of oboe (and wind) techniques. See for example *Studie über Mehrklänge* (Study in Multiphonics, 1971) or Berio's *Sequenza VII* recording (1969, written for Holliger).
[250] E.g. by using 'tactile' possibilities (see chap.1) of piano/percussions (in *Pneuma*) and strings (in *Atembogen*).
[251] Pitched and unpitched materials are used distinctively, and merely interact or combine in both works.
[252] A perspective is to be established with other post-war orchestral developments utilising the orchestral 'mass'. For example, the clusters of *Metastaseis* (Xenakis, 1954) or *Atmosphères* (Ligeti, 1961) use extensively 'individuated' orchestrations (each orchestra instrument plays a specific part). The novelty of Holliger's 1970s orchestral works is the utilisation of similar processes incorporating air-sounds/techniques.
[253] This includes the conductor using two different tempos (left and right hand), instrumental groups independently conducted by the 1st soloist, full tempo independence of each performer of the orchestra. *Atembogen*, Score.
[254] Bow/breath (or bow of breath/arc of breath) are possible translations of 'Atem/bogen'.

breath (down-bow/exhalation) as *slowly* as possible. At the end of it, the strings should 'reach the very tip of the bow, trembling, as though gasping of air' (freely repeating a combination of given notes) as the winds 'squeeze out' 'rests' of breath in 'shaky thrusts'.[255] Sound modification stems here from the physical (and psychological) impact of the extreme *end* of the gesture-breath creating uncontrollable combinations.

These various, essentially 'horizontal' paths – starting from the 'individual' (the performer as a *sound source* and *concentration* of various gestures-actions) to generate the 'whole' (the textures and their movements and articulations in time as part of a formal structure) – are a *possible* approaches.[256] Their integration within and extension towards a broader harmonic 'mass' thinking through a malleable, intertwined vertical-horizontal approach incorporating the multiplicity of air sounds and the complex gestural dimension of air techniques *in all their forms* deserve further investigation. In the compositions, micro-variation and improvisation are approached as parts and extensions of the air/breath-friction-resonance continuum. In *Hólo(s)* (for ensemble) they become, for example, the very means to implement spatialization. Improvisations create 'flows' (on friction and breath-based gesture-sound materials) that allow selected performers execute various actions, including movement and changes of position, in free independent or conducted fashions; micro-variations, movement and improvisations are interrelated tools allowing gradually extending the ensemble spatial disposition, creating poles of resonance within it.[257] In *Concerto pour piano et ensemble*, the proliferation of actions creates a specific 'concerto' perspective on texture *porosity*. Complex air counterpoints create an energetic 'flux' and a force in constant dialogue (or contrast) with the pianist's virtuosity (traditional and extended), shedding a new *souffle* light on the solo/ensemble interactions. *Sha'aph* for orchestra explores radical developments: breath-friction sounds form compact, vertical 'blocks' of air. The overwhelming presence of breath-friction sounds and actions 'saturates' air. Radical 'block' articulations push air and friction techniques to their limits, exploring extreme dynamic extensions.

Expanding previous explorations, frictions arise as rich air-like techniques in ensemble/orchestra contexts (see 'energy of friction' below discussing Lachenmann's orchestral applications), extending texture and generating structure through mediation with air/breath-based actions. In *Hólo(s),* the structure stems from the respiration/friction gestural duality and continuity, which permeate the form and establish perspectives beyond their 'technical' distinction, by adapting movements, articulations and techniques to create hybrid orchestral entities. Throughout the work, the friction actions and their gestural extensions generate residues (speed and pressure 'accidents', granulations, resonances and echoes, see chap.1) that become materials for texture variation. Ultimately merging through spatialization,[258] the respiration and friction gesture-actions create a new multilayer 'resonant' entity. In *Concerto pour piano et ensemble*, the soloist's actions create a *continuum* that generates the form, progressing from 'reduced' frictional contact to dense overpressure on the wood, strings and internal parts of the piano. The ensemble's constant friction/breath proliferation builds a complex sound 'matter' and visual layer in interaction with the soloist's evolving virtuosity and choreography.

[255] *Atembogen*, score. Holliger's *string quartet n°1* (1973) includes similar bow and breath associations.
[256] Lachenmann's (contrasting) *musique concrete instrumentale* approach in large forces is discussed below.
[257] Expanding aspects developed in *Atma(n)* (2.1).
[258] In the last section, six performers play offstage while a trio remains onstage playing almost silently, preventing visual perception and identification of the sound sources (and friction/breath).

Respiration and perception: sound, time, expectation and associations

In the compositions, the respiration *movements* are a medium to work on form and structure (see below). Beyond metaphorical uses, such assimilations are not the prerogative of contemporary explorations. For example, le Touzé, in his intriguing analysis of Debussy's *Prelude à l'après-midi d'un faune* (1894), shows how the work is deeply anchored in (and build through) the very rhythms of inhalation and exhalation in terms of timbre, melody, articulation and form.[259] In the works of Grisey (e.g. *Les espaces acoutiques* cycle, 1974-85), the inhalation-exhalation-rest ternary articulation plays a key role as part of the form conceptualisation. This articulation, and perhaps more importantly the slow, gradual evolution within it and as part of larger-scale transformation processes, is assimilated to the tension-release-rest and stability-instability pathways (periodicity-harmonicity to aperiodicity-inharmonicity).[260] Beyond the inhalation-exhalation (tension-rest) articulation, other respiration-related aspects served as inspirations. For example, in *Arsis et Thesis ou la chanson du souffle* (1971) for amplified bass flute, Levinas describes ways in which, after having recorded the 'cough' of his father,[261] he heard in this action the 'suffocation' of the sound. Transformed into 'respiratory rhythm and timbres', the *suffocating cough* became a 'model' generating the work's structure and form.[262]

Beyond structure principles, the sound of respiration allows reaching a specific level of communication. The corporeal, cyclic and mechanical dimensions of respiration irrigate several levels of perception. For example, Sciarrino remarks that a 'triangulated identification of musical representation' materialises (see chap.2 epigraph).[263] As observed by Helgeson, this can be viewed as a poetical variation of a triple perception process in which the sound is presented as 'ambiguous' to our perception, this ambiguity 'calls into question the physical circumstances of sound production', and the ambiguity is resolved 'through our previous experience with similar sounds.'[264] As a specific, universal sound and action, respiration may, in composition, encompass various impressions, techniques, gestures and modes of sound production and become a prolific resource for timbral 'fusions' – combinations where humans and instruments (and air/breath and friction) merge into a single sound and element. As seen in chapter 2, extended texture applications and equivalences allow *playing with* and exploring territories *beyond* the body-instrument 'borders' to create changes in perception and illusions in sound and in time.

Respiration is a fundamental process and universal mechanism. It is made of two phases separated by pauses: inhalation (-short pause), and exhalation (-medium pause). Respiration involves three actions (inhalation, exhalation, pause – breath is briefly held) in a two (or four) steps cycle. Respiration is the only neuro-vegetative phenomenon on which we can have a conscious action.[265] To some extent, each step-action may be

[259] Le Touzé D. (2015) *Présence du souffle dans le Prélude à l'après-midi d'un faune de Claude Debussy*. Muriel Joubert; Denis le Touzé. *Le souffle en musique*, PUL, pp.143-161, Collection Mélotonia.
[260] See analyses of *Périodes* (1974) and *Partiels* (1975) in Baillet J. (2001) *Gérard Grisey : fondements d'une écriture*. Paris: L'Itinéraire L'Harmattan.
[261] Emmanuel Levinas, whose illness in 1970 left him struggling for breath.
[262] 'The 'respiratory breath' (*souffle respiratoire*) of the flutist in the 'air column of the instrument' engendered a melody, a melodic phrase, a formal structure, a piece of music whose origin was the arsis and thesis of breath.'
[263]Sciarrino, Entretiens: Salvatore Sciarrino et Gianfranco Vinay.
[264] Helgeson (2013) *"What is phenomenological music, and what does it have to do with Salvatore Sciarrino?"* Perspectives of New Music 51(2): 4–36.
[265] In biology, other neurovegetative phenomena include for example digestive and circulatory system.

controlled.[266] Modification, control (or lack thereof) may translate various emotions. The impact on perception may be considerable since the mechanism and by extension the *rhythm* and *sound* of respiration imply continuity, periodicity and predictability. (For example, Nonnenmann describes the long, undisturbed breaths in the central section of *temA* (1969, Lachenmann) as a 'Schlafkadenz' – sleep cadenza.[267])

The continuity and predictability respiration implies is to be considered as part of a wider perceptual time frame. According to Husserl, perceptual time appears to us as a moment in which successive events are available to our consciousness ('all at once'). Husserl calls this perceptual time the 'temporal span', which arises in three main parts: primal impressions, retention and protention. Primal impression and retention are inextricably linked in the perception of a 'now'. Protention is our anticipation of the next moment, the moment that has yet to be perceived. As described by Helgeson, sound 'enters consciousness as a primal impression', and, as further sound enters consciousness, 'the initial primal impression passes over to retention'. Husserl likens retentions to 'reverberations' or 'echoes' that sink into the 'just-past:' the retentional sound is not *actually present*, but 'primarily remembered precisely in the now.'[268] The perception of a sound 'lingers on' even after the presentation of new sounds. Helgeson notes that this allows sonic objects to encompass several different sounds, while still retaining their 'all-at-onceness.' Merleau-Ponty offers a poetical variation of the triple process which, running from the perceptual field itself 'draws along in its wake its own horizon of retentions, and bites into the future with its protentions'.[269]

As a continuous process unfolding through repetition, respiration may become a rich *sonic object* in which the perception of the 'now' and 'just-past' create associations, assimilations and expectations. As observed by Helgeson, in the context, for example, of clock chime, the sonic object of our perception expands to encompass 'the totality of bell strikes within a given chiming.' It is the entire chime (not the individual moments within it) that forms the sonic object: 'after I hear the first bell sound, I simultaneously apprehend its resonance (retention) while at the same time my expectation (protention) allows me to anticipate the striking of the next bell sound.' With respiration, the sonic object encompasses the pattern of inhalation and exhalation, perceived as cycle whose reiteration creates expectations. However, and differently from clock chime expectations, interruption or discontinuity may translate various *physical* tensions and emotions. Time and sound utilizations of the expectations (retention-protention) and associations (primal impression) respiration creates may strongly impact perception. As highlighted by Chion, sound perception is 'three-quarters preperception': the 'fragile image in its native state recruits a double from the atlas of possible sounds' (the auditory memory). 'In spite of flaws in the signal, the auditor hears a hybrid, halfway between the perception and the already known which locks the sound image'.[270]

The sound of respiration possesses an inner strength of communication *locked* in universal auditory memory as a deeply corporeal action and sound image; an image which may convey specific impressions despite *possible*

[266] Under normal conditions the breathing depth and rate is automatically, and unconsciously, controlled by several homeostatic mechanisms. Automatic breathing can be overridden to a limited extent by simple choice. Pocock, G., Richards, D. (2006). *Human physiology: the basis of medicine (3rd ed.).* Oxford: Oxford University Press. p. 320.
[267] Nonnenmann, K.R. (1997) Auftakt der "instrumentalen musique concrete": Helmut Lachenmanns "temA" von 1968. *MusikTexte* 67/68:106-114. p. 108.
[268] Husserl, E. (1964). *The Phenomenology of Internal Time-Consciousness* (Heidegger M., ed.). Bloomington, Indiana, USA, Indiana University Press.
[269] Merleau-Ponty, M. (1945), *Phenomenology of Perception,* Paris, Gallimard.
[270] Chion, *Sound,* p.28.

flaws in its signal (e.g. a 'mimicked' respiration sound through an instrumental friction). Perception (and pre-perception) creates an 'automatic' association, a 'hybrid' evolving between the actual ('external') sound and the ('inner') sound of the already known.

Respiration and perception: liminality, horizon and proximity. Kubrick's (inner/outer) breath

In the movie *2001: A Space Odyssey* (1968), Kubrick recurrently utilises the sound(s) and rhythm(s) of respiration.[271] The final confrontation scene between Dave and HAL[272] consists of more than six minutes of systematic, repeated breath. During the whole scene, Dave's breath ('amplified' through the spacesuit) becomes less and less regular and accelerates. As the respiration *sound* and *rhythm* change (or are suddenly stopped as in Frank's death, a previous scene), a specific tension communicates to the viewer; the tension intensification stems from the specific sound associations and time expectations created by respiration. The presence, partial absence or overpresence of the two fundamental actions (inhalations and exhalations) and the changing, gradually *briefer* pauses that (normally) separate them are among multiple signs impacting sound and time perception. The sound of breath is put in perspective with another complex form of air, a constant white-noise in the background. Omnipresent during the movie, it is 'filtered' and changes according to a second extended temporality stemming from the inner/outer perspectives (human, machine, spaceship, space). However, this sound 'horizon' *fails to* create any clear counterpoint (or complementary perspective) to other sounds, such as the human breath. It is complex, latent and indeterminate. No visual-sound indication is given as to its origin, nature or purpose; as a result, a *double temporality* (and 'bi-continuity') emerges. A double tension materializes *within* and *between* the human breath (in the foreground, clearly audible but escaping to control) and the machine/space 'breath' (in the background, indeterminate and subject to irrational 'colour' changes).

Both *cyclic clarity* and *aperiodic complexity* impact the viewer's perception. Despite the overall volume remaining at a stable level, a crescendo arises as the confrontation scene progresses: the cyclic rhythm of respiration generates an increasing sense of tension through its growing assimilation to effort and suffering, in constant association with another equally tense air 'horizon' that might be seen as an 'expanded form' of respiration. Its 'dark/bright' filtrations (the results of perspective variations) become irrational 'mechanical' forms of inhalations and exhalations – a second, changing form of respiration.

This double 'horizon' perception strategy finds echoes in composition. For example, commenting on Sciarrino's *Infinito Nero* for voice and ensemble (1998), Helgeson notes that establishing a 'liminal auditory horizon' and using 'peripheral sonic objects to rescale perceptual focus' create a 'surrogate' which cannot become a focus due to its liminality, but nevertheless is able to 'modify the auditory field.' Referred to as 'surrogates for silence', these liminal sounds (a very soft bass drum roll in *Infinito Nero*) serve to present sonic objects to our perception in ways that otherwise might be physically impossible; sonic objects that might have remained 'peripheral' can move into focus. The liminality and horizon *rescaling* functions offer key perspectives for air/breath strategies of utilisation: envisaged through the light of the *specificity* of the shape and mass of air, the horizon itself may become a specific sonic object with a specific presence.

[271] Besides music (e.g. Ligeti), breath and white noise are key sound-elements of the film, especially in the second half (trip to Jupiter).
[272] Dave is the main protagonist. HAL 9000 is the fictional artificial intelligence character and main antagonist in the movie.

Throughout *2001: A Space Odyssey*, the omnipresence of breath in its foreground-horizon and human-'dehumanized' forms is key to create the 'subjective experience' reaching the viewer at an 'inner level of consciousnesses' Kubrick intended.[273] The bi-continuity (and 'bi-proximity') creates a double inner/outer (or internal/external) perspective – breath/human and white noise/air horizon – demonstrating a specific feature of air-related sounds such as wind or white noise: their complexity and lack of 'proximity cues' and their indeterminacy in terms of weight and 'shape'. Helgeson observes that our prior experience with sounds gives us details about the objects that *make them*, such as their location, movement and speed, size and weight. We can 'identify certain aspects of objects' (such as shape) through sound.[274] Remarking the importance of *scale* (both of the *cause* of sound and of the *receiver* of sound), Chion introduces the concept of 'weight-image' (*image-poids*) nourished by 'proximity cues' (*indices de proximité*). The latter help us to infer the representation of the strength and distance of the *cause of sound* in relation to *our own scale*. 'We can achieve a representation of the strength of the cause of sound without needing to identify it and independently from the intensity with which the sound reaches us.' For example, a sound's agility or ability to 'shift rapidly in its details' helps to situate the cause and contributes to building its 'weight-image'. The volubility (or lack thereof) of a sound phenomenon also gives us a sense of scale. But the 'weight-image' of air (souffle) *escapes to such rules*. 'Certain sounds, like that of the wind, don't necessarily include proximity cues or characteristics that would allow us to determine whether they are powerful and heard from afar, or slight and heard from close by.'[275]

The complexity, 'weight' indeterminacy and lack of 'proximity cues' point to a second key ambiguity in composition: since continuous and complex 'moving' forms such as the wind (and by extension other similar 'air' sounds) contain less (or no) signs (or 'cues') for identification (scale, proximity, shape, weight), a further level of indeterminacy of the *sound source itself* arises. The ambiguity is exploited by Kubrick: despite the overall softness of the air/white noise 'horizon' (compared to foreground sounds such as speech or breath), it is impossible for the viewer to determine whether the sound source is near or far away and what is its 'shape' or 'mass'. It has no (or little) 'perceivable' weight and evolves in a complex 'intermediate' state between statism and volubility. Along with respiration, this creates a double 'air' perspective – a human and 'infinite' micro and macro scale dimension encompassed within a wider sonic space and horizon.

Applied to large forces composition, an encompassing (or enveloping) sonic object arises; an object without 'clear' perceptible shape, weight or volubility unfolding through an expanded temporality and 'diluted' perspective which may be put in dialogue with a 'first' form (breath/respiration) that possesses its own sonic ambiguity and temporality. This opens new possibilities, not only in terms of the potentiality of air (*souffle*) as a multiple sound 'matter' and energy, but also in terms of plurality of (breath-air) *mutual* interactions. The plurality *of* and *in* continuity as well as the extended possibilities in terms of merging, combinations and *pluri-reinforcements* are key to create a 'souffle' orchestration through sound and perception.

Commenting the specific impact on perception of computer/electronic-made sounds, Risset highlights that the notion of instrument is 'blurred'. 'Sound sources lose their identity: they are no longer visible, they become

[273] Fenwick, J. (2015) Stanley Kubrick: Adapting the Sublime, *Adaptation* 8(3): 383–390.
[274] Helgeson, *What is phenomenological music* (see footnote 264).
[275] Chion, *Sound*, p.8.

difficult to spot; it is no longer enough to designate them to specify their timbre.' 'With the computer, you can build a sound with an arbitrary physical structure: but what matters is its perceptible effect (*effet sensible*).'[276] Respiration extends beyond humans and instruments. As remarked by Levinas (chap.2), the exhalation (expiration) of sound is an 'archetype' that can be found in any sounding body.[277] Kubrick's utilizations of the 'air' sound(s) and temporality(ies) show how two parallel perceptions of air and respiration may change through associations. They also illustrate the complexity and inherent ambiguity of the 'mass' of air (souffle) in all its forms.

Through pluri-utilizations/perceptions, the sound sources also 'lose' their identity. But differently from electronic or computer sources, they become, 'again', souffle: an elementary, yet complex and porous matter. The *effet sensible* is malleable. Each sound, even the most abstract, is potentially figurative. As highlighted by Chion, the 'objective hearing' of a sound is 'influenced and parasitized by all kinds of associations and extra-sound representations.'[278] But souffle (air/breath) already has a figurative sense that *sends it back to itself.* As in spectral principles (in which harmony and timbre are porous parameters transformable into each other), the 'extended' souffle orchestration embraces air as a wide and malleable object – porous not only with other sounds materials (pitch, noise) or other qualities of the timbre, but also *with(in) itself.*

Two different categories for perception (harmony and timbre) are (in the spectral music example) *no longer* different for the writing. The 'shift' between the two forms occurs from the point of view of perception.[279] Within the *souffle* bi (or pluri)temporality-functionality (of which breath and white noise, or air and sound may represent the frontiers) the 'shift' (sound-air, white noise-breath) may also occur from the point of view of perception. The writing (composition-orchestration) can play with perception: 'it can mislead the ear, compose with its flaws, play with memory and associations; it can explore the thresholds of perception.[280] As observed by Dufourt, 'all the dimensions of music can be converted into each other by seamless transition. The interest of such a perspective does not lie in a crystalline or fixed definition of the sound object, but in the exploration of intermediate categories, hybrid objects, thresholds, illusions or continuous transformations.'[281]

Friction and breath: malleability, continuity, temporality. Hypothesis for large forces composition

In chapter 2, bi (or pluri)continuities are explored with regards to the human, instrument and resonance interactions – the *breath-friction-resonance continuum* – and 'mechanically-implied' continuities (2.3 *Tracer le souffle* for amplified accordion and effects). In this context, the actual or 'implied' bi-continuity (breath and white noise) was extended towards the mechanical uses of the instrument itself (accordion) – and through amplification and electronics effects integration (pedalboard). Large forces applications, through their extended possibilities, allow working with several simultaneous perspectives (e.g. using instrumental mass, spatialization and/or movement of sound sources) to question the human-instrument dualities, tensions and 'horizons' not only sonically but also in terms of plurality of space and temporality. In the compositions, breath (respiration)

[276] Risset, J-C. (1988) 'Perception, environnement, musique', in *InHarmoniques* n°3, p. 11-12.
[277] And 'not limited to wind instruments' see chap.2 introduction.
[278] Chion, *Sound*, p.201.
[279] Solomos, *From Music to Sound,* p.37.
[280] *Ibid.*
[281] Hugues Dufourt, 'L'espace sonore, "paradigme" de la musique de la seconde moitié du 20e siècle', *in* Jean-Marc Chouvel, Makis Solomos (ed.), *L'espace : Musique-Philosophie*, Paris, L'Harmattan, 1998, p. 182.

and air (white noise) are approached as two *possible* time and sound forms and perspectives with multiple intermediate and communicating states and shapes – dialogues, continuities, parallels, echoes…

For example, in *Hólo(s)*, the respiration-white-noise (and breath-air) bi-temporality (and bi-functionality) is an extension of the breath-friction (and human-instrument) duality and continuity. 'Extended' forms are assimilated to the gesture and soundworld of friction, whereas 'condensed' forms are assimilated to air-based actions creating breath 'blocks'. The two forms are malleable and combine in various ways – fundamentally distinct to deeply intertwined – (re)creating dynamic entities through their dilution-compaction and merging-combination. Frictions create specific air forms and dialogue-interactions ('circulating waves') through an essentially horizontal approach and *diluted* time-sound unfolding. As the work progresses, they gradually evolve and ultimately merge within a more 'compact' and vertical *breath perspective*.

The overall hypothesis of this chapter is that the utilization(s) and perception(s) of respiration(s) are sufficiently rich, malleable and potent that they may allow influencing the perception of air (souffle) in all its forms and energies. Such developments can create *tools* and *processes* to extend compositional possibilities, overcoming the 'weaknesses' of air in large forces applications. The very presence of inhalations and exhalations (and as importantly their *absence* and the pauses that separate them in the cycle of respiration) generate tensions and synergies impacting actual and perceived actions. Through the building of an orchestration system, extended orchestration applications explore various perspectives, investigating the perception of air and of the specific temporality (or *temporalities*) of respiration. The temporalities *of* and *within* air unfold both as part of a complex 'human' perspective and within a broader orchestral 'whole' built from the plurality of actions – using the vertical-horizontal spatial, textural, visual and gestural perspectives to reinforce the multiplicity. The compositions include 'pure' and 'porous' developments in various structures, textures, sound 'masses' and articulations ranging from dense, compact air 'blocks' to expanded, stretched and 'diluted' white noise forms.

Investigated until their extreme compaction and dilution, *articulated developments* and sound *energies* create 'rests' – granulations, perforations, echoes/resonances – that become tools for enhancement and open new paths for texture expansion (see below). Their integration as part of a wider air-based orchestral vocabulary opens to new questions: what is their role as part of extreme utilization-associations and as texture-mass extensions; what is the nature of their 'porosity' and how can we *control* it within a 'souffle' vocabulary (including in extreme 'compact' (grain) or 'diluted' (resonance) forms); what is their possible (re)generation as part of an extended air-friction-resonance orchestral continuum.

As both breath and friction time-sound forms become compacted (or 'stretched') to their limits in *Hólo(s)*, granulation, instrumental resonance and echoes become natural responses. In the last movement, a new form or 'state' emerges in which air becomes an extensively 'diluted' element evolving as a near-imperceptible movement *within* resonance – as a *halo* of resonance. The movements of sound sources, which gradually build the spatialization, contribute to developing this 'dilution' effect not only sonically, but also physically ('stretching' of the ensemble shape, see p.136-140). The physical dispersion of the performers in the end expands the pluri-continuity/temporality principle: a 'respiratory wave' (a trio) continues to 'breathe' onstage, while six other musicians expand a second, indeterminate white noise 'horizon' that *visually* disappears in complex, ever-changing sonic and spatial perspectives.

Respiration, structure and extreme utilisations: presentation of the works

Envisaged as a multi-level tool and parameter, respiration (and its extensions) impacts the micro and macro-structure of the works. Applications include radical uses and associations. *Extreme* utilizations (saturated presence or conversely partial absence and 'apnoea' effects) create formal tools and technical means using perception assimilations. The 'end' of breath and its 'saturation' are specifically investigated (see below), expanding previous explorations. A double 'intermediate' step of respiration, 'silence' – or perhaps more accurately 'absence' – is also a powerful tool. Sciarrino remarks that the transfer of physiological sounds such as respiration create a 'silent drama' in which the music tends to 'reverse the terms of presence and absence'.[282] The uses and consequences of 'silence' as a reversing phenomena 'increasing' the presence (in both 'compact' and extended temporalities) are explored: resonant 'apnoea' (*Hólo(s)*, *Concerto pour piano et ensemble*), stillness, presence and absence of sound and/or visibility, 'organic' fermata and pauses (*Hólo(s)*, *Sha'aph*), extended 'breathless' resonant-playing (*Concerto pour piano et ensemble* 3rd movement, see 'end of breath').

The exhalation/inhalation alternation (and continuity) impacts the structure of *Hólo(s)* on multiple levels, creating energies developed in 'compact' as well as dilated forms – near 'static' textures to fast, articulated air-based movements 'blocks'. The exhalation/inhalation alternation generates the form (from sections/sub-sections, to phrases/phases and musical actions) integrating friction as a sound/form parameter *embedded* within respiration (assimilated with the 'exhalation' phase and action). The first movement is built on the principle of movement/stasis and compaction/dilution (in terms of texture 'mass' and time unfolding) and develops through the alternation of tension-building 'inhalation' phases using predominantly wind-breath techniques-gestures, and tension-release 'exhalation' phases using predominantly friction-nonwind techniques-gestures. The 'extreme' assimilations play a key role as part of the form construction and material generation. As breath/friction interact and 'evolve' within gradually denser, saturated textures and 'thicker' sounds masses in movement II (including noise-based elements, over-pressured strings/surfaces, 'beating' multiphonics), new dialogues 'push' the sound(s) of air to their limits in terms of movement, articulation and dynamics. In this context, extreme respiration-related 'states' and associations (e.g. 'gasping' climax, movement III) become specific, *unifying* form-sound articulation processes and perception-impacting tools.

In *Concerto pour piano et ensemble*, the air and white noise complexity and indeterminacy change perspectives on and within the solo-ensemble dualities. A near-constant, intense level of air-based 'energies' (using in some cases extreme dynamics and/or articulations such as polarizations on inhalations, fast alternations of inhalations and exhalations) dialogue with and shed a new light on the corporeality of the soloist's 'triple' virtuosity (traditional, extended, 'passive' in movements I, II and III). Generating a growing *tension* through proliferation and intensification, the ensemble's plurality of air 'flux' (souffle) dialogues with complex pianistic timbral layers in which resonance, vibration, and dense and ultimately saturated frictions are the main materials. Evolving within a constantly changing perspective (foreground and background air and sound dialogues), souffle sounds and actions emerge as complex, indeterminate yet specific, energetic elements. In the climax (end II) – a *tutti* in which all sound layers (pitch-air-noise) and techniques reach their highest dynamic density – the very *sonic nature* of inhalations and exhalations (here systematically repeated and amplified through

[282] Comment on *Introduzione all'Oscuro* for ensemble (1981). Sciarrino S. (2001) *Carte da suono* (1981-2001) Edizioni Novecento, Mascalucia.

woodwinds as though 'gasping' of air) allow them to be clearly perceived and identified. Despite their weakness as part of (here) an overall 'saturated' orchestration, their underlying presence arises as reinforced though perception *associations* and time *expectations*. The climax peak – a 'blast' effect – transforms into a longer, less graspable 'suffocation' effect. Developing near-silent frictions (piano strings/inner parts), the immediately following 'apnoea' cadenza arises and develops from the resonance(s) emerging from the 'release' of the 'blast' energy, materialized in echo and grain *residues*. However, the 'breathlessness' is here not an end, and these residues provide materials for expansion: a third 'static' form of playing builds from this, creating the following movement (III) in which the 'solo' instrument resonates/reacts to *external stimuli* – a 'resurrection' and unexpected form of virtuosity.

Sha'aph, for orchestra, is a radical development of both the breath/respiration and friction/white noise extremes. The work is radical in both senses: an 'extreme' application using the orchestra as a 'mass' of air built on an elementary *binary* basis stemming from the fundamental inhalation/exhalation (and compaction/dilution) principles that regulate the structure and actions. Furthering the double inhalation-breath and exhalation-friction assimilation (two temporalities-gesturalities) the work is characterized by the clear, distinct alternation of the two forms. Conversely to *Hólo(s)* and *Concerto* where the forms dialogue or merge, the 'human' respiration (orchestral 'blocks' of 'breath') and the 'instrument' white noise ('spread' orchestral frictions) forms succeed to each other in their *respective* radically *extended* versions but *do not interact*. Developing 'extreme' dualities (stasis/pulsation, solo/mass), textures build through (over)pulsated tempos, dense tutti 'blocks' or extremely stretched, diluted, static and apulsated sections. These utilizations systematize 'peak' expansions of texture, mass and dynamics, exploring air as a dense, energetic, saturated (or conversely soft and static) element.

The energy and orchestral 'writing' of frictions (Lachenmann); rests and granulations as expansions

Frictions are a rich, malleable (and possibly lesser used) tool to extend timbral mediations in large ensemble contexts. Their deep investigation is key to expanding orchestration possibilities. Friction air-timbre *porosities* are addressed in chapter 1 (chamber works). As an introduction to their existing and potential utilisation in larger ensembles, Lachenmann's *Shreiben* (2003) is discussed. The reflexion then extends to a key aspect, the friction *granulation expansion* towards an expanded *souffle* orchestration.

Frictions techniques are at the heart of Lachenmann's *musique concrete instrumentale*.[283] In *Shreiben* for orchestra (2003), frictions develop as orchestral elements. As expressed by the title, the friction *gesture* is part of the work's conceptualization. Through the triple tension between the 'scream' (*schreie*), the 'rubbing' (*reiben*) and the 'writing' (*schreiben*), Lachenmann builds a piece in which the orchestra 'writes'. This idea is physically-sonically translated into various friction actions. In addition to piano, strings and percussion techniques, frictions are applied to other elements (such as the music stands) which become sources for 'writing' actions. As a concept, the 'writing' gesture is particularly consistent with the *musique concrète instrumentale* approach. As pointed out by Nonemann, by his reference to the homonymic quality of 'Schrei(b)en', *Lachenmann underlines the instrumental concreteness of the latter* since 'one can clearly hear

[283] Explored in their various forms, starting from the late-1960s in chamber works such as *Pression* for solo cello and *Guiro* for solo piano (1969/70), and *Gran torso* for string quartet (1972) (see 'touching/feeling a sound/breath' in chap.1).

the mechanical and energetic conditions under which the sounds thus written are actually generated on the instruments.'[284]

Consistent with Lachenmann's *klangtypen*, the breath (air) and friction combinations *articulate* an animated 'discourse' stemming from attack/resonance figures. The approach to friction and air is of an *energetic* nature. Friction and air ('writing') are the main elements of the piece's first part and last section (a 'reprise'). Textures progress in movements in which articulation combinations are key. As 'mechanical and energetic conditions', friction and air sounds-actions develop through *mediated continuums*: constant *articulation* and *colour* associations are crucial to achieve 'energetic' developments, addressing the sonic weaknesses of air. For example, guero effects (piano-keys friction) combine with similarly rattling flutter-tonguing techniques (winds) and 'affiliated' sounds such as tremolos (strings). These actions dialogue with different frictions creating 'colour' associations. For example, the percussionist, using sticks to rub ('write') on wooden music stands (a recurrent action) creates dark/bright 'colours' by changing the point of friction; these filtrations echo similar sounds and articulations (such as glissandos) made by the other instruments.

As in *Air for orchestra and percussion* (another orchestral work on friction and air, 1969 rev.1994/2015), Lachenmann's 'organ manuals' approach is a major aspect.[285] The breath-friction combinations create group articulations involving selected parts of the orchestra in mutual echo-resonance, but never in the form of expanded tutti or combination of multiple 'individualities' (see Holliger's *soliste multiple*). Prominent in the first part, the friction-air combinations involve a relatively reduced number of simultaneous actions (compared to latter noise/pitch-based sections). Lachenmann creates dialogues between selected groups in the orchestra and never 'over-expands' the instrumental masses. The expansion is obtained through articulation; too much simultaneous action/information (and spread textures or multiple 'solos') would impact the overall articulation 'energy', 'blurring' perception of the *instrumental concreteness* ('mechanical conditions') of the friction/air techniques. Pitch (and non-air)-based materials becomes prominent in the intensification starting in the second fifth of the piece, putting aside 'air' techniques when more 'harmonic' mass (or higher dynamics) are needed.

As in Lachenmann's previous orchestra-ensemble works, there is an overall distinction between pitch and air. These forms do not merge; they form two extremities of a wider sound spectrum of which unpitched/noise-based elements may be seen as the centre. This 'tripartition' is reflected in the very structure of the piece, which gradually introduces an air-to-noise and noise-to-pitch evolution. This evolution is the very aim and outcome of the piece: reaching a 'scream' climax through intensification of 'writing' and 'rubbing' actions. As part of this progression, 'denser' noise-based materials appear distinctively; they are not put in perspective with air or 'hybrid' air elements (e.g. 'porous' air-timbre/air-noise mixes that might represent here intermediate steps or 'states' to rework texture composition during the overall progression). The transformation graduality is obtained by two main 'bridging' parameters, articulation and granulation, acting as (inter)connections. Echoing previous techniques (flutter-tongue, guiro), overpressures (strings, piano) create intermediate scraping/grain articulations, reinforced through associations with techniques such as tremolo (previously associated with

[284] Nonnenmann, K.R (2005), *On Music that Scrawls and Screams,* in Lachenmann Schreiben, Double, CD booklet, Vienna, Kairos
[285] See *Lachenmann,* Helmut. *Musik als existentielle Erfahrung*. Wiesbaden: Breitkopf & Härtel, 1996. E.g. commenting a section of *Air* (b.150-160) Lachenmann identifies four overlapping 'manuals': 'rubbing movements on skin instruments, complex 'riding crop cracks' through the air, blown guiros, and a air-sound combination on flutes and brass instruments.'

air/air-like sounds such as flutter-tongue/guiro friction). If the air/friction expansion towards high dynamics or dense masses isn't part of Lachenmann's orchestral investigations, these transition 'states' provide ideas for texture expansion using the timbre and energy of frictions. Granulation-frictions (here overpressures in their various piano-string forms) emerge as linking elements 'prepared' through *previously created articulations and associations*.

Another association process takes place in the climax. A high violin-unison *'scream'* is held *fff* for 20 bars (a possible reference to Penderecki's *Threnody for the victims of Hiroshima* (1960) in which such passages create for Joubert *sensations of apnoea*).[286] Despite its intensity, this effect's very register *physically* generates fingerings/positions in which the strings vibration cannot unfold properly. Nonneman observes that all one hears is a 'half-suffocated, whistling tone.' As the violins continue the gesture by sliding still higher towards the bridge, a timbral transition emerges. A *perceived* more than actual effect in its peak presentation (before the bridge transition), the 'half-suffocated whistling' *gesturally* evolves to *physically* include increased *audible shares* of air through the string to bridge sound transformation, becoming an actual *air-containing* ('half-suffocated') high ('whistling') effect. The transition arises from the gesture itself which, while maintaining overall energy, creates gradual changes, here from a high string 'unison' to a second hybrid air-sound texture. This effect illustrates how, despite the need of greater mass and impact, specific friction utilizations may create sound-air pathways through combination of *physical change* and *perception association*. This also raises the key question of the possible role of (and interactions between) air and other (pitch-noise) sounds elements in dense masses and high dynamic-levels sections such as climaxes. Lachenmann's gradual evolution towards the instruments' register limits may be viewed as a response. However, the air-share increase (transition towards the bridge) is here little predictable and is inevitably accompanied by a decrease in dynamic, despite overall maintained 'gestural' energy (*fff* throughout). As put by Nonemann: 'much like in a scene of devastation from a Mahler symphony', the "scream" wrung out of the instrumental-concrete structural context is finally retracted in toneless blowing, rubbing and writing motions'.

Chion highlights that sound is 'perceived as the carrier of a value' (he mentions the 'absolute' value of pitch and the 'differential' value of phonemes) that, 'once it has stood out as a component of a discourse' (a *phoneme* in the case of speech, the *pitch* of a note in the case of a melody), tends to 'relegate the other features of a sound to the rank of supporting role, platform, vehicle, coloration, or perceptual remainder.' He adds: 'It is this remainder that today gets adorned with every quality or reified, but that we refuse to analyse and concerning which we are attached to preserving the indeterminateness – synonymous with plenitude – intact.'[287] Working on the 'perceptual remainder' (or 'rest') – the 'residue' and 'grain' of souffle (and more specifically the one of friction) until extreme presence and 'saturation' (as seen in chap 1.3 in chamber contexts) – provides, in the compositions, fruitful elements for extension. As 'perceptive rests', granulation-echoes build a specific sound-gesture extension, an inherently *physical* form deeply connected with the 'tactile' aspect of hearing. As observed by Bailblé, 'the grain, a distant echo of the tactile ear, transforms into a caress; a 'simple' cable from the auditory cortex uncovers the asperities of sounds and projects them to the tactile cortex to awaken the

[286] Joubert M. & le Touzé, D., *Le souffle en musique*, Lyon, Presses universitaires de Lyon.
[287] Chion, *Sound*, p.199.

sensation – grained or smooth – of an inner touch.'[288] Frictions may (re)create the soft 'inner touch' and echo of grain. Granulations (and echoes) create a *complementary multiplicity through and within* air allowing 'decomposing' and 'recomposing' it. They can also transform it into a saturated matter.

Continuum extended: orchestrating saturation, residues and granulations

Friction granulation is a versatile technique that may, according to its speed or control, 'isolate' the grain (of a string or of any 'overpressured' surface), 'compress' or 'expand' it in various ways. For example, composers such as Cendo and Bedrossian, have integrated the friction granulation as an 'energy' part of a broader 'saturation' approach to sound (constant 'excess of matter', see 1.3). However, through the 'lens' of souffle, they take on new roles as extended *gestural* '*tactile'* forms: through simple gesture change and surface-pressure variation, the air-frictions transform into granulation-frictions (and conversely) in fluid and continuous fashions.

As seen previously, the 'grain' and 'echoes' that arise from 'granulated' frictions are envisaged as deeply intertwined with the 'air' form – as 'saturation' or 'rests' (a breathless *entropy*). The orchestral textures incorporate granulation 'sub-layers' to extend acoustic presence in otherwise 'unreachable' registers through exclusive use of air techniques. In soft utilizations, the 'grain' and 'residues' imperceptibly extend an otherwise empty harmonic 'field' *widening the musical space* by creating a 'liminal' horizon of resonant-granulated matter. In denser sections or climaxes, granulations expand mass and volume possibilities, allowing reaching new dynamics while keeping the *sonic* and *gestural* connection with the 'friction' 'air' mode of sound production. Approached as a dual extreme (soft 'residues' as well as saturation materials), granulations (and as will be detailed, their echoes and 'emulations') represent rich expansions. As seen in chapter 1, through the 'lens' of *souffle*, granulation-frictions emerge as novel enhancement tools that *arise* from air and *nourish* it: an increased density and even 'saturation' *of* and *from* 'air' (souffle in its materiality) becomes possible in the orchestration.

Commenting Xenakis' *N'Shima* (1975) (*N'Shima* is the Hebrew for breath/souffle, panting, groan, spirit) Solomos observes that Xenakis' reference to the 'spirit' is not through evocation or representation: it is 'by working to the extreme of the physics (of breath) that the piece hopes to attain the metaphysics (of the spirit).'[289] Commenting Giacometti's statues representation of 'breathless, emaciated, expiring human bodies,' Levinas establishes a perspective with Balthus' vision of Giacometti's fingers, described as having 'petrified and saturated the corporality of matter.'[290] In both examples and interpretations, saturated matter resonates breathlessness: the 'saturated' materiality provokes echoes *of* (and *in*) immateriality through *extreme physicality*. The end (or 'death') of sound becomes transfigured, beyond silence, in a cyclic transfiguration where breathlessness is the very saturation of corporeality in its materiality.

[288] Bailblé, C., 'La musique et le corps', in *L'audiophile* n°46, p.88-97.
[289] Solomos, M. (2015) "Modèles du souffle dans la musique d'aujourd'hui". In Joubert, M. & Le Touzé, D. (eds.) *Le souffle en musique*, Lyon, Presses Universitaires de Lyon, pp.171-188.
[290] *Levinas,* M. (2006) *La Chanson du souffle, une épiphanie du visage*.

The end of breath (and a Proust variation)

The *dernier souffle* (last breath) finds its 'natural' translation (from a compositional perspective) as the 'exhalation' of sound – i.e. the musical path from sound to silence. In the mentioned works, this path is echoed as an ending 'sonic gesture': following the writing-friction metaphor, *Schreiben* (2003, Lachenmann) ends 'by not having ink anymore, out of breath' (Noneman); Holliger refers the structure *Pneuma* (1970) as a 'large exhalation' in which the end is the 'final exhaustion'. But this 'final' path is precisely where the 'expiration' *of air and breath* (and by extension *of their continuity)* may reveal its complexity and extend *beyond* exhaustion.

Meanings such as groan, gasping, pant are deeply rooted in ancestral words for 'breath' (such as '*N'Shima*' or '*Sha'aph'*). Extreme breath-related actions (e.g. cough, gasping, breathlessness, saturated breath, exhaustion – illustrated by Levinas and Xenakis) are key in Holliger's chamber works (1968-75).[291] For example, Holliger insists on the 'extreme' assimilations-actions taking place in ending sections. In *Atembogen* the final bow/breath associations and 'stops of breath' become sources for specific developments. The final part of *Pneuma* is described as being 'perforated' by 'stops of breathing' and the end – 'the first pause of the work' – as the 'suffocation of respiration'.[292] A compositional perspective is established beyond the 'normal' continuity of breath, with 'unusual' states. (For example, Breath-related problems (or conditions) are often associated with 'obstructed airways' or assimilated with unusual speed-density of air accumulation.[293]) But this idea of *perforation* (and extreme/radical developments) does not find in an acoustic realisation due to previously mentioned problems and limitations. The compositions of this chapter ask a further question: what happens *during* and *after* the formal-metaphorical exhalation or 'end' of sound – the exhaustion, 'out-of-breath' and even 'suffocation' of breath and air developments? Can we break, freeze, extend or continue the 'silent' path?

Lachenmann's utilizations of resonance in orchestral contexts might give us insights. In *Schreiben*, the trombonists 'play' into the piano (opened, with pedal depressed) through 'forced-sounding signals'. Using a loudspeaker system, the trombone sounds are amplified and reverberated in the piano: as highlighted by Nonneman, one instrument 'writes/screams into the interior of another'. Extensively investigated *in relation to air* in chapter 2 (chamber contexts), this reverberation/resonance idea is more rarely developed in orchestral contexts where sympathetic vibration and instrumental reverberation are traditionally avoided phenomenon.[294] It becomes a key element, generating in *Hólo(s)* the extended utilisation of *poles* of resonance (instrumental amplifications in specific parts of space, used for example to create the 'resonant apnoea' effects).[295] In *Concerto pour piano et ensemble*, a full movement utilises the piano as a *vibration body* and malleable *entity* reacting to external stimuli in a new, unexpected form of virtuosity.

[291] Also literally: stethoscope amplification of the gradual acceleration of the performer's breath and heartbeat in *Cardiophonie* (1971); extreme bow and breath associations in *string quartet n°1* (1973) until physical apnoea.
[292] Holliger, H., Pneuma, program note.
[293] Andreoli, Thomas E.; et al., *Dorland's Illustrated Medical Dictionary* (30th ed.), Philadelphia, PA: Saunders
[294] E.g. the harpists systematically mute the strings when not playing to avoid sympathetic vibrations created through other instruments interactions (http://sites.siba.fi/fi/web/harpnotation) – see 1.3 for chamber utilizations of this principle).
[295] Expanding principles of *Atma(n)* (2.1).

Evoking the action of morphine and oxygen on breath and its 'continuation', Proust (in *The Guermantes way*, 1920) provides us with a rich variation on the artificial echo and 'halo' beyond respiration:

> The doctor gave my grandmother an injection of morphine, and to make her breathing less painful ordered cylinders of oxygen.(…) Released by the twofold action of the oxygen and the morphine, my grandmother's breath no longer laboured, no longer whined, but, swift and light, glided like a skater towards the delicious fluid. Perhaps the breath, imperceptible as that of the wind in the hollow stem of a reed, was mingled in this song with some of those more human sighs which, released at the approach of death, suggest intimations of pain or happiness in those who have already ceased to feel, and came now to add a more melodious accent, but without changing its rhythm, to that long phrase which rose, soared still higher, then subsided, to spring up once more, from the alleviated chest, in pursuit of the oxygen.[296]

In the 3rd movement of *Concerto pour piano et ensemble*, a new, second life is given to respiration-air through resonance. Just as in Proust's variation, the 'revitalized' respiration through external 'stimuli' (the 'morphine', here 'instrumental' stimuli: saxophone and clarinet moving near the piano to work on its vibration, itself light and modified by the soloist) is created by a need. The work's specific form creates a necessity for continuity. The resonant 'apnoea' at the end of the 2nd movement creates a long, tense silence building from an intense, pulsated and saturated breath/sound energy. The silence's tension is the result of the tension built during the whole piece through the systematic intensity and proliferation of air/breath sounds, inviting the audience into a listening state in which silence creates no absence or relief but on the contrary builds more presence and tension through its assimilation (absence and apnoea, silence and suffocation). The tension created by the prolonged silent 'apnoea' immediately following the climax starts well before in the piece. It builds from the air 'flows' of movement I and develops through the dense (over)pulsated crescendo-accelerando in movement II. After its climax 'explosion' and 'absence' in the near-silent cadenza (that immediately follows), tension needs to be echoed or released in some way. The 'echo' or 'revival' through sympathetic vibration in movement III becomes a necessity. It creates a near silent yet resonant 'lightness' (or echo), 'intimations of pain or happiness in those who have already ceased to feel' – the *haleine* (Proust's original word for 'breath', between 'halo' and 'breath' – 'ring of breath') in which air and resonance combine as the breath becomes 'imperceptible as that of the wind in the hollow stem of a reed.'

In the work's premiere (New York, June 2019) the piece was ended at the end of the 2nd movement – after the 'apnoea-cadenza' – for practical reasons. In this context, the release itself (the large exhalation 'echo' and 'halo' in III) didn't sonically and physically happen. This absence left the listeners in the audience (including myself) in an expectation, waiting state, full of tension: the absence created more presence. The tense silence lasted, for approximately one minute. Time was needed for to 'exhale' and 'end' the piece – each through our own individual rhythm and respiration. Finally happening, the 'relief' (which was double for me since it gave way to sustained applause and enthusiasm) allowed ending the work in this unexpected way – a silent apnoea individually 're-composed' by the audience after II, immediately after the 'gasping' crescendo and 'blast' climax. Following this experience, I realised that 'ending' the piece in II (a choice that I perceived as a risk but decided to pursue) is also an effective (and to some extent radical) illustration of the specific presence-absence 'reversion' effect of the air-respiration perception: the work's thus 'unbalanced' form creates a spectacular effect. Beyond allowing considering this option as a possible solution for futures performances, this experience also inspired me to 'use' this tension process for other works, including the last, perhaps most radical orchestral development of the research (*Sha'aph*, for orchestra).

[296] Proust, M. (1920) *The Guermantes way*, translated by C. K. Scott-Moncrieff. New York: The Modern Library, 1992.

3.1 Souffle (air) as a force, an orchestration system – Hólo(s) for large ensemble. Creating a multiplicity

'Hólos' (Ancient Greek ὅλος) is open to multiple interpretations. It refers to the presence and interdependence of all the parts as a 'Whole' (a total), transcending the mere sum of all the parts. 'Hólos' may refer to the 'body in its entirety' as well as the 'Altogether' working as a system – here the Whole. In sacred writings, 'Hólos' may also describe the 'wholeness' or the 'to be made whole', i.e. the actions of restoration and healing.[297] Inspired by these interpretations, the piece explores air (souffle) as a form of energy and complex physical and acoustic phenomenon of which every single (micro-) aspect impacts the whole resulting sound and texture. Throughout the work, the various individual instrumental forms of air merge and become a whole body, a 'metabolism' of sound that creates a wider textural element. Textures become circulating 'hybrid' masses developed as flux and forces, using the energy of air (souffle) to create a system based on its multiplicity ('Hólos').

The work aims to overcome the weaknesses of air (as a sound material) and extend texture and dynamic possibilities. The first objective is to apply the air-friction-resonance continuum to a large ensemble, and extend it using the multiplicity *of* (and *in*) instrumental density. The second objective is to investigate how other parameters may allow implementing this and influence perception. In addition to the deep investigation of techniques, previously developed processes are extended: gradual spatialization creating resonance 'poles', guided-improvisations and 'micro variations' at the individual and ensemble scales. Respiration acts as a multilevel parameter. The inhalation-exhalation principle (and associated tension-rest) 'irrigates' the work: it generates movements, energies, articulations and phrases; it builds the structure, integrating friction as a tool that emerges to form a second element ('waves' of air) embedded within the very process of respiration.

Building a (souffle) orchestration system: reinforced individualities, hybrid functions - the instrumental scale

The work was written for ensemble *Zone experimentale Basel*.[298] The ensemble's uncommon instrumentation (oboe, saxophone, French horn, trombone, accordion, percussion, piano, harp and violin) opened new paths for technical investigations. Harp, piano and percussion are approached as a resonant 'frictional' group, which, combined with accordion – whose techniques incorporate both air and friction (see 2.3) – create a versatile entity with rich sonic possibilities. The 'reservoir' of air-like frictions includes various contacts and types of materials, techniques and gestures. The continuity and 'pathways' towards hybrid elements (friction air-timbre transformations) and resonance (created by or extending friction actions) are key aspects of the orchestration.

Furthering previous investigations (chap.1-2), the piece explores 'hybrid' instrumental functions. The violin (here the only bowed-string instrument) is a multifaceted entity amplifying, filtering or reacting to air and friction (fig.82). Utilising the f-holes as resonant filters, three levels of breath amplification develop.[299] The 'rotation' technique (breath resonance through f-hole amplification, strings vibration and instrument rotation) extends towards novel applications, such as improvisation (fig.83). Friction developments (bow) investigate the

[297] See for ex. Liddell & Scott (1940) A Greek–English Lexicon, Oxford: Clarendon Press.
[298] The work was premiered at the Hochschule für Musik Basel (January 2019) and performed at the Impuls Festival, Graz (February 2019, recording) conducted by Mike Svoboda.
[299] Three positions create three sound/breath modifications/amplifications. Positions 2 and 3 involve slightly lifting the instrument, while position 1 is performed in ordinary (chin on chinrest) position (see score introduction).

resonance/amplification of specific instrument 'zones' chosen for their *double feasibility*, the simultaneous or combined utilizations of both breath and friction sounds/actions (see fig.82-83).

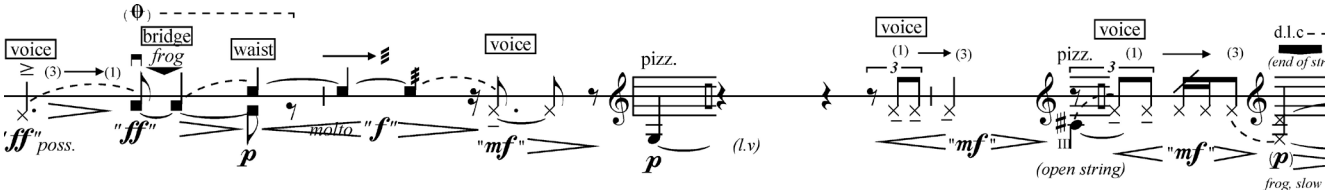


Fig.82 Violin as a hybrid (id)entity: breath (3 positions/amplification) and other techniques/sounds (frictions, pizz., granulations)

The violin creates both air (breath filtration) and air-like (contact-friction) variations that become materials and tools. Beyond allowing working on several layers and air/sound mixtures (as in fig.82), two core *gesturalities* and *temporalities* emerge, enhancing each other within a single hybrid instrumental (id)entity. Applications range from texture reinforcement to micro-variations and 'solo' developments. For example, the investigation of the scroll 'zone' (one of the most resonant violin parts) creates texture possibilities impacting the form (see 'scroll section'). In the second half of the work, friction and breath combinations build 'micro-variations' and 'flows' that become the sources for new interactions. These 'hybrid' articulations (fig.83) merge breath modification (instrument body/strings) and friction amplification (scroll/tuning pegs, with pressure variations creating soft air/whistle transitions). Playing positions allowing physical stability, sound reinforcement and in-performance *movement* specifically develop.[300] Allowing moving between different ensemble positions, these techniques are key to implement spatialization (see spatialization).

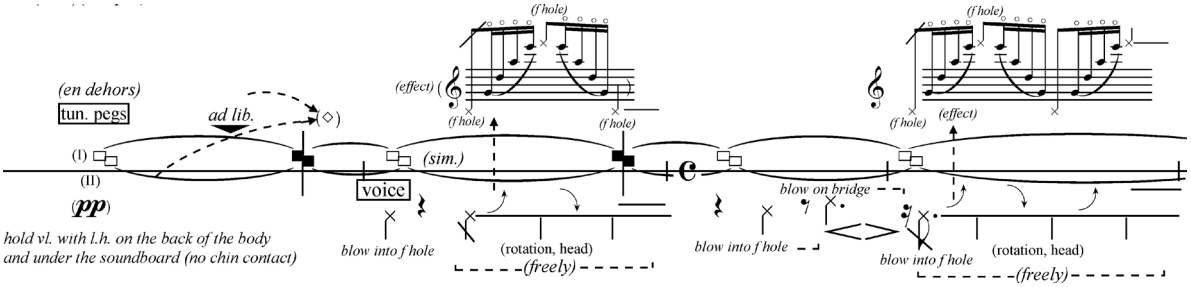


Fig.83Violin as a hybrid (id)entity: air/friction combinations-improvisations (pegs, breath, rotation technique)

Beyond their extended development at the ensemble scale, combined utilisations of friction and breath-based actions (exemplified by the 'hybrid' violin applications) take various forms. Essentially approached as friction instruments and complex resonating bodies, piano, harp and percussion incorporate breath as an extension. Explored in chapter 2, the utilisation of the movement and 'force' of breath to interact with (and generate) vibration – from piano and harp strings to vibraphone bars and percussion skin – is incorporated as an amplification-resonance extension and texture reinforcement. For example, the 'air-guiro' technique[301] extends towards new combinations creating, at the ensemble scale, filtrations, accents and 'resonances' through their attack/echo.[302] These dialogues *reinforce* texture movements. For example, in b.65-68 (fig.84), the 'echoes' created by the vibraphone bars/piano strings 'air-guiros' are sustained (pedals) and expanded by other elements

[300] A violin piece (which can be played independently) was composed in parallel. *En dehors* sections (e.g. fig.83) use fragments of it.
[301] Blowing on the vibrating material (e.g. strings, bars, skin) using fast head rotation to 'brush' it/its surface, creating vibration through movement/projection (the violin 'rotation' technique is an example). See.2.1.
[302] This technique generates attacks and 'echoes' of breath, modified/amplified by the instruments' strings/surfaces.

(e.g. vibraphone motor).[303] Their accent/resonance reinforces other 'affiliated' percussion-breath actions (e.g. violin, winds – see score).

Throughout the piece, each instrument is systematically extended towards new hybrid functions. For example, here (fig.84), the vibraphone is a friction (resonator tubes 'guiro') percussion ('impact' on pedal 'struck' with foot) and 'wind-resonating' (breath-stimulated vibration) instrument; violin, piano, harp and accordion incorporate similar 'hybrid' extensions. The extended 'repertoire' of breath, friction, percussion and resonance-generating techniques and actions creates possibilities which are key for the orchestration (see below).

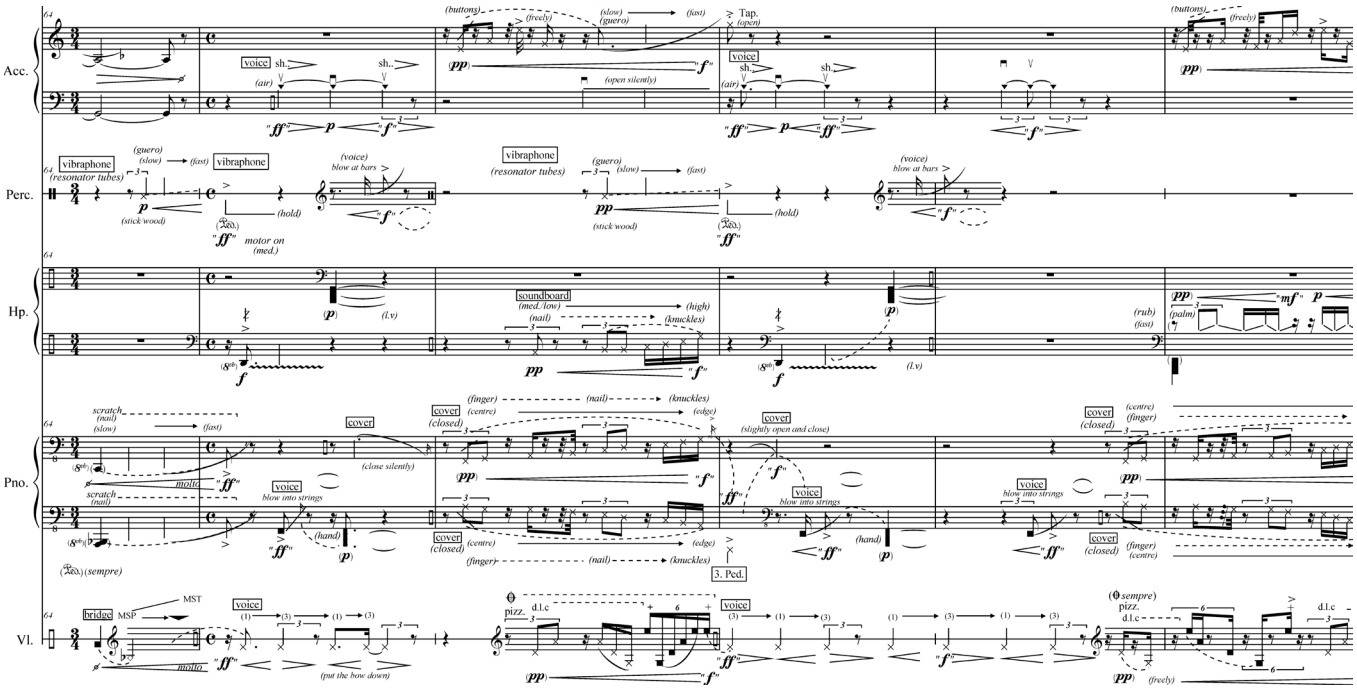


Fig.84 Extensions/hybrid techniques dialogue (friction, breath, percussion, air, resonance), 'echoes' (piano, vibraphone)

Specific extensions *increase* wind instruments amplification and timbre variation possibilities. For example, the mouthpiece-reversed technique (one of the most effective/projecting brass-instrument 'air' techniques)[304] incorporates an additional parameter, the distance between the mouthpiece and the tube (French horn, full 'contact', short-medium distance to mouthpiece-only, fig.85). Position variations increase flexibility in terms of amplification (*ppp* to *f*) while extending the range of timbre variations (low and 'dark' air-sounds to bright and harmonic-like whistles). Such 'revised' extensions[305] are applied to the other wind instruments and incorporate as key elements for orchestration. They include (among others) extended reed-removed, inhaled playing (oboe), articulations and mouth-mouthpiece distance (saxophone), voice interactions (trombone), and air/friction combinations (accordion).

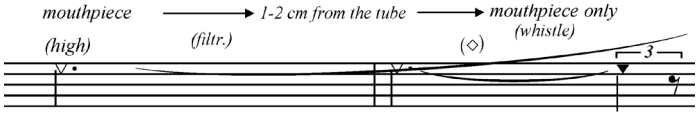


Fig.85 French horn mouthpiece-reversed technique: position/distance variations

[303] Motor speeds impact the breath/vibration attack/echoes (medium/fast speeds are particularly effective). The motor itself creates a soft air-like 'flow' changing according to speed/instrument. See 'idle' applications in *Atma(n)*.
[304] See for example Hill, D. *Extended Techniques for the Horn* (1996).
[305] Investigated-chosen for their dynamic and sound possibilities and effectiveness.

Building a (souffle) orchestration system: flux and forces, hybrid masses - the orchestral scale

Stemming from the air/breath-friction-resonance continuum, the orchestration system is based on the systematic combination of four main parameters: attack/impact, air/friction, echo/resonance, linking material. Each texture-movement (independently from its nature and duration) mixes-merges air/breath and friction, is extended by echoes and resonating 'equivalents' and reinforced by percussive 'equivalents'. The attack/impact (percussive element) enhances the sound and dynamic impact of the air/friction mixe(s) whose combination creates the 'colour' and texture. Both actions generate vibration and resonance echoes extended by parallel friction/air linking materials *within* and *between* the textures and movements. For example, in b.8-beat1, the harpist's string whistle 'accent' (fast/bright 'whistled' friction on strings) extends the oboist's filtered inhalation (bright) itself 'coloured' and reinforced by the violinist's amplified breath (though f-hole position 3, bright). Echoes are created by the harp's strings resonance and vibration (the result of the friction) as the accordion and bass drum parallel crescendo-diminuendo create a soft air/friction 'echo' that works 'inside' the sound as a linking material. The links, resonance(s) and echoes act as underlying elements within the texture *movements* (e.g. b.8-beats 2-3). Expanding principles of chap.2, they create an overall legato widening and 'opening' the musical space (e.g. through their very presence in otherwise inaccessible registers through exclusive use of air).

In addition to allowing texture and movement development, an intertwined and malleable 'vertical-horizontal' approach is crucial for extending dynamic possibilities. Using combinations of the previously described instrumental extensions, the sound impact and possibility to create a sustained and varied air-based 'discourse' lie in the *interactions between* and *effectiveness of i)* the friction-air-percussion dynamic mixes, *ii)* the extended integration of 'echoes' and linking elements (including resonance and vibration) and *iii)* the use of breath and other voice elements as a further reinforcements and resonance-generating materials. The resulting interactions create multiple possibilities. For example, in b.6, the whistle-air mixtures (winds) merge with the soft friction and resonance mixes (violin, harp, percussion) to create a bright, almost *static* and suspended texture, whereas the deep, *pesante* and *rauque* ('raucous') movements of respiration (p.8) develop through combinations of voice, growled and flutter-tongued air techniques (winds) and low 'granulated' resonant frictions and percussions (harp, piano, violin and percussion). Applications include compact and 'condensed' forms (vertical 'blocks' building air 'phrases', e.g. p.1, see form – 'inhalation sections') as well as extended 'diluted' forms (circulating 'waves' of air developed in echoes, e.g. letter B, see form – 'exhalation sections').

As the work unfolds, *porosity* (presence-interaction of air and non-air sound materials in timbre/texture) plays a key role in reaching higher dynamics and creating denser texture and sound 'masses'. The development of denser applications required the investigation of efficient ways to achieve air-enhancing combinations i.e. mixes reinforcing air as a 'colour' or aspect and maintaining it as the main *perceived element* including in 'high' levels of density or porosity. In some cases or combinations (such as dense 'porous' textures evolving in high dynamic levels, see below) air cannot be the predominant or foreground sound material. But it may be perceived as such through perception assimilation and associations, including (or combining): *movement assimilations* (use of air-related articulations, e.g. respiration, 'wind-like' movements), *timbre or texture 'colour'* quality (emphasising aspect(s) of the association, e.g. exhalation and 'deeper-darker' sonority) and

overall continuity within the form (role as part of previous and/or subsequent structure developments, playing on memory, e.g. repeated uses of the assimilations).

For example, in the crescendo-accelerando developing from letter B and reaching its peak in C ('inhalation' section n°2, see form), textures develop through two main air-based *articulations* and *movements*: respiration (inhalation-exhalations) and wind-like 'wave' movements. They gradually incorporate other elements, including 'thicker' sound materials (e.g. overpressures, multiphonics, see fig.86). Combinations generate increasingly porous, dense textures. As the crescendo and accelerando develop, purely 'air-based' sounds and materials are gradually 'submerged'. However, air remains perceived as a foreground *movement* through specific uses and associations created by sound assimilations and rhythm expectations.

The whole section unfolds through systematic, repeated 'breath-related' movements (inhalations and exhalations in various amplified and filtered forms) and wind-like 'waves' ('upward' i.e. dark to bright air and friction mixes systematically developed in parallel groups and echoes). These two elements are intertwined and *omnipresent* since the very beginning of the process (letter B) where they clearly appear as foreground materials. As the crescendo-accelerando develops, the additional 'non-air' materials (gradually increasing the overall 'mass') are perceived as complementary *reinforcements* through their *association with* (and *assimilation to*) the inhalation-exhalation and waves of air and to the specific *expectations* these create. Air and 'porous' forms merge thanks to the very continuity within the overall texture articulation; additional layers become a *part* of a broader 'air' movement.

Systematic enhancements of specific aspects reinforce assimilations. Each instrument is an extended 'hybrid' sounding body. The function extension principle (described above) is applied to each individual part, contributing to the construction of whole 'flux' and impacting the ensemble scale. For example, the piano 'hybrid' techniques-timbres ('guiro' frictions, pedals-strings-body percussion, scratches, voice and 'air-guiros', see fig.86) create specific articulations, accents and resonances that enhance *selected aspects* of the overall texture movements. In b.24-25, the percussive accents (metal frame, here reinforced by bass-drum shell percussion) generate a 'dark' colour that enhances and *resonates the exhalation* and accentuates *the starting points* of the air 'waves' (winds, violin). The harp's granulated frictions (slow string scratches using fingernails) transform into resonant 'whistles' (through increase of friction speed). This timbre-gesture transformation (see *friction embedded in respiration* below*)* creates a dark to bright glissando and 'wave' coinciding precisely with the starting point of the respiration and wind-like 'wave' movements (b.25). A reinforcing action, the granulation-whistle resonance *extends* and is *extended by* other elements within the texture (e.g. piano, accordion and percussion breath 'attacks'). It is also developed within the individual part itself (e.g. resonant percussion, soundboard and strings). The overall (gestural-rhythmical-textural) continuity allow enhancement of the global movements, creating air *synergies* that, even in their increasingly 'hybrid' versions, remain perceived as the main *articulated energies, sounds* and *movements*. The gestural and textural continuity also allow concrete instrumental feasibility.

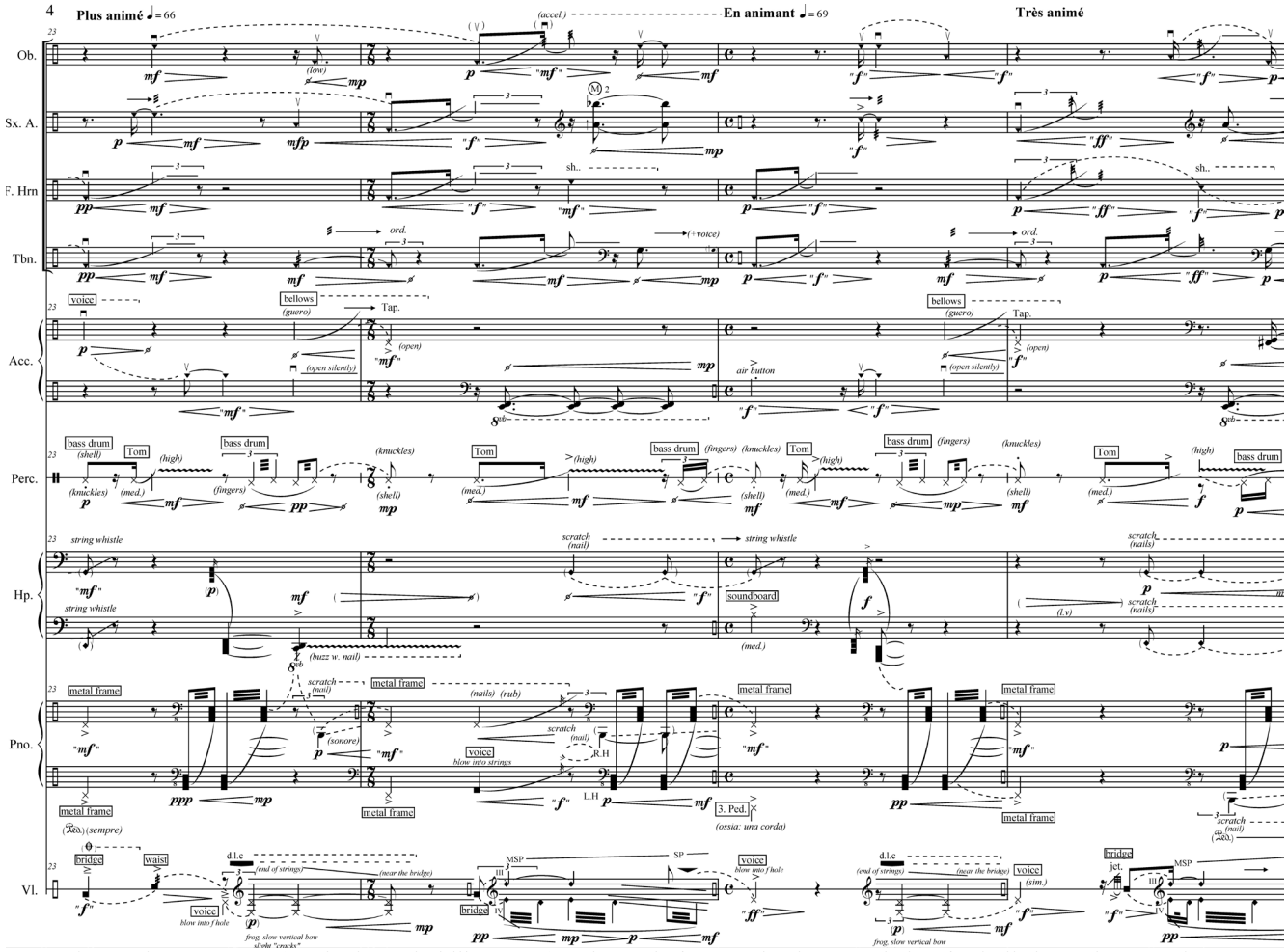


Fig.86 Air movements (respiration, wind-like waves) and porosity/texture density: associations/assimilations, air perception

Respiration and friction as meta-materials: structure and form

Key modes of sound production, breath and friction are also at the heart of the form conceptualization. Stemming from the air and friction duality, energy and ambiguity, the piece develops two main *movements* and *'shapes'* (respiration and waves as illustrated by the previous example) in various forms of mass and temporality (compact blocks to wider echoes). The piece explores different energies and *flux* (Table 8). In movement I,[306] the two respiration steps-actions generate the musical phases and 'phrases' as well as the sections and their subdivisions. Breath and friction are core materials and form parameters respectively assimilated to inhalation and exhalation. Frictions, as specific gestures-processes and 'extended' temporal form build wind-like *waves* in 'circulating echoes'. The latter are gradually compressed and merge with breath 'block' actions towards a single compact mass and hybrid element creating, in turn, new resonance(s) and 'residues' (movement II). In movement III, 'porous' mixes create increasingly dense, ultimately saturated textures (IIIa) culminating in a tense 'gasping' climax, whose peak 'apnoea' generate resonant 'rests'. Using the renewed and extended ensemble *shape*, the second part of the movement (IIIb) develops the 'rests' in spatialized mixes in which air and resonance interact in various foreground/background (and onstage/offstage) perspectives, becoming a complex 'evaporating halo'.

[306] See form description – movements do not appear in the score.

I – Respiration/friction (b.1 to 41)	II – Waves/resonance (b.42 to 76)	III – Porosity/spatialization (77 to end)
Inhalation/exhalation: alternation (air-blocks/breath) (slow waves/friction) Tension/rest – Peak percussive uses of air	Respiration/waves: merging (air-blocks/breath) (compact waves/friction) Animated – 1st climax 'resonance/impact'	IIIa waves/respiration: porous mixes 2nd climax 'gasping section' - 'apnoea' IIIb spatialized layers – air/resonance

Table 8: Macro Structure – three movements

Respiration and friction as meta-materials: the macro-scale (example of movement 1)

The structure of movement I (Table 9) stems from the overlapping alternation between breath-based sections/actions and friction-based sections/actions, built on the principle of tension-rest associated with *inhalation* and *exhalation*. 'Inhalation' and 'exhalation' articulate tension-building phases (vertical 'dynamic' applications) and tension-release phases (horizontal 'circulating' applications). 'Inhalation' phases are characterized by their clear articulation into sub-phases and 'phrases', whereas 'exhalation' phases are conceived as a more uniform, static movement. A compact 'block-writing' is put in perspective with a 'diluted' application. The contrasting character of the two phases allows developing two distinct approaches, which are designed to merge as a single element, flux and force as the piece develops. Two *temporalities* and *perspectives* emerge. This fundamental duality impacts both technique and form parameters on several levels, resulting in a renewed approach to instrumental hybridity and texture-time malleability ('diagonal', compact or 'diluted' perspectives alternation-combination); it also generates new approaches *beyond* the air/friction distinction.

breath-based (b. 1-11)	friction-based 2 (b.12-19)	breath-based 3 (b.20-31)	(breath)→friction-based 4 (b.27-32)	friction-based 5 (b.33-41)
Tempo Dynamics				
:Breath → Whistles: X 3	Circulation (in echoes) 'Scroll section'	Inhalation/exhalation	Breath → Whistles *ff* (+sound)	Circulation → Animated whistles
: Movement → static : X 3				
Tension			 Peak 1	

Table 9: Movement 1: structure and form conceptualization

Respiration and friction as meta-materials: the micro-scale (1). Compaction/dilution (ex 'inhalation section' 1)

At the heart of the macro form, the inhalation-exhalation duality also creates the subdivisions. For example, the first 'inhalation' section includes three sub-sections built on the inhalation/exhalation alternation principle (Table 10). The sub-sections also consist of two overlapping phases assimilated to the same alternation idea: phases of *tension* (e.g. b.1-2) and phases of *rest* (e.g. b.2-3). Phases of *tension* (assimilated to inhalation) stem from a specific air colour arrangement and 'shape' (five colours/qualities ranged from 'low' to 'high' – or dark to bright) developed through quasi-systematic orchestration associations (e.g. 'bright' woodwinds colours, violin bow/waist friction and piano-harp metal frame and soundboard percussion; 'dark' brass colours with piano black key guero friction and violin f-hole-filtered breath, see fig.87). Overall movements create articulated air 'blocks' building animated breath-based textures and phrases. Phases of *rest* (assimilated to

exhalation) stem from softer textural mixes creating slow upward 'waves', a suspended air, whistle and resonance combination (e.g. winds air-whistle sounds mixes within the crotales bright resonance, combined with mixes of bright string/wood/key guiro and frictions, see fig.87). On each sub-section, the tempo and dynamics of the *tension* (inhalation) phases slightly increase while the duration of the overlapping *rest* (exhalation) phases slightly extends, creating different *compaction/dilutions* and *concentration/expansions* (a double principle-process extended throughout the piece).

Sub-section 1 (b. 1 to 3)		Sub-section 2 (b. 4 to 7)		Sub-section 3 (b. 8 to 11)	
Air colours	whistle/wave	Air colours	whistle/wave	Air colours	whistle/wave
Tension (inhalation) →	*Rest* (exhalation)	*Tension* (inhalation) →	*Rest* (exhalation)	*Tension* (inhalation) →	*Rest* (exhalation)
♩= 66	------ ♩= 60	♩= 68	------ ♩= 62	♩= 72	------ ♩= 62

Table 10: Movement 1: inhalation section 1, structure and form conceptualization

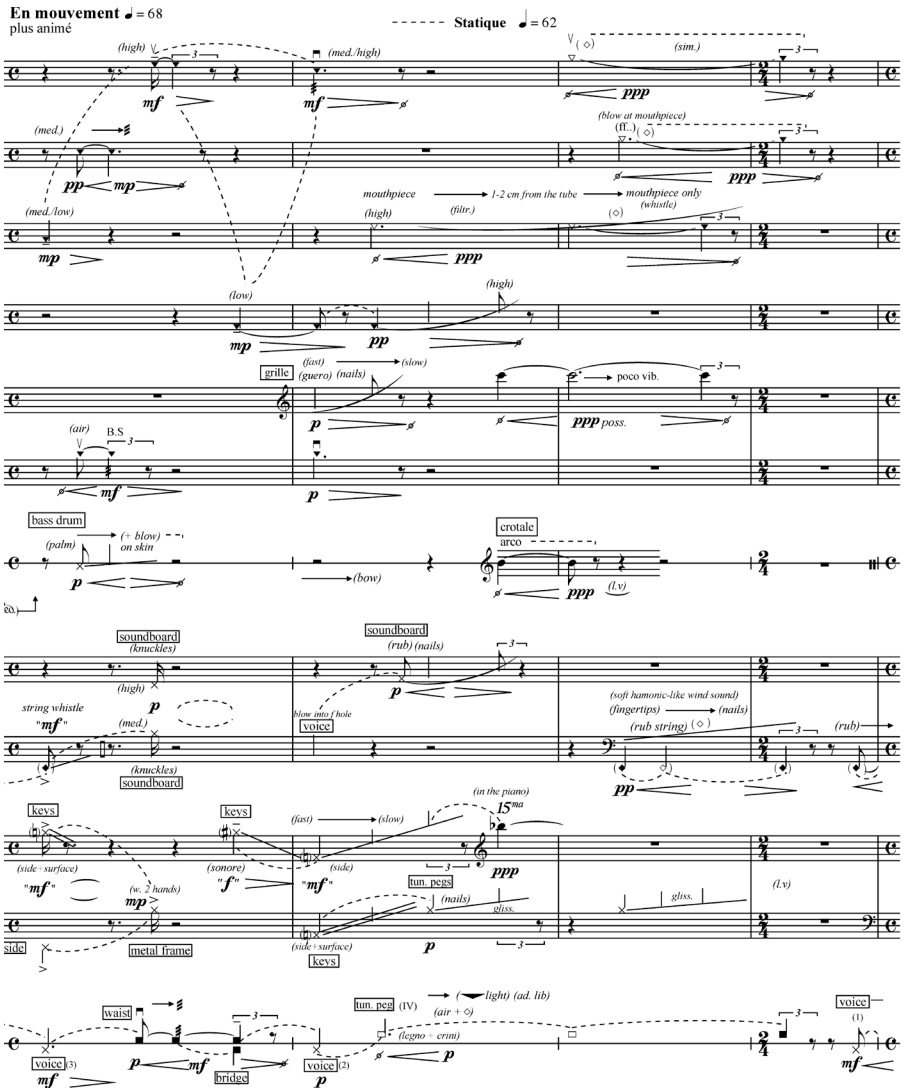


Fig.87Sub-section 2 - inhalation/exhalation phases: *tension* (air 'blocks') and *rest* (waves)

The five air colours 'blocks' are core elements. They are permutated and combined in various ways in the *inhalation* phases. The first occurrence ( ) builds a *reservoir* and overall 'shape' designed to *reappear* throughout the work in various forms. The 'shape' (and to a lesser extent its permutations in the first 'inhalation' section) articulate a dark/bright 'colour' arrangement, filtration and association clearly presented in the introduction. An underlying link, the reservoir 'shape' allows playing, through reiterations and variations, on and with perception – from dense and dynamic forms (e.g. b.99) to soft 'echoes', spatialized 'mirrors' and distant *memories* (movement III, see below). The *reservoir* (here in its initial presentation) also illustrates the first vertical 'block' perspective, which dialogues and interacts with a second horizontal 'friction' approach.

Respiration and friction as meta-materials: the micro-scale (2). Expansion/dilution (and residues)
(ex. of 'exhalation section' 1, the 'scroll-section')

The 'exhalation' sections stem from a second approach to sound, texture and material and form based on *friction*. For example, the first 'exhalation' section (letter B) develops from a specific action: the violin's bow and scroll friction. The choice, here, of this (uncommon) instrumental part and 'zone' as a basis stems from two main reasons: its resonance qualities and control possibilities. The scroll is one of the most resonant parts of the violin[307] and is easily 'playable' through simple, accessible bow contact. Here, the specific position (bow in the scroll angle) allows a *double* contact (bow wood and scroll, bow hair and pegbox, fig.88) creating sound enhancement, bow stability and versatility in terms of dynamics and articulations. New manipulations become possible since this specific instrumental 'zone' resonates and 'reacts' to all types of bowings (up/down, slow/fast, tremolo) and *physically* supports them. This allows rich air-like effects such as continuous 'air-glissandi' using the full length of the bow – brighter/darker according to bow direction.

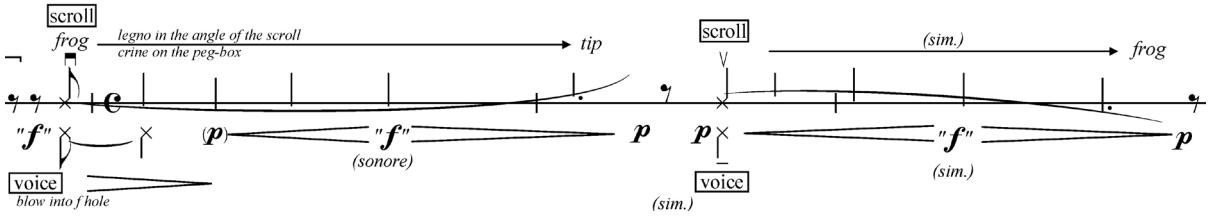


Fig.88'Scroll section' material generation: 'air glissandi' (bow wood/hair)

Throughout the section, the 'air-glissandi' effects (upward-downward 'waves') are core materials expanded and echoed by two instrumental groups: a 'friction' group (piano, harp and percussion) and an 'air' layer (extrapolated from the scroll effects, trombone and French horn). Merging several air-like frictions (on skin, wood, string, key-ivory using brush, bow, fingers, nails) and air-sounds (here phonetically '(re)produced' air-glissandi), these five intertwined 'echo waves' generate an expanded, 'diluted' texture whose movements are reworked directly 'from the inside' at a second *micro-scale* (Fig.89). Additional micro-layers *sub-detail* and 'reshape' them (e.g. accordion air 'shakes' and *ricochets* accelerating and decelerating within the 'air-glissandi'); soft *granulated* frictions, such as slow 'compressed' guiros and scratches (on strings, keys, buttons, e.g. piano, harp and accordion) as well as 'assimilated' sounds (air/key 'clicks' e.g. accordion, saxophone)

[307] Strange P. and Strange A., (2001) *The contemporary violin, extended performance techniques.*

create multiple micro-elements *within* the echoes (a 'micro-organism' contributing to the whole). These elements – literal or 'recreated' forms of friction *residue – granulate* the echo-texture(s) but also *generate* new forms of echoes. Their resonance(s) (strings vibration, rests of scratches and granulations) create, in turn, an underlying layer *sustaining* the overall textures and overall linking material *opening the musical space*, for example by creating more presence/resonance in an otherwise relatively empty range/register 'unreachable' through the exclusive use of air sounds.

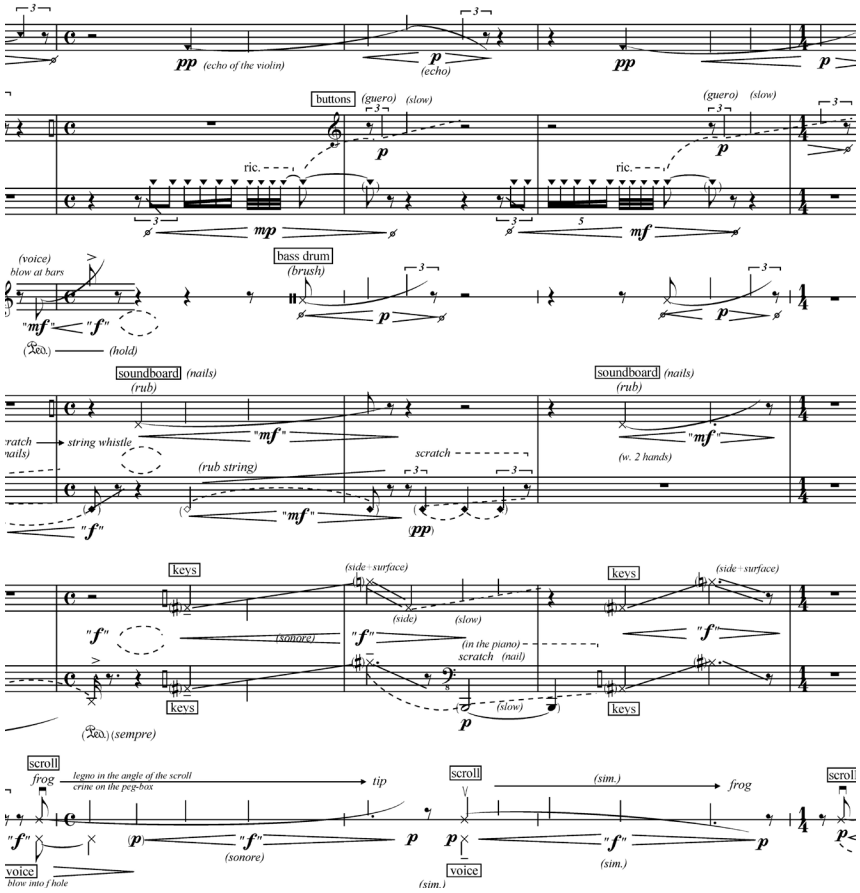


Fig.89 'Scroll' section: material expansion: air, echoes, granulation (excerpt)

Four successive 'echo phases' take place. While the primary elements ('air-glissandi' and waves) remain broadly unchanged, the secondary elements (friction '*residues*') create micro-variations sub-detailing the echoes. Variations include changes in granulation colour or 'detail' – low, sporadic 'grain' to bright and near-continuous rubbings. For example, the piano 'grain' techniques range of from slow, 'compressed' guiros to fast 'air-like' rubbings (on black and/or white keys, whose surfaces and sides create various type of 'granulations' used in one/two hands combinations); from the low 'grain' of strings (softly scratched using the 'wrapping') to the bright, whistle-like tuning peg rubbings (creating soft and bright resonances). This creates a complementary material *embedded* within the overall air texture, stemming from the very gesture and action of *friction*.

(Extending the) orchestration system: grain and compaction - friction embedded in respiration

A contribution to the overall texture 'space' expansion in the 'scroll' section, the sub-details *augment* the 'air' articulated movement(s) – here 'wave' echoes (mass/dynamic increase-decrease and upward/downward i.e.

brighter/darker 'colour' variation) – and create *transitions* between them. The very gesture of friction impacts the sound (here 'wave' movements) and its granulation (here the micro-details 'residues'). Along with the investigation of the friction (time-sound) 'compaction', the 'grain' and 'residues' processes create key extensions that become orchestration elements. This section provides a brief description of their utilisation.

To some extent, (air-like) friction possibilities are '(self)contained' within the physical space (distance, material) their very development *requires* (e.g. to change colour, mass and dynamic) and *allows*. For example, the *same bow length* (frog to tip) is *required for* and *allows to* generate a slow expanded scroll-based air-glissando 'wave' *pp* to *mf* (fig.88-89) and a fast compact *ff* scroll-based 'wave' (e.g. b.18). Variations are possible between these two extremes, creating new combinations: for example, here, through *speed increase* and *gesture 'compression'*, friction actions create 'compact' air-like movements. The latter can easily merge through assimilation with the denser 'block' approach and *verticality* of the 'inhalation' sections'. This 'compact' friction-based material creates new combination possibilities, such as dynamic 'wave/breath' mixtures that become *embedded* within the very movements of respiration.

This development of frictions through 'compaction' appears in the last part of the fourth echo 'phase' in the 'scroll' section. The friction 'waves' and echoes suddenly accelerate to form a single dense, dynamic movement. In the following sections (and throughout the piece), textures develop various merging and combinations of articulated and modified inhalation/exhalations (voice and wind instruments) and 'compact' frictions. Through 'loops' and repetitions, 'compact' frictions become specific *circularly changing colours* and *gestures* assimilated to the inhalation and exhalation gesture and sound alternation; they merge *as repeated movements* within the very rhythm of respiration. For example, in letter E (see fig.90), frictions reach a new dynamic 'block' form through speed increase and gesture 'compression' achieving a *verticality* (or 'circular diagonality') which merges with the breath-based 'blocks' (winds) to create new, *extended textures and air-sound masses and movements*. The combination of the violin tasto-ponticello *circular bow* (strings muted), skin percussion *centre-edge* friction and piano *upward-downward* black-white key guiros create rich *dark/bright* air-like filtrations and variations (also modified by contact materials, e.g. wood-hair, brush-palm, fingertips-nails). The resulting hybrid instrumental mixtures generate new synergies allowing extended dynamic possibilities, using the multiplicity of the air (souffle) gestures-techniques to create a *force*.

Friction temporality, continuity and gesturality (discussion)

In the 'exhalation' sections, frictions are at the heart of the form: the textures, articulations and movements are extensions (and combinations, echoes and amplification) of frictions. Throughout the piece, a parallel emerges between *friction* and *exhalation*. The parallel stems from several observations and allows working with specific ideas. As part of the cycle-steps of respiration, the exhalation is a longer action than the inhalation.[308] As gestures and actions, frictions imply (and allow) a different, 'wider' approach to temporal development compared to air/breath-based techniques and articulations (here assimilated with inhalation). Crucially, and conversely to air/breath-based musical actions, friction-based actions aren't subjected to the limitations and 'needs' to accumulate air.[309] Possible time-sound applications are thus considerably extended (e.g. to 'white-

[308] And the same applies to the pause/apnoea following these two actions.
[309] Circular breathing (wind instruments) is rarely utilised beyond chamber applications.

noise' forms) since the 'limits' and 'borders' are of a more *malleable* gestural and spatial nature: distance, pressure, velocity and space *of* and *for* the movement-contact. Moreover, as seen in chap.1, the gesture and sound *continuity* and *fluidity* friction techniques allow (and convey) open rich paths in terms of modifications or transformations *stemming from air* (souffle) frictions.

Frictions encompass multiple types of contacts and 'resonate' through various materials. As a gestural form, most friction actions can create *continuous variations* and even *transformations* between 'filtered' air-like forms and other/non-air sound materials and 'matters' in fluid, controlled (and natural or 'accidental') ways. A mere parameter change (e.g. in contact point(s), surface(s) and/or gesture speed or pressure) (re)create *pathways* between different, even contrasting *sounds* and *sound-worlds* that *become interconnected* through the very gesture-action of friction. These aspects, explored in chap.1 in chamber contexts, extend to a large-ensemble friction *gesturality* and *temporality*; a malleable form of time, timbre and texture development through gestural continuity incorporating the air/sound 'pathways' as extension and enhancement possibilities. Applications range from soft echoes and 'residues' micro-detailing the sound and 'widening' the space (as in the 'scroll section') to development of expanded sound 'masses' that *emerge from air*

In movement I, the 'exhalation' phases develop soft circulating[310] 'air' textures whose resonance and impact are expanded through 'air-like' frictions and 'granulation-frictions' combinations. Approached as sub-details or 'residues', the granulation-frictions play a vital role as underlying texture-expanding elements. As movement II reaches higher dynamic and 'density' levels, the new *compact* breath and friction 'block-wave' *entity* creates a 'flux' that incorporates an increasing number of new 'residues' – the very results of friction variations and transformations (as well gesture 'accidents').[311] 'Reinforced' granulations (e.g. using overpressure transformation) build new 'thicker' materials and textures *emerging from air* and in direct *gestural continuity* with air-like frictions. These elements become concrete, efficient tools allowing malleability in terms of sound modification, enhancement or transformation through their versatility and reactivity in manipulation.

Developed as a core process, this double compaction-granulation assimilation reaches a peak in which friction(s) and respiration(s) form 'blocks' and movements that become percussive forces and energies through their orchestral expansion. The 1st climax section (letter G-H) builds complex mixtures of air, residue-granulations and 'extrapolated' residue-granulations[312] enhancing the overall mass and impact. *Compact* air-frictions and *dense* granulation-frictions form an *interrelated entity* whose increased volume (also enhanced by percussive and breath-based techniques) creates new possible utilisations. For example, the crescendos leading to the main percussive peaks and 'impacts' (followed by short resonant fermata e.g. b.70/72) build from combination of multiple 'residues'. The resulting 'masses' achieve dense, *ff* 'augmented' air-textures. Their impact is extended through systematic *tutti* counterpoint of sound 'masses' to create (and augment) a *single overall* dynamic effect and idea (crescendo/impact).

[310] Literally (circular gestures and loops) and texturally (in parallel/echoes between instruments).
[311] Friction 'accidents' do not necessarily appear in the score (e.g. 'squeaking' surfaces) and may result from less controllable aspects (e.g. instrument specificities, dryness/humidity, e.g. see recording). Radical dynamic developments of extended/hybrid *breath-based* techniques create new results/possibilities utilised as sound materials ('symbolised' in the score with an adapted sign/notation), such as extreme mouthpiece-reversed utilisations, French horn, creating *ppp* 'harmonics' (e.g. b.32) and *fff* 'saturated' white noise (e.g. b.65), reedless inhalation, oboe, creating *ppp* air/harmonics mixtures (e.g. b.3). See *souffle metalanguage* (3.2).
[312] E.g. left and right-hand muted strings and behind the bridge pizz. (violin), nails and finger tapping and percussions (accordion/harp/piano), see below.

The diversity of actions and specific *articulated* combinations of *different* techniques (air, friction, percussion and 'residual' air) allow achieving the desired effect, using instrument-specific amplifications and extended possibilities (fast articulated changes of air 'colour' in group combinations, winds, white noise 'pushing' the texture, French horn, expanded residues and breath amplification, violin, friction/guero, resonance and percussion harp, piano and accordion – see 'reinforced individualities' above).

The condensed multiplicity of techniques and articulations (combinations of air and air-related elements) create a 'compact' and expanded texture mass built from the very developments of a single overarching element, material and idea. The extended dynamics possibilities are the results of complex combinations built from air(souffle)-based actions which create, are associated with and reinforced by 'residue' elements and extended by the extensive integration of percussive and resonant 'impacts'.

Air (souffle) becomes a 'force' and energy through multiplicity. Elements I initially approached as *links* and *echoes* formed, through composition investigation, a full category of air-related *enhancements* – ranging from micro-scale 'residues' to dense 'mass-expanding' tools. They became the very means to develop a large ensemble 'energy' strategy, a dynamic application whose compositional development created, in turn, *new echoes:* a second type of 'mirror-residue' (expanded vibrations and resonances, see chap.2) resulting of these extended uses. Creating new materials and ideas, these second 'mirror-residue' also raised new questions and required investigation of new methods for composition. In addition to the exploration of their 'radical' developments (movement IIIa), this led to the incorporation of a new perspective, spatialization (IIIb).

Composing (with) the air/friction residues: air mass, grain and perforation (an extended typology) (IIIa)

The category of sounds and articulations that emerges from the 'granulation-frictions' *generates* and *results from* a form gesture and sound 'perforation' – an *interruption* (and *expansion*) of the 'filtered' air-like continuity and filtration that gives birth to a complementary sound matter and material – the 'grain' *of* (and *from*) air (souffle).

Such expansions are rich and take various forms according to techniques and instruments. They vary according to parameters such as material, contact and surface(s) characteristics (malleability, ruggedness). As seen in chap.1, 'filtered' 'air' frictions (e.g. brushed/rubbed surface) can transform into other sounds 'matters' not only through speed/pressure variations but also through the very 'resistance-obstacles' (natural or recreated[313]) of the contact surface itself (e.g. strings warping 'irregularity', skin percussion 'ruggedness', 'space' between the piano keys). Throughout the work, this principle is extrapolated to extend the 'grain' category. Other techniques become assimilated to and incorporated within this category. They include 'grain-like' sounds such as tapings, clicks (e.g. keys/buttons) and other similar sound-mixes (e.g. the violin's 'muted' pizzicati in front and behind the bridge, letter H). They form additional materials part of an expanded family of (natural and recreated) 'residues' which become, in turn, new texture materials (that impact other parameters) as part of an 'extended' souffle orchestral typology – an orchestration system that can incorporate new, radical utilizations.

[313] See 2.3 (accordion bellows elasticity and evolving striation).

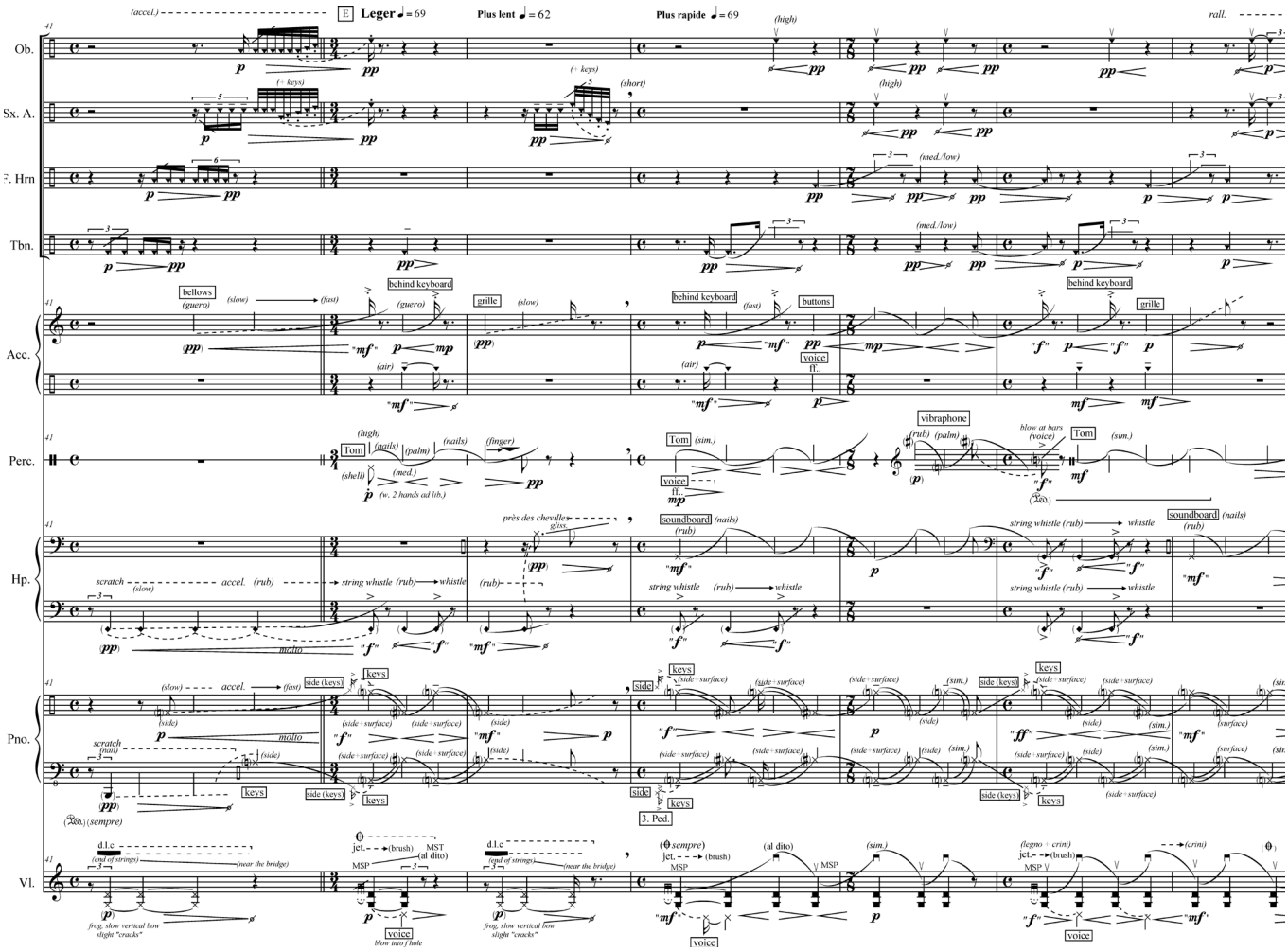
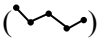


Fig.90 Friction/respiration merging/mixes (II)

Mass and Flux, forces and residues: extreme uses (III)

The 'limits' of air-friction compaction and texture expansion develop through radical applications in movement III. Following the first climax (ending movement II) and building from its air 'residues' ('diluted' in vanishing granulations e.g. b.74 to 77), soft breath-friction mixes gradually emerge. They develop variations of the initial air-colour *reservoir* 'shape' () in various perspectives, including echoes (e.g. b.80), repetitions in foreground and background applications (e.g. letter K) and modified 'blurred' version (e.g. b.85). This colour arrangement and 'shape' material build the first, quiet part of the movement – a 'release' of the previous climax tension.

As the movement unfolds, air and friction elements interact with denser noise and/or pitch-based and ultimately 'saturated' sound materials (e.g. continuous overpressures, 'beating' or strident multiphonics). As the air/sound interactions becomes increasingly disproportionate and unbalanced, respiration *movements* play a key role, expanding the air *reservoir* 'shape'. In the second climax and dynamic peak of the work (*haletant* 'gasping' section starting b.110, see fig.91), the accelerating alternation of 'inhalation' and 'exhalation' texture-movements create 'radical' extensions and articulations. 'Exhalation' texture-movements develop *crescendos* and 'block' mixes of dense saturated sounds (overpressure-granulations, 'buzzing' strings, 'beating' multiphonics and voice-pitch distortions). 'Inhalations' textures-movements *abruptly interrupt* the 'exhalations'

creating *resonant impacts* – (over)accentuated (actual or modified) 'block' inhalations through air/voice/percussion mixes (including five harp and piano 'resonance-generating' players, see below).

The alternation of these compact hybrid 'blocks' within a continuous accelerando, their extreme dynamics and irregular rhythms create irrational, unnaturally loud and dense repetitions of the two breathing actions, generating an increasing tension. The last step and outcome of the process (an *fff* 'inhalation impact' *held* by the performers) gives way to a 'breathless' fermata – here a literal apnoea (fig.92). However, the *breathlessness* is neither a silent pause nor an absence or interruption, but an *intense halo* made of the 'rests' of the 'gasping' crescendo. This results in an *overpresence* of (piano/harp) string vibrations. Intensively *stimulated* through the previous reiterated impacts, the vibrations are also exacerbated by the 'multiplied' sources: five performers, spatialized around piano and harp, utilise them as percussive bodies, amplifications and resonance-generators. Resonance becomes an omnipresent 'rest' and density element – the *physical result* of extreme applications, and (lost) energy of the 'gasping' towards respiration.[314]

Apnoea and resonance, a 'silent' scream and mirror of souffle

Apnoea (the cessation of breathing) shares with the scream a 'suddenness' quality and irrationality. If apnoea can be involuntarily or observed during periods of emotion, it is, in all cases, a *cessation*, an *interruption* that needs a form of continuation, relief or release, creating otherwise more tension through the *very silence* of its *interruption*. But here, apnoea is neither envisaged as a silent interruption nor as a stopping action: its tension is reworked, pursued and extended and finds its very echoes (and representation) in the resonant 'rests' – here the echoes of the 'gasping' section, its *own* breathless residues. Instrumental resonance takes on a new role and becomes the 'mirror' of apnoea. However, apnoea (or breathlessness) is here not an end but a *starting point* to *extend* air as a new element *reappearing* (or 'resurrecting') *within* vibration, *as a form of* resonance. Following the 'resonant apnoea' of the climax (see fig.91-92), interruptions of breath (referred to as 'apnoea effects') are continued, systemically echoed and mirrored through the resonance 'spectrum', creating breathless 'resonant silences' (see spatialization).

A basic principle of anatomy is that the lungs cannot be emptied completely: 'in an adult human, there is always still at least one litre of residual air left in the lungs after maximum exhalation.'[315] The extensions of exhalations (here the 'sonic residues' and echoes), find 'residual' responses within resonances. After the intense climax and 'apnoea effect', the extended 'rests' become the new materials. They are *stretched* and *extended* in the following section of the movement (IIIb, a 'release' or 'coda' of the previous *surplus* of energy and tension) and *revived through* new spatialized resonances effects exploring, at the other end of the dynamic spectrum, the near-silent development. A new form of playing arises through the inclusion of a dense 'resonant background' merging air and sympathetic vibration. Using the 'extended' ensemble configuration (see spatialization), foreground-background perspectives create new fusions, functions and hierarchies incorporating resonance as an omnipresent element. 'Focalized' within two extended 'poles' (harp and piano), the resonance(s) become new mirrors, giving a second residual 'echo of life' to air-breath after its apnoea 'exhaustion'. Reversion of parameters and functions allow envisaging air (souffle) as a surrounding 'immersion' element, a 'breathless'

[314] Developing chamber explorations (see 2.1, 2.2).
[315] Tortora, Gerard J.; Anagnostakos, Nicholas P. (1987). *Principles of anatomy and physiology* (Fifth ed.). New York: Harper & Row. pp. 556–582.

form ultimately evolving at the border of silence and resonance. The *physical* dispersion of the performers creates expanded forms of 'air-vibrations' (spatialized frictions, air/resonance echoes, air residues and 'waves') that ultimately merge and become a single indeterminate element, a *diluted exhaustion*.

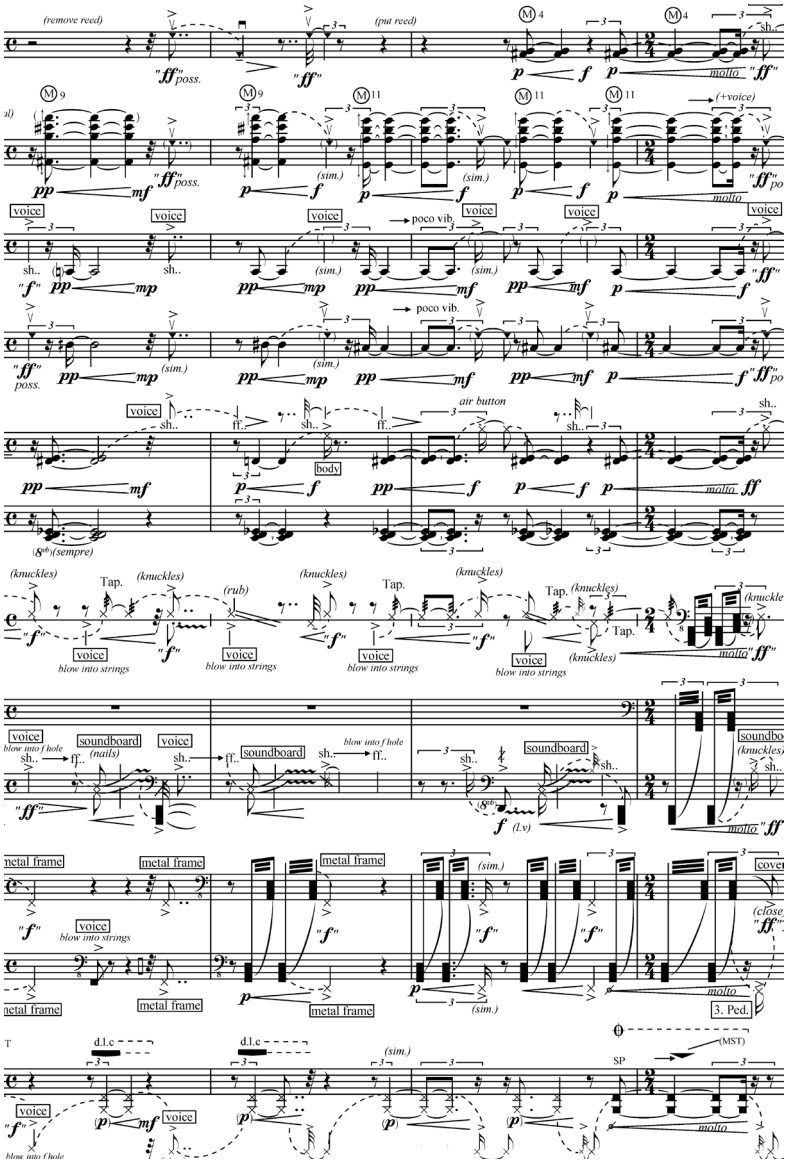


Fig.91 'Gasping' climax. Percussion/inhalation, saturation/exhalation

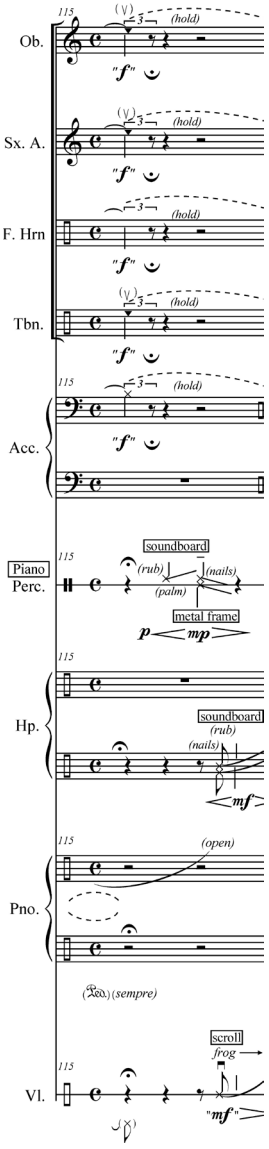


Fig.92 'Apnoea effect'

Multiplicity and space - hybridities extended (III)

Spatialization, guided improvisation and micro-variations develop as *parallel means* to extend the air-friction-resonance continuum(s). Developing (and deployed through) the orchestration system, spatialization arises as a new perspective to extend the range of possible applications and address challenges in large forces compositions. Starting in movement III, the process incorporates individual as well as collective movements creating gradual changes of position on stage (and ultimately offstage). Resonance is at the heart of the process: new positions generate new interactions and extended ensemble 'shapes'. Expanding principles of *Atma(n)* (2.1), a double 'polarization' around resonating instruments emerges; two 'poles', revolving around harp and piano, become spatialized resources for resonance and instrument amplification. Guided-improvisations (on given air-based materials) create *autonomous* movement possibilities while allowing working with individual and collective 'micro-variations' that *evolve* within texture and space. The resulting multiplicity (sounds

sources, physical actions and movements) allow approaching the air-friction-resonance continuum *extension* and respiration-resonance *merging* in new complementary fashions, playing on several levels of perception.

Gradual spatialization examples (deployment of several instrumental positions in ensemble pieces) can be seen in Leroux, *de la texture* (2007) for eight instruments. Initially forming a group around the piano (playing inside it), the performers gradually form a 'rectangular figure' on stage.[316] The piece includes seven position changes and ensemble 'shapes'. They create changing interactions between the instruments and between the instruments and the audience, as the piece plays on the *extension* of the ensemble shape and on the distance between the performers (always on stage) and the audience. Similarly, in the last section of *the tree of strings* (2007) for string quartet, Birtwistle develops a 'gradual' movement idea. Each performer moves in turn to reach a second more distant position, while playing. The second position increases the space between the players while keeping the original string quartet 'shape' (instrument distribution in space). The incorporation of the process in a relatively late development of the piece is particularly effective since it renews an already well installed visual and aural perception (and attention), allowing ending the work in a visually dramatic way (an 'obstinate' cello solo within a spatially 'extended' string quartet, followed by an exit of the performers).

In chapter 2, spatialization movements extend the air-friction-resonance continuum. Gradual position changes impact the performers' (inter)actions *on* and *with* resonance. The piano is an anchor, a 'polarization' and amplification through sympathetic resonance/reverberation. This allows approaching the air/friction/resonance continuum in new fashions. Combining individual guided-improvisation as a 'horizontal' texture-building process (see Holliger discussion in chapter introduction), gradual developments (Birtwistle, Leroux) and continuum extension (chamber applications chap.2), *Hólo(s)* investigates spatialization as a new compositional dimension impacting the air (souffle) perception. The principle of *auto-generated* 'micro-variations'[317] extends to the ensemble and individual scales. Air-based improvisations and micro-variations (see fig.93) *develop through* and *allow developing* spatialization; they become the very means to implement it by allowing achieving continuity in movement and sound.

Position changes involve a group of four performers: violin, saxophone, oboe, percussion.[318] They gradually 'transform' the original ensemble shape into an 'extended shape' using harp and piano as position/sound 'anchors'. The overall process creates a double 'polarization' and intermediate 'shapes' (performers have prepared position directions and 'meeting points' around and ultimately beyond the resonant 'anchors').[319] The physical-musical path(s) between the meeting point(s) are conceived to allow sufficient time and freedom for improvisation and movement. Given material (loops/free repetitions based on friction/air sounds and techniques, see fig.93) create *variations in motion* and air-based *micro-polyphonies* within the overall texture, in solo 'independent' and parallel 'group' developments (see below). Air-based movement-improvisations become rich tools for autonomous, unconducted applications. They allow approaching spatialization as a *continuous* flow and logical extension *within* the material-form development.

[316] Leroux, *de la texture* (2007), score introduction.
[317] Semi-improvised, randomly-changing air mixtures/articulations within the texture based on single/multiple combination(s) of given techniques – explored in *Atma(n)* (collective process) and *Un eco di soffio II* (solo application) (chap.2).
[318] Two to four different positions each (changes are gradual). The work's end also includes the pianist and harpist slowly moving offstage (while continuing to audibly inhale and exhale).
[319] Near the 'anchors' and in specifically indicated parts of the stage (up to three different positions).

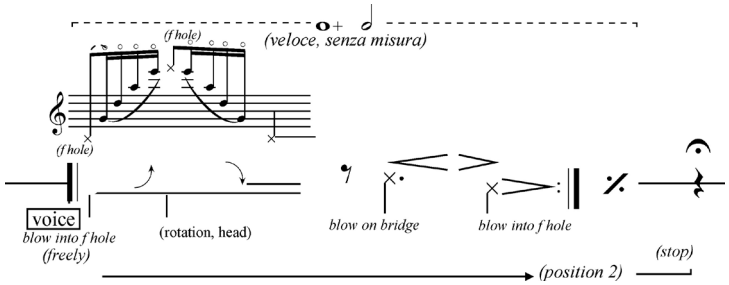


Fig.93 Air-based 'moving' micro-variations: improvisation (given elements/loops) and position changes (violin, II)

Spatialization expands the air-friction-resonance continuum(s) and variations. The resonance 'poles' are key resources: gradual polarizations around the 'anchors' (piano/harp) create resonance *zones* which become *stereophonic tools* for new 'spatial' developments of air-resonance interactions. The different ensemble 'shapes' (see fig.94) impact instrument interactions, resulting in variations, revisions and even *reversions* of previous balances and functions. Developing throughout the 3rd movement (see form Table 8), the process incorporates (and generates) various parameters changes, allowing working on sound identification and visibility, perception, reiteration and 'memory', and multiplicity and ambiguity through density and simultaneity.

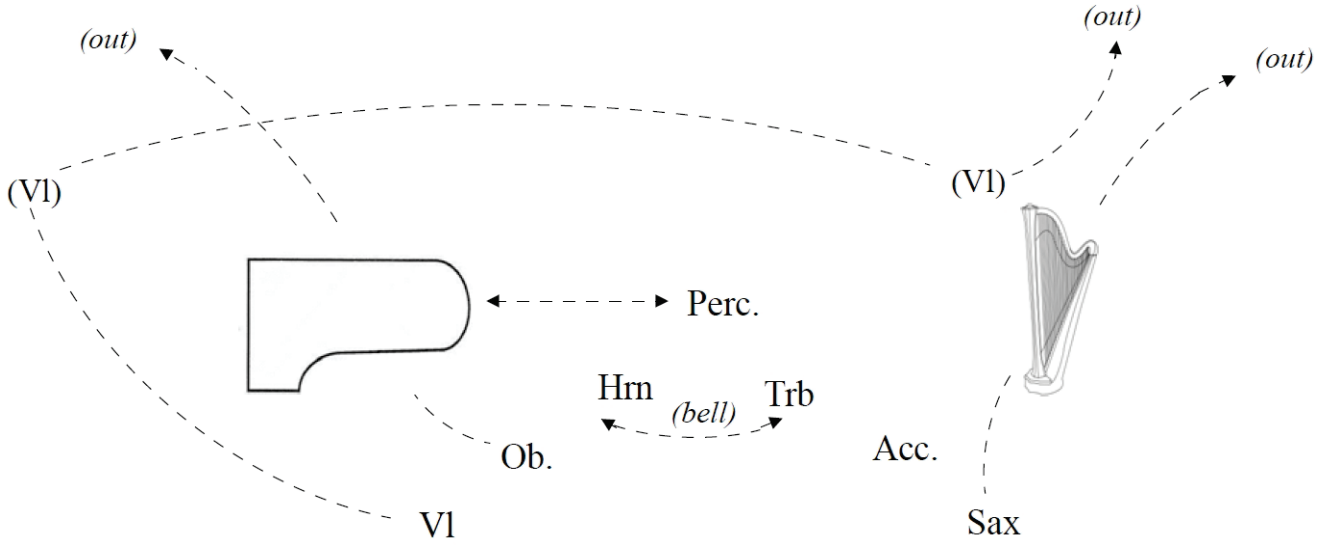


Fig.94 Gradual spatialization movement III: 'shapes', movement and resonance 'poles'

Spatialization and multiplicity – simultaneity/density

During the spatialization implementation (starting b.92 and reaching its first 'peak' form b.112), the *density*, *plurality* and *simultaneity* of physical actions (gestures and movements) and sound (inter)actions strongly influence perception. Here is a short description of the overall process and actions (see also fig.94).

- The oboe and saxophone players are 'assigned' to their *respective* resonance 'pole' (piano and harp), gradually moving/changing position to reach them in the back of the stage (left and right).
- The percussionist is a *double performer* playing on/with two instrument/resonance bodies (percussion/back of the piano, here separated by a short distance), using the 'rear' piano materials (soundboard, frame, strings) as extended *friction* and *percussion* elements (see also 2.1).

- The violin is an independent (p)layer. Moving between three relatively distant positions (initial front-left position to back-left/right positions), the player builds complex *micro-variations* using hybrid breath/friction techniques (see orchestration) generating foreground/background air flows.[320]
- While the French horn and trombone players remain in their initial positions, their playing incorporates changes of bell direction modifying sound directionality and mutual distance, enhancing beatings and microtonal interactions (e.g.). Along with the accordion *reinforcing* this effect (microtonal glissandi/beatings), they generate a specific sound-movement layer *within* the ensemble. (The idea develops until the piece's end as this trio remains the only constant, *synchronised* entity and ultimately only visible element, see below.)

The multiplicity of actions, stemming from various (in some cases uncommon) techniques and modes of sound production, creates an intense level of information. The level of details is designed to *submerge attention*, gradually overwhelming aural and visual perception. For example, section K (fig.95) incorporates multiple simultaneous sound, movement and action layers including *i)* moving improvisations (unmeasured air-sounds 'flows' moving towards harp, saxophone), *ii)* movements and vibration effects (bell/instrument direction, beatings, French horn/trombone), *iii)* front/back dialogues, mutually reinforcing or independent (e.g. back/left of the stage friction overpressures, violin, front/right microtonal glissandi and beatings, accordion), and *iv)* friction, percussion, resonance echoes and 'stereophonic' dialogues (harp and piano, left/right 'poles' in the back of the stage).

The left/right resonance 'poles' are themselves a *concentration* of multiple actions. For example, the piano (here a complex resonance object and percussive body) *concentrates* several modes of sound production. The pianist and percussionist (facing each other on each extremity of the instrument) develop various friction and percussion techniques on specific resonant parts and 'zones' of the instrument (e.g. frame, strings, keyboard, soundboard, played/stimulated with hands, brush, mallets, through voice). At the same time, the oboist utilises the piano as an amplification body and sympathetic resonator through voice and multiphonics (chosen for their complexity and 'beating' qualities).

The intense activity creates a complex multilevel perspective, a multiplicity within *porosity* impacting overall perception. While specific actions may be temporarily 'clear' or defined (audible and/or visible due to nature-distance) the overall sound and movements are of a complex, less 'graspable' nature. The *dispersed multiplicity* of sound sources, not only physically (movements, changing directionality) but also in terms of role and function *within the ensemble* (individualities-groups, creating resonance and additional acoustic effects) impacts the overall result. Through their development in space, the timbre(s) are physically and sonically 'spread' with fewer possibilities for establishing fusions or mediations and merging as a whole 'hybrid' element. Textures become characterized by a sense or form of *confusion*. Therefore, the (listener's) attention tends to be attracted by *specific* aural and/or visual *aspects*, perceiving only a partial or 'blurred' version of the 'whole'. *Constantly changing* sound and movement identification/visibilities (and non-identification/visibilities) allow developing specific dynamic processes and 'illusions' playing on perception focus.

[320] Other sounds serve as punctual reinforcements, e.g. overpressures reinforcing the oboe and saxophone multiphonics (e.g. b.92).

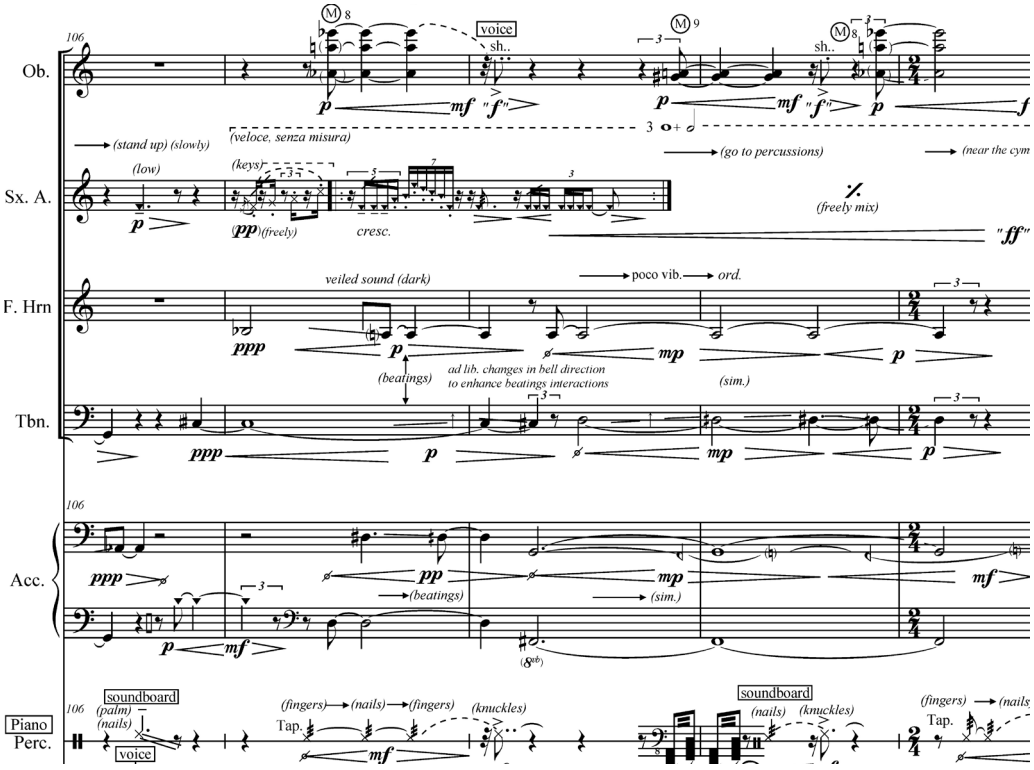


Fig.95 dispersed multiplicity: ob./perc. inside the piano; sax. improvisation/position change; Brass bell direction/beatings (+acc.)

While the whole section (letters K-L) builds an overall crescendo, the real 'mass' increase (reaching the *ff* 'gasping' climax) only takes place when *all* the performers have reached a form of *stability* (unmoving position, uniform directionality, conducted/non-improvised playing). However, the stability is not *immediately* perceived while the 'real' increase takes place. As the climax-building accelerando-crescendo develops through a dense 'block' writing reaching high dynamics (see above), the 'blurred' multiplicity that *precedes* and *initiates* it creates a contrast that *reinforces* it. Spatialization (and movements multiplicity) *increases* the vertical/horizontal (and block/contrapuntal) dualities, balance and qualities, allowing building the *first* from the *second* and evolving from a general sense of 'dispersion' ('afocused' perception) to a strongly tension-building section (and 'focused' perception) – here through 'radical' utilizations of inhalation and exhalation. The *blurred horizontality* 'makes' the (physical and musical) space for a *vertical clarity* reaching the work's highest dynamic and 'tension' levels. The process peak (the 'apnoea' effect) itself reinforces through the physical disposition in space that forms *during the process*. The double-resonance 'anchorage' (piano, three performers; harp, two performers) – a crucial step of the spatialization process *precisely reached* at this climax point – allows extended combinations of percussion, friction and resonance-generating actions amplifying overall impact and achieving an otherwise impossible balance. The last impact generates complex resonant 'rests' providing new 'residue' materials developed in the subsequent sections.

Extended continuities, Fluidity, echoes and dispersion - Air/resonance merging(s) in space

Starting from L (see fig.96), instrument interactions generate new dialogues between *spatialized forms* of air and friction – 'resonant breathings' and 'apnoea' effects. The extended ensemble 'shape' allows building several 'echo' layers investigating the air-resonance *augmented* continuities. Air (souffle) is envisaged as a *surrounding* element, at the heart (and as a *part*) of resonance.

The L section builds through a *triple interaction* between the resonance 'poles' (a 'stereophonic' resonating background, far from the audience – harp, piano and oboe, saxophone and percussion players), a 'respiration' layer (a 'breathing' trio in the foreground, near the audience – trombone, French horn and accordion), and a 'air' layer (a 'moving flow' in the background, very far from the audience, moving from left to right – violin solo). Complex resonance-air interactions within *changing perspectives* emerge. The frontal 'respiration' merges various inhalations and exhalations *forms* and *timbres* creating 'breathing' textures. 'Unfiltered' breath (*nose* inhalations*, mouth* exhalations) is put in perspective with and reworked by instrumental 'equivalents' – (re)created or filtered forms of breath.[321] The background resonance layer(s) incorporate 'secondary' extension parameters ('augmented' sympathetic vibration through oboe and saxophone bell movements, microtonal interactions between woodwind multiphonics/string harmonics). These effects create additional phenomena (beatings, directionality changes, vibration interactions) that *extend* the resonance(s) impact and duration.

While the 'frontal' layer plays on the *continuity, predictability* and most importantly *interruptions* of respiration ('apnoea effects', performers suddenly holding the inhalation/exhalation movement), the 'background' layers (left and right 'poles' and violin air 'flows', six performers) create a constant air and resonance *halo*. Each foreground 'apnoea effect' interruption 'makes' (the) space for a double 'mirror' through which air becomes its own spectrum: the interrupted breaths create no silence, but tense resonant fermata(s), here the very results of the *sudden* emphasis on (and 'apparition' of) the resonant horizon(s). The violin, a distant flow of breath and friction, is itself a part of the complex *horizon; it evolves and merges* with(in) resonance and resonance-associated phenomena (beatings, vibrations). This distant 'flow' (and its changing directionality/position) incorporates inside the resonant horizon, *as a form of* resonance. Tension-generating foreground breathings thus reappear through their very silence within (and as) a complex background 'halo'. Air in its *multiple forms* (souffle) becomes a pluri-temporal element, an indeterminate hybrid resonant 'matter'.

The frontal respiration timbres and movements are themselves the sources of echoes and dialogues. They are 'enveloped' by soft *surrounding* frictions *from* the background 'resonant' sources (e.g. soundboard/metal frame dark/bright air-like rubbings mimicking inhalations and exhalations, piano and harp, see fig.96). These create subtle bridges between the three (here clearly) spatialized layers – of which the background violin 'flows' are a synthesis mixing air and friction. Air (souffle) becomes an *enveloping* material, an element of 'immersion' literally *surrounding* resonance and *within* resonance. The subtle energies that create, vibrate or *live* within the newly conceived air-resonance entity (airflows and softly rubbed surfaces, slight vibrations, resonance and beatings) generate an extended 'halo' of sonic 'dust', a hybrid form of resonance and 'counterforce' to the previous climax 'radicalities' (percussions-inhalations, (over)developed saturated sounds) using its breathless 'rests/residues' to softly surround the musical space.

[321] See chap.2. The 'equivalent' process is detailed in 2.1.

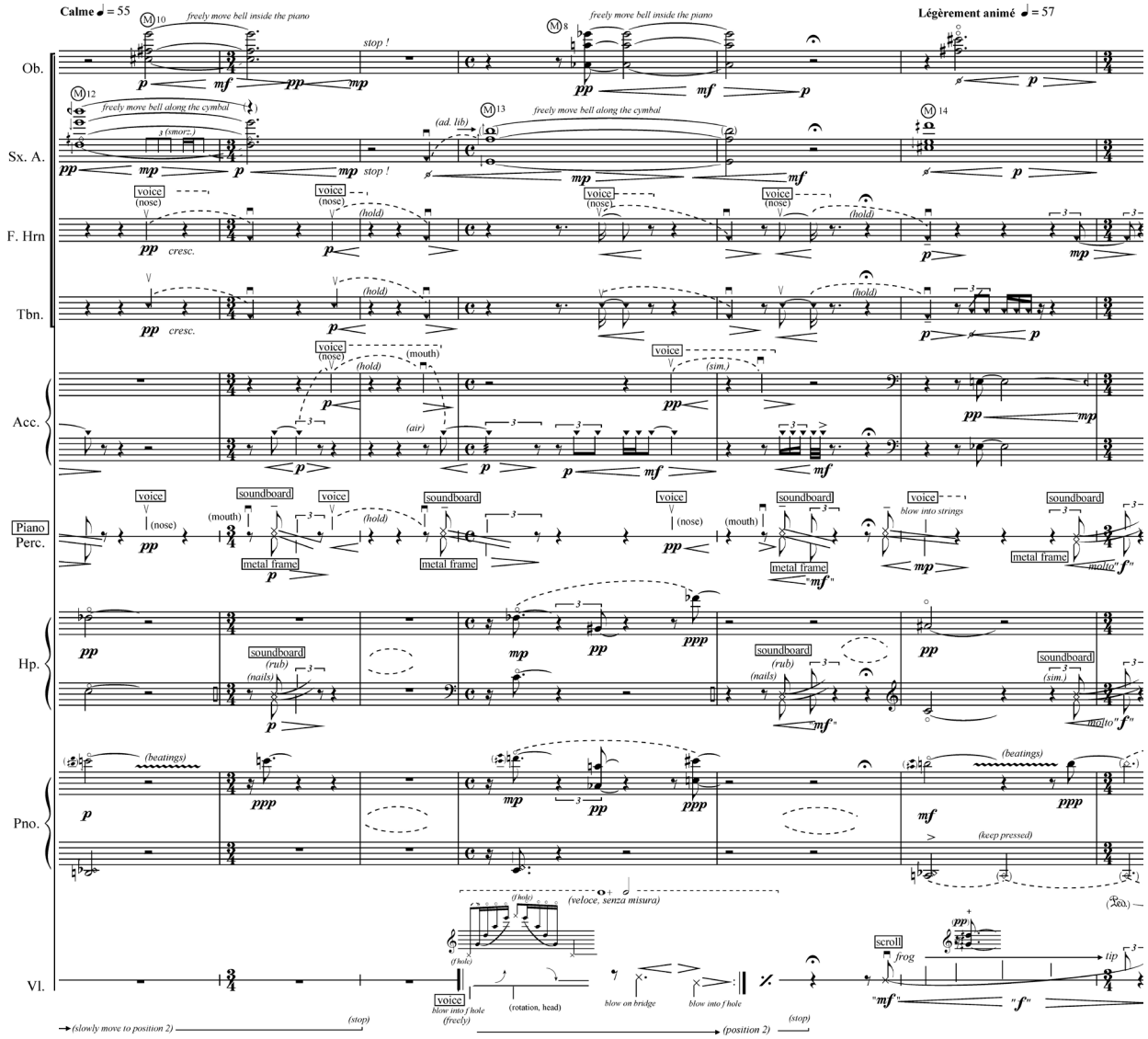


Fig.96 'Stereophonic' resonance(s) - respiration (and echoes/apnoea) – moving airflow (violin)

Resonant spatial echoes: blurred memories, new functions and hierarchies

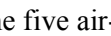
The merging develops throughout the following section (letter M to O). The friction-air combinations generate expanded, 'diluted' textures evolving in various foreground-background (sonic-spatial) perspectives. The resulting 'fluidity' and broadly apulsated temporality (stemming from the 'friction-exhalation' approach) is a key step towards the fully 'diluted' spatial dispersion of the end (see below). The renewed instrument position(s) and ensemble shape(s) generate changes within the breath-friction and air-resonance functions and hierarchies, creating spatially revised versions and *reversions* of previous textures and orchestrations. Spatialization becomes a tool to create new continuities and temporalities playing on perception and memory.

'(Re)construction' of memory is part of the works of composers such as Pesson. For example, *Nebenstuck* (1998) stems from a 'blurred' memory of Brahms,[322] in which underlying timbre and corporeal aspects become, through re-composition and constant use of extended techniques, new materials.[323] However, here the compositional 'memory' is barely changed in the writing. The de(re)construction appears through spatialization: the 'air' material generates its *own* re-composition. The overall emphasis on the secondary 'friction' temporality *reveals* a wider, blurred time and sound form (assimilated here to 'exhalation'). The IIIb

[322] Ballade op. 10 n° 4. See Gailly. V. (2022) Nebenstück de Gérard Pesson : l'invention et la mémoire, *La Revue du Conservatoire n°7.*

[323] Other examples of past-present 'recomposed' pieces-memories through 20-21st century processes/techniques can be seen in the works of Schöllhorn (e.g. *Anamorphoses*, 2010).

section develops ‘spatialized’ versions of previous elements/sections. The friction-breath and echo-resonance balance(s) reversions are the main basis for the spatialized reiterations. (Re)appearing in new forms and *physically* deployed in the foreground of the stage-space (and by extension of the texture-sound), initial ‘echo’ linking elements take on new roles, reversing previous hierarchies. Core materials become part of a broader ‘resonant’ space as blurred, underlying elements, reappearing as *fragments*.

In the re-spatialized ‘inhalation’ phase (fig.97, initially in introduction), a compact, vertical ‘block’ arrangement reappears as a wider texture through new orchestration in a ‘mirror’ version. Core, articulated *breath-based* techniques (here the five air-colours ‘reservoir’ and key  ‘shape’) become distant elements, whereas secondary texture-reinforcing and linking ‘matters’ (resonance, air-friction ‘echoes’) become foreground materials through front-back position/balance reversion. Modifications *in the writing* are minimal. But the new emphases create perception changes. Reinforced by the increased presence around the background resonance ‘poles’ (five performers), the renewed resonance-echo emphasis allows ‘grasping’ an initially *barely audible* (yet critical) *underlying* ‘widening’ material, revealing the legato and *horizontal* continuity of the initial ‘block’ section: its second extended temporality. The resulting broader sense of space ‘(re)creates’ a less articulated, extended time form, here the one of echoes and frictions, but also of a *blurred memory* or *imperfect recollection*. The initial version (re)appears as *passed through a filter* blurring its ‘clear’ vertical articulation, creating a sense of dispersion. The ‘memory’ association is reinforced by the very nature of the re-spatialized material: the air reservoir and ‘shape’, clearly presented in the introduction and reiterated throughout the piece in variously articulated versions, is here the material of the ‘memory’ spatialization.

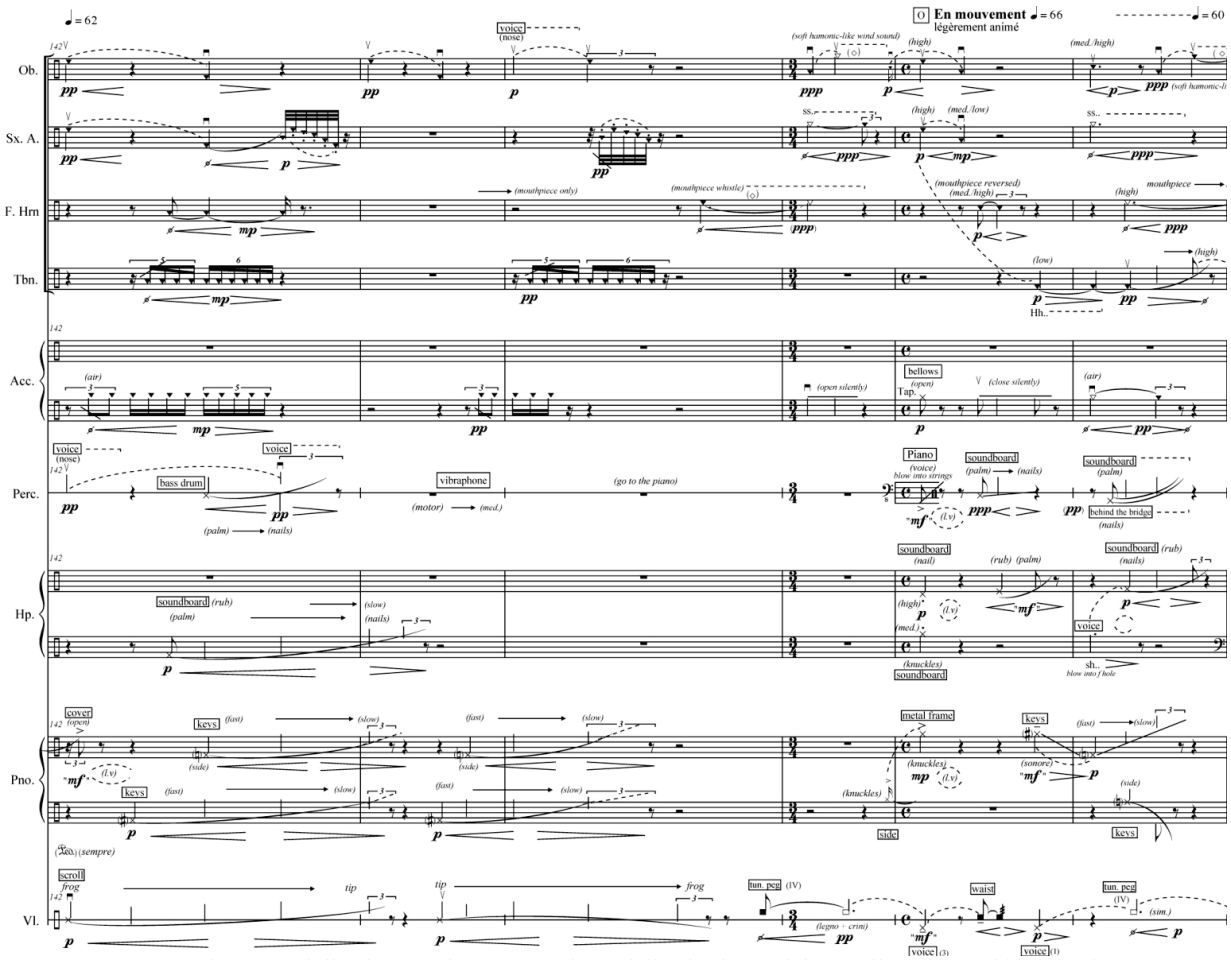


Fig.97 Spatialized Memories: ‘reversed’ spatialized echoes of the scroll section and introduction

Another revision-reversion takes place in b.142-144. Spatialized echoes of the 'scroll section' (see fig.97, initially in movement I 'exhalation' section 1) reverse the friction-air and 'residue' hierarchy and function. The violin scroll 'air-glissandi' and their echoes, initially the core material, reappear under new angles through spatial reversion. The violin, previously in the front-left of the stage, is now in the back-right (behind harp), almost invisible and with less sound impact/projection. The six 'core' actions (friction waves and echoes in six parallel friction-air layers) are here a soft, friction-only background element (four friction layers). The initial 'residue' sub-layers (soft air-articulations and 'grain') develop here as a denser 'frontal' form (three foreground instruments: trombone, French horn and accordion). Additionally, a background 'respiration' element, underlying in the first 'echo phase' (see letter A), is here fully revealed (oboe and saxophone, here left/right back of the stage in their respective 'resonance zones'). Through their increased presence as foreground elements, 'residues' (re)create new types of movements. As the section unfolds, they evolve and merge within the 'foreground' trio entity (accordion, French horn, trombone). 'Compacted', their combined articulations within the front trio (re)create new residue-based 'waves' (e.g. N) becoming *core elements*. The frictions 'echoes', here less identifiable, form an underlying flow that 'resonates' the front layer, its own (transformed) 'residues'. As the 'residues' proliferate, they create new free, dispersed air 'waves'. The spatialization extension ultimately 'merges' these materials creating a 'multiple' form of air (souffle), semi-improvised and 'self-contained' in the novel breath-friction-resonance-space continuum extended entity.

Spatial dispersion, multi-temporality and static respiration

The work's end (fig.98) expands this idea through (literal) dispersion. Starting from the extended ensemble 'shape' (as described in the previous sections), gradual position changes increase distances between the performers (and between the performers and the audience) until the complete dispersion onstage and beyond the stage. The process involves several simultaneous layers in changing onstage, distant and offstage performance. A trio 'block' developing the previous residue air 'flows' is put in perspective with six solo 'units' individually developing air-friction-respiration elements. The whole texture-section develops through these seven parallel group/unit guided-improvisations and loops (on specific air techniques/materials). These layers, gestures and movements (auto)generate complex micro-polyphonies in constant spatial and timbral evolution.

French horn, trombone and accordion (remaining in original position) form a central entity. Their combined loops, made of soft articulated mixtures of air ('residues'), generate movements and flows merging as 'waves'. The six other performers create an expanding 'irradiating' entity: [324] six autonomous 'micro-units' slowly move to reach a final offstage (non-visible) position.[325] The process gradually modifies the overall sound and space interactions, extending and 'stretching' the ensemble 'shape(s)'[326] until complete dispersion of the six 'micro-units'. While these six moving performers (and sound sources) generate evolving mixes of air-breath and friction in their respective changing and ultimately non-visible positions, the *obstinately unmoving* central trio expands the 'residues', working on their transformation.

As highlighted by Helgeson, 'the auditory and visual fields often overlap in their presentation to perception. While this overlap causes intentional objects to join together across modalities, this doesn't mean that their

[324] The conductor moves silently offstage, 'freeing up' the space for full visibility of the process.
[325] Specific directions are given as to the offstage paths and positions.
[326] A specific movement order (vln/perc., sax./pno) creates continuity within spatial expansion, until full left-right offstage dispersion.

movements within each field are parallel. For instance, objects can move into focus in the auditory domain while moving toward the horizon in the visual domain.'[327] Here, the process leads to an *asynchronised presence* of sounds and visual-physical movements. The parallel moving-unmoving layers and actions create disconnected 'steps and stops' within the visual and sonic dispersion. The overall complexity of the asynchronised air-loop improvisations within the 'moving' units and 'unmoving' trio group create ever-changing visual and sound interactions, playing on presence/absence and illusions. A consequence of the lack of possibility of movement-gesture and sound association, the sonic-visual ambiguity allows merging the different forms of air in an undistinguishable 'resonant' halo. Visual and sound duality prevents clear visual identification-differentiation of the sound, their sources and (friction/breath) nature. The movement/stillness and sound/visibility – presence of sound/ and absence of visible movements (or conversely absence of sound but presence of movements) play on identifiable gesture/sign as well as the absence and *disconnected presence* of sound.

Six performers ultimately continue to play offstage while the French horn, trombone and accordion trio remains *visible* onstage. The trio's final stillness is transfigured by the soft (yet ongoing) 'external' actions – complex layers of air, white noise and respiration. The last 'visible' action/sound (accordion *ppp* air bellow-shakes, one of the softest instrumental air sounds) leads to a general 'stop' of gesture, a stillness of the three performers onstage and a *near silence* of the six invisible performers offstage – a gradual 'death' (*morendo*) of the sound through disconnected, aleatory interruptions within the dispersed positions.

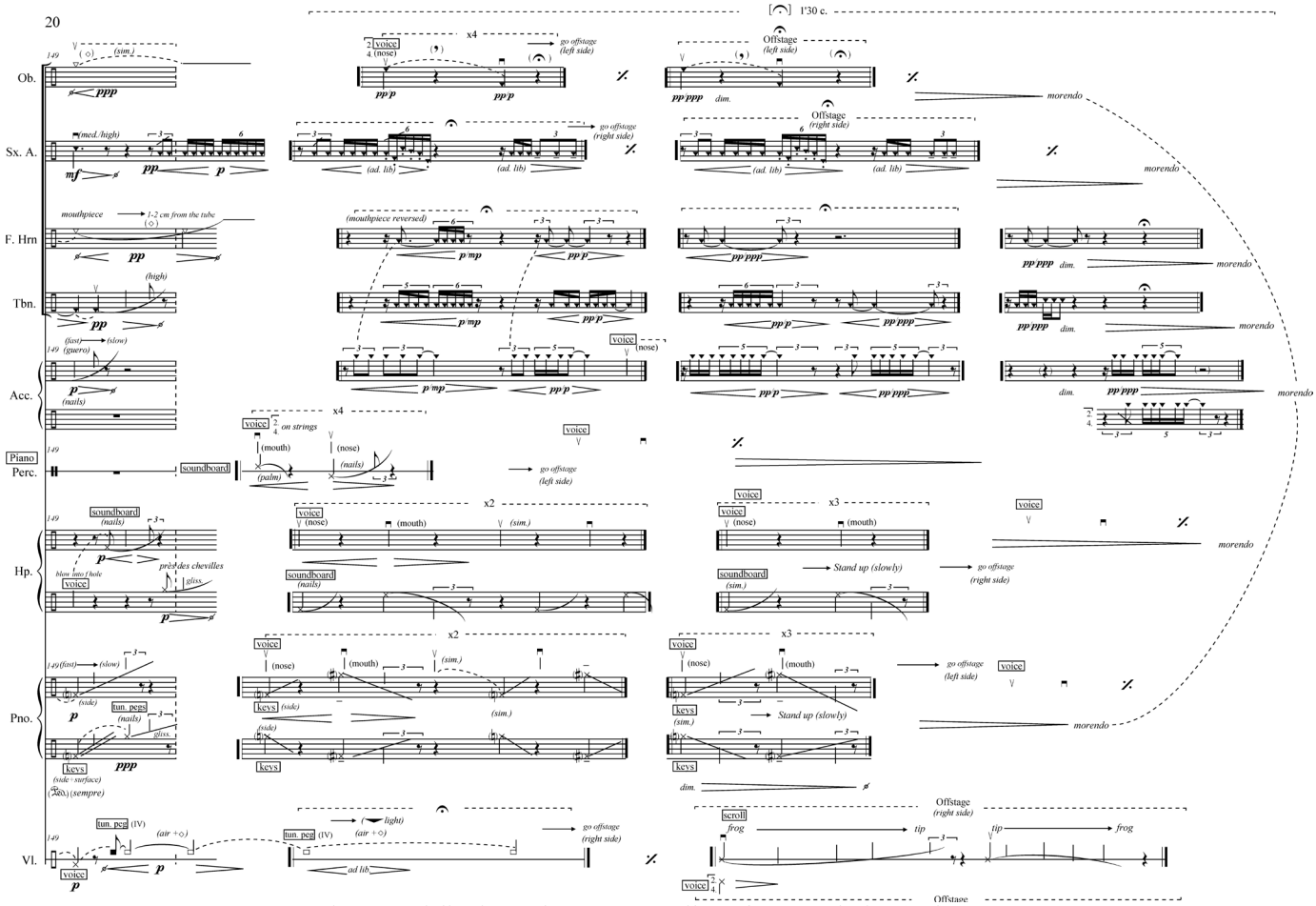


Fig.98 Spatialization and movements, offstage/onstage playing (end)

[327] Helgeson, *What is phenomenological music* (see footnote 264).

3.2 Air (souffle) and virtuosity: until breathlessness. *Concerto pour piano et ensemble*

Concerto pour piano et ensemble applies the orchestration system to a specific instrumental form. The work revisits traditional concerto hierarchies through the lens of air (souffle). The concerto approach creates a double development perspective combining the 'micro' investigations of chapters 1 and 2 ('tactility' and resonance, here key elements in the slightly amplified the solo part) and the 'macro' developments of the current chapter (dynamic extensions and multiplicity in large forces, here the ensemble as a complex instrumental 'mass' and entity).[328] The subchapter examines how the solo-ensemble air and sound 'porosities' can unfold as part of traditional and contemporary forms of virtuosity. By envisaging air (souffle) as an orchestration force, the piece develops unconventional forms of 'expressivity' within the concerto form.

Broadly absent in contemporary explorations (see below), the inherent concerto duality and hierarchy are here fully assumed. They become composition principles, putting in perspective two contrasting (perhaps incompatible) ideas: air (souffle) and virtuosity. Throughout the piece, the ensemble creates a continuous air 'flux'. While evolving within this dense breathing mass, the soloist 'persists' in another approach and soundworld, the one of pianistic virtuosity. Velocity, spectacular actions and complex mixtures of techniques emerge as key features and materials, but also as choreographic elements – and as processes. Such principles create a multifaceted dialogue with air (souffle) – here equally developed in its full orchestral energy.

Coexisting, these sound matters and instrumental approaches transform themselves and 'reveal' each other. But their interactions generate new questions. Can the ensemble achieve levels of 'air' energy (in dynamics, sound thickness, articulation or rhythm density) that may interact with, impact and even challenge the soloist's virtuosity (here also as a form of sound proliferation, timbral thickness and texture density)? Can air (souffle) emerge as a polarization element and question the very notion of virtuosity as part of the concerto form, in its traditional and contemporary explorations? In this purposely dual frame, can the 'air' extension elements (e.g. resonance, granulation, see previous chapters) emerge as new or complementary forms of virtuosity expanding these dialogues? Through these questions and composition foci, this second large-forces application broadens the research and reflection, exploring a simple, yet key question: what is a (piano) concerto today?

The subchapter firstly summarizes the application of processes and developments from previous steps of the research: extension of the porosity principle, orchestration and instrumental approach. Two piano concertos (Furrer, López López) are then discussed to illustrate the piano concerto approach of today, in which the timbral developments inevitably impact the figure of the soloist and the solo/orchestra hierarchy and interactions. The notion of virtuosity (in the 'classical' soloist figure) is put in perspective with the research approach, highlighting complex interactions with air, breath and friction as traditionally undesirable (and hidden) sound elements. This leads to discussing the 'triple' virtuosity of the work (traditional, extended, and passive), which builds the form in three movements. Stemming from the evolution of the pianist's gestures and virtuosity, the form is detailed, highlighting changing perspectives with the instrumental ensemble air (souffle) multiplicity and energy: parallels and contrasts, mutual reinforcement, competitive exchanges and dialogue.

[328] Two microphones on the sides of the piano keyboard enhance percussive and friction actions (on keys, cover, pedals and other parts).

Porosity and multiplicity, orchestration system and virtuosity: instrumental developments

By working both with air (souffle) as a core element and orchestration tool, and on and with virtuosity as a composition strategy, the piece aims to extend the principle of porosity towards the idea of a multiplicity *of* (and *in*) porosity.[329] As energetic fluxes and expressive forces, the air-based textures establish an acoustic and physical counterpoint in constant 'contact' with the soloist's sounds and actions, shedding new light on the solo and ensemble interactions. The 'porosities' thus develop through and within several instrumental layers. The core sound elements (friction, air, breath) – through the constantly changing sound perspectives they create within the ensemble – emerge as specific, yet in many cases ungraspable or fragile materials, which are controlled or left to their natural expansions individually and at the ensemble scale.[330] By incorporating air as an *evolving* density-impacting element, the textures build (through) complex air/sound interactions. Air (souffle) arises as an energy and movement in dialogue with virtuosity.

The souffle-based orchestration system (and the continuity/malleability principles, see chapter introduction and 3.1) allow approaching these 'bi-polarized' interactions in renewed fashions.[331] As in *Hólo(s)*, a reinforcement system through action-articulation creates orchestration possibilities utilising instrument-specific extensions. The air and sound porosity develops on a large-scale but also through various instrumental sublevels (see below), developing processes of *Un eco di soffio* and *Atma(n)* (1.2 and 2.1). The piano's timbre features (and the pianist's actions) are put in perspective with a mixed, versatile ensemble. The air (souffle) *complexity* and *instabilities* create changing perspectives on and within the solo-ensemble dualities. The overall resonance/timbre relationships emerging through this are re-evaluated in the light of souffle and within the concerto form – from which compatibilities, incompatibilities, mixtures and fusions emerge.

A quadruple instrumental scale creates a wide spectrum of possibilities, stemming from the individualities (air sounds, mixed or fragile air-containing techniques) and expanded to the instrumental families (blocks and counterpoints of air and other techniques), and to the ensemble (air texture(s) and other elements in combinations, contrast, or interdependent), and, in parallel to this, within the solo entity (frictions and other percussive actions emerging through microphone amplification, unamplified sounds, resonances and timbral developments). Extreme developments, dynamics and articulations as well as fragile utilisations of air and breath (see 1.2 and 2.2) interact with the underlying (or visible) corporeality of virtuosity, by extending or even 'extracting' it – gently or forcibly.

The research's instrumental developments extend to build the ensemble's air and breath (souffle) mass. Percussion techniques systematize hand-playing and friction. Wind instruments incorporate dynamic and sound projection enhancing modifications (e.g. mouthpiece-reversed, reed-removed playing) and develop a wide range of air sounds, techniques and articulations. Previously developed in solo contexts, the 'hybrid' approach to strings as friction and wind instruments extends to the string section.[332] The string players systematically combine physical and 'tactile' air sounds, mixing breath filtration and friction 'air-like' actions. The 'rotation' technique (breath modification through the f-hole/instrumental body amplification, open strings vibration and

[329] See 1.2 for definition of air/sound porosity.
[330] See work introduction discussion below.
[331] Micro-macro scales, extended echo/resonances incorporation, radical breath/air-related forms, etc.
[332] Instruments' bodies as breath/friction filters and amplification.

instrument rotation) extends towards wide-scale combinations.[333] Such expansions form a hybrid string 'wind' section, whose possibilities and variations create new materials and tools (e.g. texture reinforcement, micro-variations, resonance expansions) developed in solo and group utilisations.

The piano solo is approached as a versatile, pluri-timbral instrument. The acoustic-amplified combination expands the instrument's sounds and techniques and generates the triple traditional, extended and 'passive' developments (see virtuosity below). Enhanced by amplification (microphones on the keyboard sides, see score introduction), the body/instrument contacts – underlying elements within traditional techniques, more present in 'extended' actions such as frictions – create an underlying bridge with the ensemble's flux of air and breath.[334]

The figure of the soloist vs. timbre exploration: homogeneity, new hierarchies. The piano as an orchestral object in contemporary concertos

As representative examples and bases for reflection, two 21st century piano concertos are here discussed: López López *Piano concerto* (2005) and Beat Furrer *Concerto for piano and orchestra* (2007). In many ways, these works illustrate the accomplishment of a post-war shift, in which the (classical) concerto hierarchies are transfigured through the contact with new materials and approaches. In both works, it is not the pianist but the *piano* that acts as a 'solo' entity; its timbral features create the sound material, which is then amplified by the orchestra. The solo and orchestra hierarchy disappears or is of a more complex, blurred nature.

These concertos are characterized by their remarkable sound and texture homogeneity. One overarching sound matter and/or articulation form tends to regulate the work's conceptualization. The orchestra emerges as an extension element, the 'solo' instrument being by itself approached as a complex orchestral entity and as a catalyst for the gestures, articulations and techniques – and their expansion as musical ideas.

Maintz describes Furrer's Concerto as a 'composed spatialization of the piano's sound'. The orchestra is a 'resonant space' amplifying the various sounds and articulations that 'the piano is able to produce'.[335] Explored from the bottom to the top' and 'through the various sonic possibilities of the various registers', the piano's sound is for Furrer the 'centre of gravitation' and the orchestra the 'amplifier' giving 'space and resonance' to the piano.[336] In López López's concerto, the 'DNA' [sic] of the piano's strings is 'extracted'.[337] The piano's timbre features and articulation details are key elements for orchestral expansion. For example, the opening section is an expansion of the sounds produced by the piano's high register prepared strings. These fast, non-resonant percussive sounds are expanded by those (very similar) of the string players plucking their strings behind the bridge with plectrums, building a 'flow of particles' coming from 'diverse locations within the orchestral space'.[338] Furrer has a similar approach: special attention is given to the resonances and vibrations of

[333] See 'hybrid' violin extension, 3.1.
[334] While the keyboard sides are slightly amplified, the strings/internal parts of the piano remain unamplified, allowing a dual/complementary dialogue/scale (e.g. amplified friction/percussion or fingers/keys contacts, acoustic resonance).
[335] Maintz, M.L (2008) in Beat Furrer Konzert für Klavier und Orchester, CD booklet, Vienna, Kairos. Maintz adds that the Concerto is the summation and continuation of a composed investigation and analysis of the piano's sound Furrer also explored in solo works such as *Phasma* (2002), *Three Pieces for Piano* (2004) and *Nuun* for two pianos and ensemble (1995/96).
[336] Furrer, B., "Beat Furrer in conversation with score follower." Interview by scorefollower.org. 16 Jan. 2017, https://scorefollower.org/featured-composer-furrer/
[337] López López J. M.,. Entrevista sobre su Concierto para piano y orquesta, https://www.youtube.com/watch?v=hOs9Xl8WIRg
[338] López López J. M., (2005) in Concierto para piano y orquestra, CD booklet, Vienna, Kairos.

the piano's lower strings, whereby the 'untempered in the tempered' is 'the point of departure for [the work's] harmonic development.' [339]

The timbre and resonance features of the piano become both the *objects* and *subjects* of attention: it is the solo instrument (as a complex sounding body) and not the solo performer (as a *virtuoso*) that is at the epicentre. As a consequence, the figure of the soloist tends to vanish or become secondary to the benefit of timbre and sound versatility. The compositional approach tends to encompass the soloist and the orchestra as a 'whole', and not as differentiated entities. Contrasts or competitive exchanges between the piano and orchestra are broadly absent. A constant expansion function is undertaken by the orchestra, expanding solo elements rather than creating different perspectives or contrasting soundworlds. The solo and orchestra dialogues become mass and timbre interactions; distinct developments, contrasting articulations, materials or textures, cadenzas and purely 'solo' sections (or conversely orchestral textures involving little or no intervention from the soloist) tend to disappear.

In both concertos, this vanishing of the soloist's figure is reinforced by the incorporation of a second 'solo' element which serves to extend the piano's timbre features and resonance possibilities: a 'manipulator' assistant (Lopez-lopez) and a second 'shadow' solo piano (Furrer). In Lopez-lopez's concerto, a *manipulador* stands next to the soloist and executes actions such as muting the low strings, creating timbre changes allowing the 'transitory, noise-like character of the sound to become audible'.[340] 'With the exception of a few moments during which one still hears a couple of spectral resonances, the orchestra moves along the same path', notes Vaggione. In Furrer's concerto, a 'mirror' solo piano acts as a 'shadow' in the orchestra, echoing certain sounds and actions. For example, 'low tones in the piano's bass strings are fingered silently and then made to sound in sympathetic vibration by the orchestra instruments and by the harmonics of a "shadow piano"; they seem to drip out of the solo instrument into the surrounding sound space.'[341] (This form of expansion of the solo instrument's sounds in the orchestra is reversed here, expanded in a full movement (III) in which it is the soloist that expands the orchestra's reverberation through sympathetic vibration and silent manipulations, see dedicated section)

This type of addition to expand the possibilities of the solo instrument is common in contemporary concertos.[342] In Lachenmann's piano concerto *Ausklang* (1985), a second piano also is placed within the orchestra. This 'doppelganger […] sometimes echoes, sometimes pre-empts, the soloist's material, while at other points his part comes into conflict, a threat to the assumed superiority of the romantic soloist figure' notes Pace. As in our examples, 'what is conspicuously absent is the type of competitive exchanges between piano and orchestra that are such a common feature of the concerto tradition.'[343]

[339] Maintz, Beat Furrer Konzert für Klavier und Orchester (see footnote 335).
[340] López López, Concierto para piano y orquestra, CD booklet (see footnote 338).
[341] Maintz, Beat Furrer Konzert für Klavier und Orchester.
[342] E.g. Bedrossian's recent *Don Quixote Concerto* (2021) for a pianist, his assistant and a chamber orchestra, which includes a second soloist (a percussion player around the piano).
[343] Pace, I. (1998). Positive or negative 2. The Musical Times, 139(1860), pp. 4-15.

Virtuosities: ordinario-to-extended pathways. Putting back the soloist at the centre. Air, timbre and energy

Concerto pour piano et ensemble follows the opposite path. The soloist is a central figure. Constant attention is brought to gesture choreography and virtuosity, which act as form-generating elements (see below). Several 'cadenzas' and solo sections develop spectacular gestures and actions (see form). As in Furrer and Lopez-Lopez's concertos, the piano's features and timbre are fully exploited. However, conversely to these two concertos, the timbres or articulations of the solo part are not (or barely) expanded by the orchestration. The solo piano and the ensemble develop as two distinct entities and transform themselves through the superimposition of contrasting sounds and ideas.

The concept of 'virtuosity' – or more accurately *virtuosities* – provides key solutions to develop the solo part and solo-ensemble interactions in this context. If the piano 'souffle' developments (e.g. friction, guero, resonance(s) of air and breath through the instrument) offer a wide range of possibilities,[344] the approach to virtuosity as a complex element and concept leads to exploring another direction, a triple gesture approach and timbral 'state'. Stemming from the *ordinario* playing (conventional key-hammer-damper actions), the virtuosity idea expands to the *extended* playing (timbre-based and percussive actions on strings bypassing or expanding the conventional key-hammer-damper action), ultimately reaching a third *passive* form of playing (sympathetic vibration controlled through visually minimal actions).[345]

Though less common in contemporary concertos, the superimposition of contrasting ideas can create dramatic effects. For example, in the second movement of Lachenmann's *Ausklang*, the 'pointillist' piano writing which takes place 'against a growing noise continuum' in the orchestra is 'immensely theatrical' in live performance 'through the sheer volume of elaborate activity', notes Pace. In *Concerto pour piano et ensemble*, the near-constant, intense level of air-based 'energy' generates a spectacular effect and tension through its proliferation, using in some cases extreme dynamics and actions to grow the air 'mass' (e.g. *ff* polarizations on filtered inhalations, fast 'gasping' alternations of inhalations and exhalations, see below). The virtuosity display and theatricality idea applies here to the orchestral and instrumental forms of air (including unconventional utilisations), which act here as contrasting, competing, but also mutually expanding elements with the solo part. Differently from the symphonic configuration, the ensemble configuration allows a detailed development of each part since each player can be approached as a 'soloist.' This allows systematising unconventional techniques while keeping the 'mass' aspect through the relatively large number of instruments (here 12 players, all instrumental families). This builds changing perspectives on the soloist's gestures and soundworlds.

The solo piano is approached as transformed by the ensemble's 'mass'. Throughout the piece, the proliferation of souffle-based elements (air-breath-friction) impacts the *ordinario-to-extended* pathways and developments. The ensemble's air 'fluxes' dialogue with the soloist's pluri-timbral layers, in which resonance, vibration, and ultimately saturated frictions are core materials. Friction techniques (on strings, but also keys and parts of the piano) expand towards granulations and 'residues' (through overpressures with variations).[346] A specific

[344] As seen in 3.1, 2.1 and 2.2.

[345] To some extent, this triple approach stems from the specificity of piano air-sounds techniques. If frictions (e.g. guiros/rubbings on keys or parts of the instrument) offer rich possibilities (see concerto introduction), they are particularly effective when mixed with breath/other air-related sounds (see *Holo(s)/Atma(n)* piano utilisations). While exploiting this piano 'tactility', the approach leads here to exploring other timbral/textural territories: the piano is also (and predominantly) *extended* by air.

[346] Expanding principles of 1.3.

notation system details the string-dampening and filtration and the complex 'bell-like' sounds (harmonic nodes and 'hand shapes' building a system of position-filtration, see movement II). This creates a versatile system for timbre exploration in constant dialogue with air (souffle).

Renouncing to (the fiction of) the mask: tradition, air and virtuosity. Shaping the (21st century-) concerto

This section provides an overview of the idea of virtuosity and its development in the work. The technical, and by extension physical challenges implied by the very notion of virtuosity lead to a complex interaction with souffle (air, breath and friction) as a cluster of traditionally undesirable, 'un-virtuoso' sound elements. The hypothesis is that approaching air and breath as timbral-corporeal elements *in* (or as forms *of*) virtuosity may allow '(re)shaping' the soloist singularity in the 21st century-concerto.

The terms virtuosity and virtuoso are both widely used in scholarly and popular literature to describe individual excellence, encompassing not only extraordinary skill and technical ability but the displaying of these capacities.[347] In the heyday of post-romanticism, the supremacy of the soloist over the orchestra is beyond doubt; the soloist's performance is at the centre of the musical discourse. A key performance feature, virtuosity is also an essential part of the composition process. It is not only a means but also an end. Technical challenges and spectacular instrumental gestures are designed to highlight and ultimately transform the soloist's skills and 'aura'.

As an instrumental approach and idea, virtuosity also mirrors the representative techniques of a time, which are exploited, at their best, towards novelty and expansion; at their worst, towards simple display, e.g. through fast, mechanical action (e.g. arpeggios, scales, etc.). This 'idiomatic' aspect of (and in) virtuosity leads to questioning the possible 'idioms' of today. In the previously discussed examples, contemporary paths towards timbral explorations inevitably lead to reconsidering classical hierarchies, and therefore the individuality, singularity and 'idiomaticity' of virtuosity.

If the post-45 'restored the sound of breath as a material energy',[348] and if air is a key timbre (or expression) elements in non-western music, these elements still have specific connotations in classical contexts. The very illustration of the underlying corporeality of the modes of sound production, air (souffle) is a 'parasite' assimilated with poor technique. The sounds of instrumental gestures and vocal techniques are to be hidden, no matter instrumental limitations. The air and breath (souffle) that 'escape' from the performer's body (and/or the instrument contacts) are thus the opposite of virtuosity for they 'escape' the performer's control. As pointed out by Lachenmann, air is 'the medium to generate beautiful sounds in traditional music, but one that is not meant to draw attention on itself'. Sounds from the body and body-related modes of sound production might indeed suggest the 'corporeal' origin of the sound, an 'animal' origin that is to be transfigured by the (classical) performer to address the 'anima' (soul) of the listener. This leads to an inherent contradiction, highlighted by Cohen-Levinas. While air is the 'foundation of the practice of singers and wind players, it is to be erased in its audibility' to 'conceal organicity under the fiction of the mask'.[349]

[347] A virtuoso was, originally, a highly accomplished musician, but by the nineteenth century the term had become restricted to performers (...) whose technical accomplishments were so pronounced as to dazzle the public Weiss, P. & Taruskin, R. (1984). *Music in the Western World: A History in Documents*. New Yok: Schirmer, p.430.
[348] Cohen-Levinas, La *voix au-delà du chant*, p.69.
[349] *Ibid.*

Through its constant mass of friction and breath sounds and air-related actions, the ensemble creates a sonic and corporeal link with the solo part – a body-instrument 'continuity'. The soloist's efforts become audible and visible, removing the 'mask' and its fictionality. The physicality and corporeality of virtuosity are transfigured as they reappear (or dilute themselves) in the ensemble flux. *Concerto pour piano et ensemble* explores the 'timbral' and 'classical' forms of virtuosity as equal 'idioms' pushed to the same performance extremes through the souffle perspective – a 'souffle' (re)definition of virtuosity.

The soloist's sounds and actions evolve through, compete with, and are pushed by the orchestral air flux. A hybrid mass of which sonic thickness is the result of a sound and articulation proliferation, the ensemble's flux is constantly animated through air, friction and other sonorities. The flux incorporates radical air/breath utilisations and becomes an expressive force and energy. Through the resulting air/timbre hybridity and movement intensity, the first 'traditional' (pitch-based) virtuosity appears under new angles – fragile, human – and as a complex element (movement I). A second 'extended' (timbre-based) form of virtuosity then emerges, attempting a timbral mixture with the ensemble – but still ultimately competing with it (movement II). Two equal forces at this stage, both the solo and the orchestral layers ultimately 'explode', suffocated and 'diluted' in a soft intra-piano cadenza (end II). Following this climax 'explosion', the only remains are indeed the 'residues' and shadows of the 'before' and 'after', resonance, imperceptible whistling and air sounds. These 'shadow' elements generate the material developed in movement III and create a new, unexpected form of virtuosity.

Gesture-position continuum: traditional, extended and 'passive' virtuosity. Creating the form

As a rich instrument and complex resonating body, the piano is approached as capable of *virtuosities*. An overarching principle generates the approach to timbre, texture and form. The actions of the soloist are part of a gestural continuum. The continuum acts as a function to create the structure, from barely touched frictional contact (rubbing on the instrument's wood, introduction) until overpressures 'digging' into the strings and internal parts in the piano (end of movement II). The ensemble builds a second complex layer of sound 'matter' in constant interaction with the soloist's evolving gestures and (sonic and visual) choreography.

This gestural approach to the solo part is inspired by my previous collaborations with Yumi Suehiro, who premiered the concerto.[350] An experienced pianist, Yumi Suehiro is also a trained percussionist.[351] This allowed rethinking pianistic virtuosity by including percussion-stemming techniques and actions (such as the use of hands and nails as percussive implements) and envisaging rapid changes of position, techniques and/or playing 'zones' using the different parts of the piano.[352]

The 'choreographing' of the techniques allows their feasibility by forming a continuity between the various forms of virtuosity.[353] Techniques arise from and develop through two main position-based approaches and modes of sound production: the *sitting position* modes (movement I) using primarily the keyboard and pedals – here the 'traditional' virtuosity incorporating the underlying, amplified sounds of breath and friction/contacts;

[350] The work was premiered in June 2019 in New York by Yumi Suehiro (piano) and ensemble Mise-en (cond. Yoon Jae Lee).
[351] E.g. see our collaboration on *Cinq figures errantes* (2017) for amplified piano. https://www.youtube.com/watch?v=SSomE1whzMM
[352] The smooth/fast execution of possibly complex transitions and position changes is part of a percussionist's training.
[353] See also 2.3 where this principle links gestures and electronics in a solo context.

the *standing position* modes (movement II) using primarily the strings and internal parts of the piano, combined with keyboard actions – here the contemporary or 'extended' virtuosity. A third mode of sound production in *'still' position* develops in movement III, and includes a limited number of (visible) actions using sympathetic vibration – here a passive 'resonance-based' virtuosity.[354]

Form and gesture/position
(Intro) – I sitting/on key playing - (transition) → – II standing/inside playing (cadenza) → – III 'passive' playing

Changing positions generate gesture possibilities and physical accessibilities that create the sound material, which, developed in movements and sections, builds the form.[355] Stemming from the possibilities gradually 'revealed' to the performer by the perspectives changes, this gesture-position 'continuum' generates the form. Each evolution creates new modes of sound production that the new position(s) allow accessing; in turn, they generate the material and form. On the subsection level, the same principle prevails: specific modes of sound production accessible to the pianist in specific positions or perspectives create the material. Changes unfold gradually. Starting from the use of the (closed) keyboard cover in the introduction (see below), the process develops various 'gestural' situations (I) and ultimately leads to the exploration of the inner 'depths' of the piano's (end II). In the last developments (III), the solo actions become minimal, as the piano becomes a resonating body reacting to external sounds and stimuli.

General form: position/gesture/material evolution
The first movement unfolds in sitting position and incorporates the modes of sound production and techniques accessible from this *perspective*. The densely written melodic-harmonic material (developing extreme registers and expanding the strings' scordatura, see below) incorporates unpitched elements, muted strings and percussion actions (pedals, keyboard 'side' parts, friction on keys and other zones/parts e.g. strings, wood). These elements create timbre and resonance variations and enhance the 'spectacularity' of the techniques and gestures, here on a 'traditional' virtuosity basis.

The second movement is performed in standing position (gradually reached) and develops the modes of sound production that become newly accessible. Changes of intra-piano 'zones', filtration of timbre and control of resonance are here the main challenges for the performer (see notation systems below), using the strings and various inner parts of the piano with and without keyboard and pedal actions. This contemporary (or 'extended') form of virtuosity stems from a 'rough' element exploiting the timbre of the four lowest strings (see below).
Following this in-depth 'inner' exploration, the third movement develops a relatively reduced number of actions in a sitting and near 'static' position. The actions of the other players (clarinet, saxophone) create the piano's sound through sympathetic vibration – controlled by the soloist.[356]

[354] The work was composed in parallel to *Un eco di soffio II* (air and sympathetic resonance, 2.2) which was initially a 'study' for movement III. Only movements I and II were premiered for practical reasons.
[355] See also 2.2 for a similar playing position and form approach in a different context.
[356] A fourth movement (not included) was drafted and involves a 'gestural explosion' exploring fast-tempo frictional/percussive keyboard-playing exclusively.

Movement I **sitting** position *(intro) 'on-keys' (transition)*	Movement II **standing** position *'in-the-piano' (cadenza)*	Movement III **'still'** position *'from-the-piano'*
Pitch-based material →	**Timbre-based material** →	**Resonance-based material**
extreme registers	Timbre and resonance filtration	Sympathetic resonance filtration
strings scordatura expansion	double key-string action	Pedals, blocked keys
percussion/friction techniques	poly-muted strings, on-string vibrato	'silent' keys percussion
'accessible' on-string actions	in-depth on-string exploration	soft intra-piano actions (frame, pegs)

Table 11: Form and gesture/position: sound material evolution

Movement I: air-orchestrated virtuosity. Dialogue, flux and movements

Movement I develops techniques of the keyboard 'zone'. Beyond the densely written melodic-harmonic developments, the solo part incorporates friction and percussion techniques on and with the keyboard, pedals and other parts, exploiting the accessible 'zones' in sitting position.[357] Solo sections are key elements in the form. Three cadenzas (with no or little orchestral intervention) develop in movement 1 (see form below). Each cadenza springs from spectacular gestures and actions: extreme piano registers and associated gestures (cadenzas 1 and 2), resonance and timbre filtration through fast alternation of on strings/on keys playing (cadenza 2), and attack/resonance effects with 'vibratos of pressure' on strings (a spectacular technique developed in cadenza 3, see below). Velocity and fast 'virtuoso' playing extend to the whole register and sounds of the instrument, with fast switches between the zones (e.g. cadenza 3).

	Section 1 (tutti) b.1 to 26 Introduction	**Cadenza 1** (solo)(tutti) 2 phases: b.27 to 39; b 40 to 49	**Section 1b** (tutti) b.50 to 60 Introduction reorchestrated	**Section 2** (tutti) b.61 to 72	**Cadenza 2** (solo) b.73 to 82	**Section 3** (tutti) b.83 to 96	**Section 2b** (tutti) b.97 to 100	**Cadenza 3** (solo) (tutti) in 2 phases: a) b.100 to 108 b) b.108 to 115	**Transition to II** (tutti) b.115 to 136
Piano	friction percussion Piano parts Strings resonance	Extreme registers Keyboard Strings gestures	Scordatura expansion Keyboard Strings	Scordatura expansion Keyboard	Extreme registers Keyboard strings Resonance/timbre gestures	Transparent writing Keyboard	Short Scordatura expansion	Extreme registers Scordatura expansion Velocity percussion keyboard strings	String filtration
Ensemble	air flux Fragile emergences	orchestral breath	air flux Fragile emergences	air mass competition		hybrid respirations air/noise/pitch			orchestral breath mixtures

Table 12: Form Movement I: tutti/cadenzas

Specific examples are discussed below, detailing processes and creating perspectives with the air and resonance typology of interaction (see chap.2). Kourlianski's idea of a 'metalanguage' – non-written elements that emerge through performance as a result of specific performance situations – extends to a *souffle metalanguage*, illustrated here by the orchestral flux and fragility in the work *introduction*. The sound material construction, which originates in solo gestures and from elements 'taken' the orchestral parts – key differences with contemporary concerto approaches where it is the piano, as an instrument and timbre object, that is the main source for sound material and its orchestration expansion – is exemplified by *cadenza 1* and the *introduction reorchestration* (section 1b). The solo virtuosity and ensemble 'virtuosity of the mass', from which

[357] This includes the string 'zones' accessible through hand extension (before the 1st metal frame bar on most pianos), here played through friction/percussion using fingers/nails and palms/hands.

balanced/unbalanced interactions, contrasts and mutual reinforcements emerge are then discussed. The increasing complexity of the solo material creates changing perspectives with the ensemble's constant mass of air, which can only 'compete' with the soloist as a 'whole'. The changing nature of pianistic virtuosity as it evolves towards timbral forms builds new, spectacular gestures and processes (impact and resonance signals, 'poly-vibrating' air textures) in the last steps of the movement (*cadenza 3*) and *transition to movement II*.

Flux and fragility, theatricality and (in) orchestration: souffle metalanguage. Work introduction (b.1 to 26)
The introduction is, literally, an *opening* staging a first theatrical gesture: the opening of the piano's fallboard. This gesture and uncommon instrumental configuration create a range of unconventional modes of sound production, since the 'lack' of access to the keys leads here to developing other sounds and actions, on (and with) the keyboard lid and other non-keyboard parts of the piano. Pedals, strings and other 'zones' become percussion objects and friction surfaces. The very manipulation of the keyboard lid develops as a technique per se mixing with other gestures and sounds. The rubbed and tapped piano lid (centre to edge) and strings create resonant frictions and soft gong-like percussion. Combined with these sounds and actions, the manipulation of the keyboard lid (open and closed, slightly lifted and then let to fall, see fig.99) becomes a rich attack/resonance material equally triggering the strings' vibration without any key-hammer-damper action.

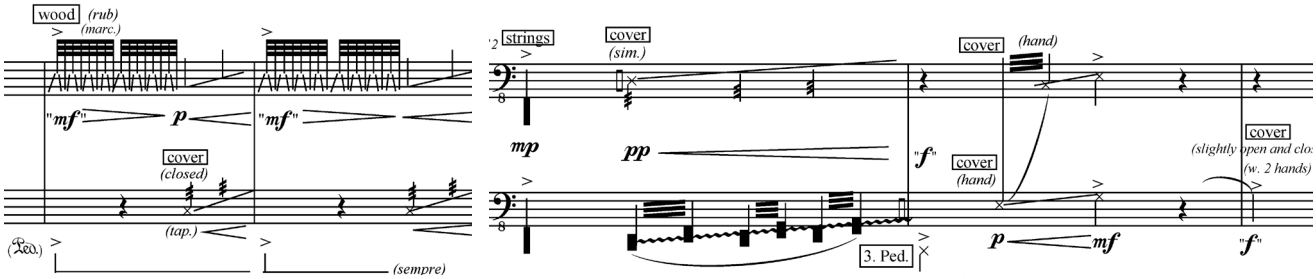


Fig.99 Friction/percussion wood/pedals, fallboard actions, on-string resonant friction/perc. (introduction)

These visually spectacular *keyboardless* gestures and sounds mix with the ensemble's flux of air, breath and friction.

For the whole introduction (1 min. c.), and except for the first bars, the ensemble is in systematic *tutti*. The introduction builds a crescendo through texture density increase and articulation proliferation. The multiplicity of sounds and actions forms a complex air-based 'matter' strongly attracting attention, while visually and aurally dispersing it between the soloist and ensemble actions. The initially soft, filtered inhalations and exhalations of the winds (b.5-8) develop to incorporate faster, more densely articulated air sounds, forming waves and echoes. While this wind-based texture increase is put in place gradually throughout the introduction through increasingly dense and complex combinations (e.g. of flutter tongue, phonetic modification, glissando, voice and 'asthma' effects, see fig.100), the other (friction-based) instruments of the ensemble start the piece in an already advanced 'state' of density and proliferation (strings and percussion 'whipping' frictions and near-percussive air-like actions, b.1-8). At first distinct and in the 'breathing' background (b.5-10), the wind section's growing layer of air-based actions reinforces, and ultimately takes the path over the strings/percussion sounds and air-like frictions in the end of the section. Slight tempo changes contribute to the 'proliferation effect' and impact on the sound result and fragility (see below). These changes (e.g. *più animato, nervoso* b.21

and 23) also ‘push’ the perceived intensity and level of sounds and actions, until the climax of the introduction: the percussive keyboard lid opening by the soloist (b.26 end).

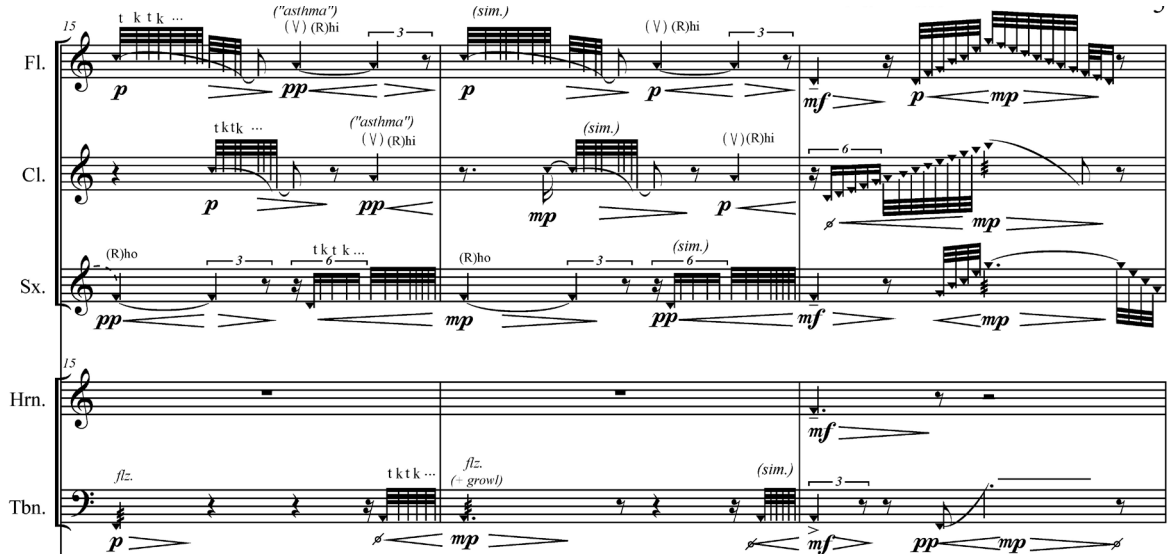


Fig.100 Air (souffle): (Gestural) proliferation, waves and echoes. Wind section, Introduction

Fragile sonorities emerge from this continuous, restless flux. Similarly to the piano, the ensemble techniques stem from uncommon, spectacular gestures. Complex combinations of articulations and/or techniques, dynamics and fingering/positions prevent in some cases 'full' control of the sound by the performers. This creates sound 'emergences' (see below) – individually and within the ensemble – which increase the flux complexity while further building the air/sound porosity and 'permeability'. These elements and non-written ‘accidents’ (e.g. random emergence of harmonics or ‘whistle-like’ sounds, see recording) participate in the inner 'life’ of the orchestral flux. They are the fruits of gestural changes and emerge as the 'accidental' results of complex, in some cases hardly achievable technical combinations.

For example, the strings develop air-based modes of sound production which are purposely 'over-exploited', mixing *ff* air-like tremolos on the bridge, fast 'whipping' frictions with bow and articulation variations, and use of breath (fully incorporated within these techniques) (see fig.101). Air tremolos and frictions develop through bow 'brushing' and 'whipping' with speed variations (e.g. fast *ff* vertical brushing followed by slow vertical-horizontal rubbing and tremolo, violins b.7). Harmonics, open strings and other sounds emerge within these complex gestural changes and are impacted by the constant left-hand 'muting' and pressure variations (dampening/un-dampening, harmonic pressure) and on-bridge/on-strings playing positions (e.g. violins b.11). The amplification of breath through the ‘blow into f-hole’ technique (e.g. viola and violins, b.5/9) creates a 'hybrid' mass developing a range of ‘souffle’ techniques within the string section (friction, breath, air-containing sounds) as well as other noise-based, non-written sounds. This contributes to creating the souffle ‘metalanguage’ in the work.

The term ‘metalanguage’ is used by Kourlianski to define the constraints integrated into the musical text ‘so that the performer cannot play it exactly.’ ‘The musicians repeat the same movements, but the sounds are slightly different each time’, and it is this impossibility of exact repetition that constitutes the metalanguage

which 'does not appear in the score, but it does appear during the performance.'[358] This 'metalanguage' related to the gestural fragility of air and breath (souffle) appears in the introduction and throughout the piece, expanding the investigations of *Un eco di soffio* (1.2) in an ensemble context. Beyond notation and the sheer number of written details (as in the score of *Un eco di soffio*), it is also here the concrete physical difficulty of the techniques (including their articulations in a short temporality) and their impact on and within the instrumental mass that create the 'metalanguage' – a form of fragility emerging from air.

The conventional (classical) performance situation is here reversed. Air and breath, as corporeal sounds or timbre components, do not emerge as sound *residues* of other elements, gestures or techniques (e.g. a bowing, a wind instrument' sound, see discussion on tradition, air and virtuosity). The performance situation lets us hear the 'conventional' sounds (i.e. pitch-based) as accidental emergences from air itself. Pitched sounds or other complex elements, which are furtive and in many cases more guessed at than explicitly heard, come from 'air'. This leads to questioning the notion of desirability/undesirability of sound (or noise) elements within aesthetic canons (of yesterday or today) or composition and sound approaches. As highlighted by Chion, a Sor's prelude for guitar without the sound of (broadly unpredictable) hand rubbings and other frictions on the strings and soundboard completely loses its vitality, and sounds without attracting the listener's interest.[359] In the souffle approach (purposely pushing the comparison to its limit) the emerging pitch-based (or non-air) material is in a reversed situation where it can also be approached as a secondary, yet 'revitalising' element – one without which the performance would not reach similar levels of interest. Hence, the complex relationship with tradition and virtuosity this concerto (following explorations in *Un eco di soffio*) intends to explore and further by constructing of the solo material from these emergences, and exploring the possible virtuosity of the air 'mass' - and the perspective it creates (see next sections).

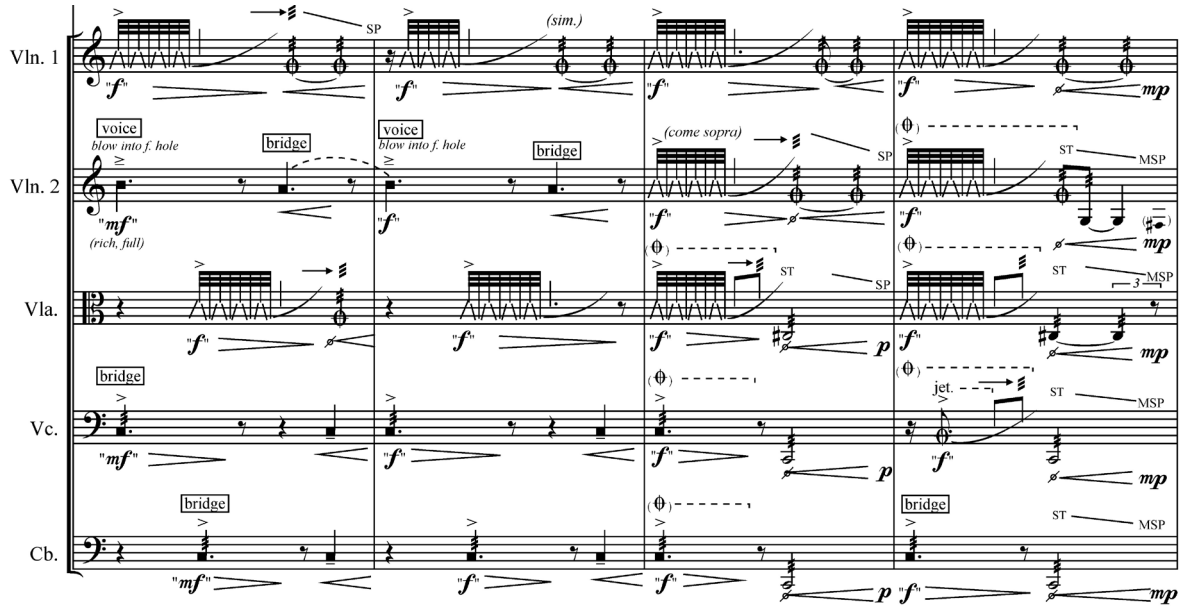


Fig.101 Flux and fragility, 'over-exploitation' of air-based modes of sound production. *Souffle metalanguage*, strings

[358] Kourliandski D., (2010) "Mécanicité et physiologie du son", entretien avec Jan Topolski. In Roullier P. (ed.), *Dmitri Kourliandski. La musique objective*, Paris, Collection À la ligne, 2E2M, p. 50.
[359] Chion, *Sound*, p.62.

Pitch construction: gestural extremes, orchestral emergences. Cadenza 1, introduction reorchestration

While the introduction's complex *tutti* (strings, winds, piano solo and percussion) seems to create an unstoppable, everlasting sonic mass and air flux, it is ultimately a visual element – the (long-awaited) full opening of the keyboard cover – that 'breaks' the flux and reveals the first movement's solo material. A spectacular percussive gesture (the cover is literally struck open) the keyboard lid opening ends the introduction and introduces the first solo cadenza.

The first cadenza section (b. 27-49) introduces the first main type of pitch material, using the extreme registers and their physical prolongations. The gesture acts as a catalyser, not only signalling the end of the introduction section, but also creating the cadenza section's material and form. In addition to the string scratches and pedal percussion (already present in the introduction), it is here the position of full arms extension that creates the material. The physical extremities of the keyboard (lowest and highest registers and 'block' parts)[360] are the main sound sources (fig.102).

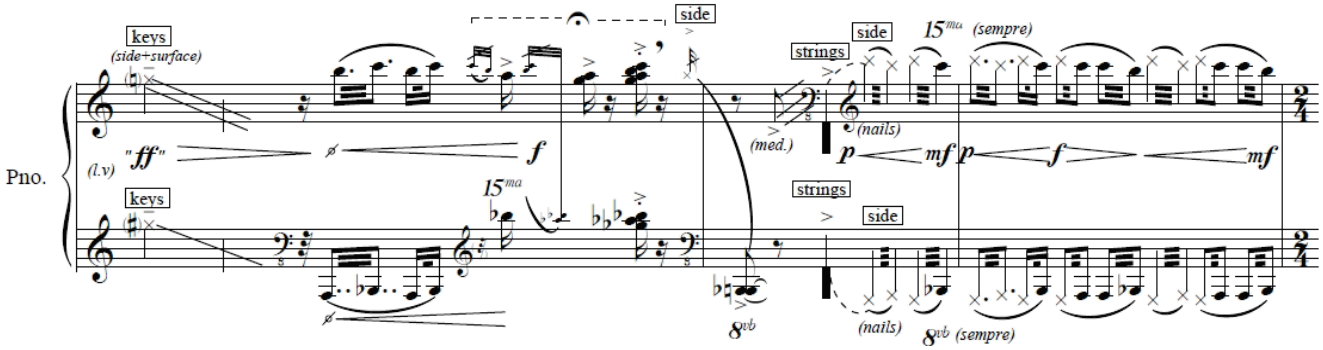


Fig.102 Gestural extremes material generation: maximal arm extension, block parts (sides) as keyboard extension; percussion/frictions

Starting from this gesture-and-register physical/instrumental extension, other piano zones are gradually 'reached' incorporating other materials and actions. A soft 'orchestral respiration' (b.40-49) in which the soloist's mixed human-instrumental breath emerges (see 'equivalents' in chap.2) ends this first cadenza and acts as a transition. A 'blurred' memory of the previously proliferating air fluxes, this brief pause (and fermata b.48-49) represents a breathing 'rest' before the intensifications yet to come in the introduction re-orchestration.

The 'orchestral respiration' gives way to a re-orchestration of the introduction (b.50-60) with an *open lid* configuration (fig.104). Widely blurred in the work's introduction (e.g. the result of the piano's rubbing, resonance or percussion techniques, or part of the ensemble *metalanguage*), the pitch-based material emerges. The ensemble's sounds and movements are re-orchestrated, expanded and echoed by the (previously inaccessible) on-keys playing possibilities. These new 'zones' expand the soloist's techniques, building the first virtuosity approach. An increasingly dense 'melodic/harmonic' writing, which incorporates gueros and percussion techniques,[361] expands to the whole piano register, while the soloist still develops other non-keyboard actions stemming from the introduction (string scratches, pedal percussion). (These non-keyboard elements expand to the inner parts and are designed to gradually become the main materials of the second virtuoso approach in movement II.)

[360] 'Block' parts after the keys (*side* in the score). The *side key* part is another part of the 'block' also utilised (see score introduction).
[361] Black and white keys (two timbres) extended in some cases to the percussions on the 'block' parts/physical extremity (*side/side keys*).

Crucially, and differently from the previously discussed contemporary concerto examples (Furrer, Lopez-Lopez), the soloist (and solo piano) sound material (and by extension timbre development) springs from the orchestral parts. The 'notes' that emerge – sometimes accidentally – from the (broadly unpitched) ensemble mass are 'taken' by, and incorporated within the solo part, building its pitch-based reservoir (initially non-existent or underlying, introduction, and then 'reduced' to the extremes, first cadenza). As in *Atma(n)* (2.1), the pitch reservoir stems from the strings' scordatura.[362] Although here exploited in a different context (a concerto, a greater instrumental mass), the tuning characteristics of the strings similarly create a reservoir for harmonic expansion.[363]

Mixing with the extreme registers and non-pitch-based materials, the string scordatura 'irrigates' the piano part, which itself develops, resonates, and expands it, from the first actual 'on-keys' material (e.g. b. 56-57, see fig.104) to the later dense virtuoso expansions (e.g. fig.103). In addition to the extreme registers (stemming from cadenza 1, see above), the scordatura and its harmonic extrapolation develop the piano's writing towards the medium (and gesturally 'central') register. The (re-tuned) open strings and harmonic expansions gradually transform into an intrinsically *pianistic* material, which, expanded, takes more complex forms (see *virtuosity extended* fig.103).[364]

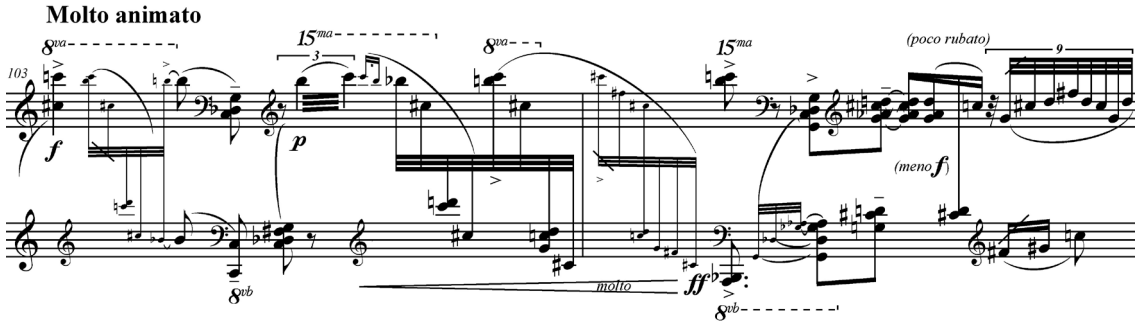


Fig.103 'Traditional' virtuosity extended: extreme registers, scordatura expansion. Velocity, register switches, complexity

[362] Here from the combination of the open strings (IV) of the string quintet: C/C/C#/F#/G (the viola evolves between C and C# - C# is fingered), e.g. b.19.
[363] See 2.1 *Atma(n)* for a detailed description of scordatura-related approaches – similar processes are developed here (e.g. combination of the natural harmonics the tuning alteration allows, predominance of open-string playing for timbre quality/feasibility).
[364] The scordatura's intervals relationships (combination of ordinary and 're-tuned' open strings and harmonics, e.g. the expansion of the semitone between the fourth strings of the first and second violin) are key.

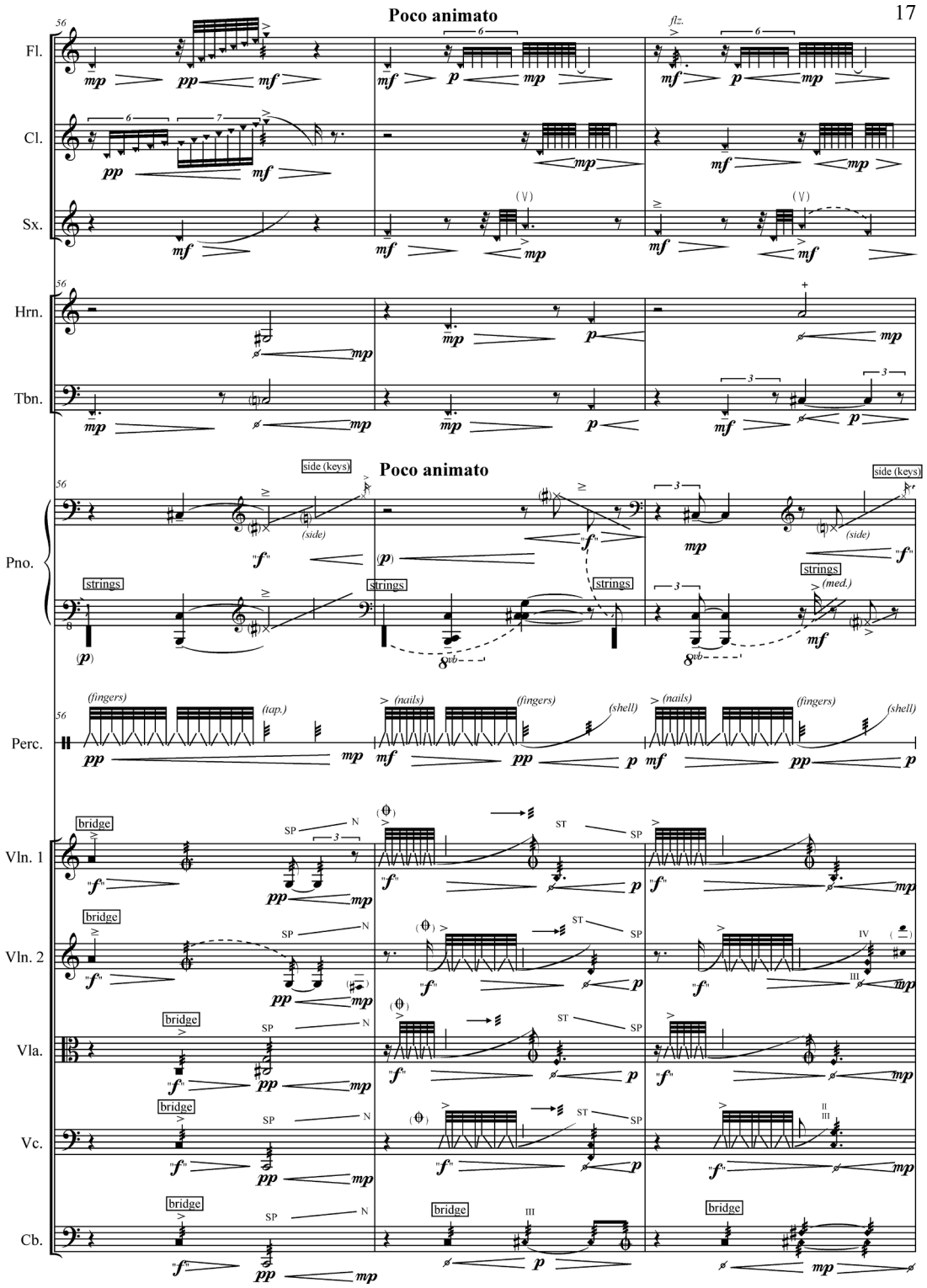


Fig.104 Intro re-orchestrated w. open keyboard possibilities revealing timbral/pitch/friction material (piano) expanding scordatura

Virtuosity of the soloist, virtuosity of the (air) mass: interactions, reinforcement, competition

As the first movement develops, the air and sound (and solo and ensemble) interactions become increasingly competitive, complex, and porous. The ensemble's air (souffle) expansions 'push' the soloist's actions in an obstinate path towards an increasingly inharmonic and ultimately unpitched, timbre-based approach. The ensemble air developments create a second, parallel form of 'souffle' virtuosity incorporating fast, complex articulations.

This ‘virtuosity’ is by its very nature a virtuosity of the mass since the mixed air-based textures of the ensemble can only compare *as a whole* with the pianist’s virtuosity (in its timbral, harmonic, traditional or extended forms). Beyond the individual (and individualistic) aspect of virtuosity (see above), it is only here through a ‘mass’ virtuosity – a virtuosity of the mass – that a competing balance can be achieved.

As two forces, piano and ensemble compete, dialogue or ‘push’ each other forward; they respond to each other and interact as either sonically balanced or unbalanced masses. For example, during section 2 (b. 61-72, see form) the air-based (souffle) orchestral parts are in intense dialogue with the soloist’s pitch-based virtuosity, and, as a movement, ‘push’ it forwards. Alternating fast ‘waves’ in crescendo/decrescendo, the two forms dialogue and overlap on complementary ‘shapes’ but still in fundamentally contrasting sound universes (see fig.105). Despite this, these distinct forms enhance each other, for they proliferate towards a common dynamic expansion and articulation direction.

Dynamics and articulations create the pathways for the enhancements and echoes. The material’s nature (pitched/harmonic or air-based/unpitched) becomes of secondary importance: the inherent malleability (and universality) of air ‘adapt’ (to) the dense and fast pianistic melodic gestures (e.g. fig.105). These two elements have in common fundamental characteristics and aspects – virtuosity, intensity, proliferation – which, as ‘expressive’ parameters, allow going beyond the timbral nature of the material.

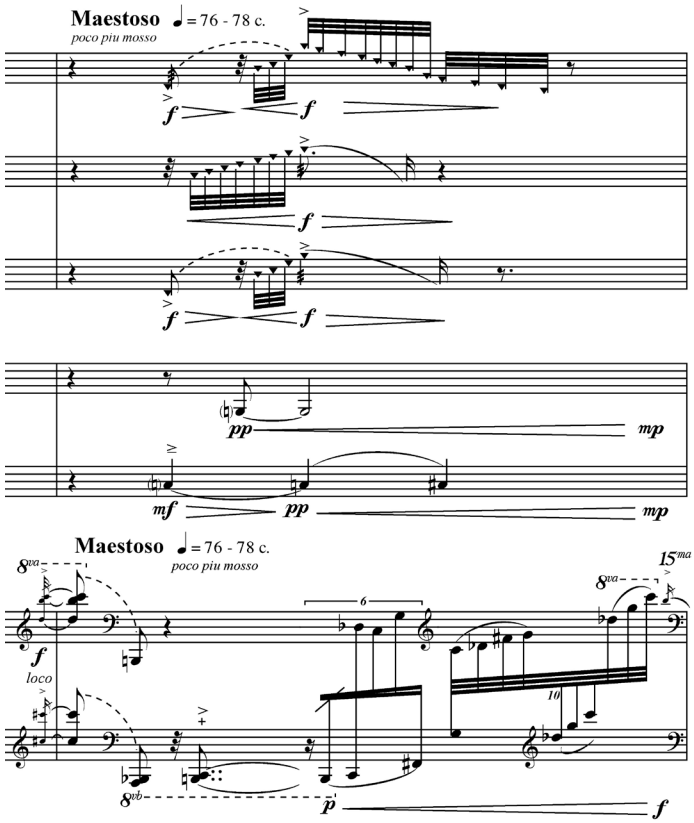


Fig.105 Air orchestral parts dialoguing with and ‘pushing’ the soloist’s virtuosity/actions (b.69, winds and piano)

(Other examples and forms of interactions are included in the movement II discussion below)

Technical challenges, new gesturality: towards a timbral virtuosity. Cadenza 3 and I to II transition

Cadenza 3 (b. 100-115) and movement I-II transition (115 to 136) are key transition sections between the 'traditional' and 'extended' approaches to virtuosity. The standing position is gradually reached while the timbre-based approach develops, building new solo/ensemble interactions. Intra-piano techniques create new technical challenges. Sound impacts and 'contact vibrato' on strings interact with (and extend towards) air, exploring the resonance and air merging and the idea of breath 'signals'. 'Poly-vibrating' textures emerge within the piano resonance, exploiting unconventional instrumental combinations (strings as a wind section) blurring transition towards the new core material of movement 2: a *resonance object*.

Intra-piano on-string techniques: virtuosity and challenges

In the first phase of cadenza 3 (b. 100-108), the double keyboard/string action develops through fast, spectacular register changes and playing zone variations. This phase is the first step of the 'timbral virtuosity' extension (double key-string action), which expands in the second phase and develops in movement II. The right-hand alternates the muting of the lowest strings and the playing on the highest keys, executing fast left and right inside/outside of the piano switches (see fig.106). Visually spectacular, such fast in/out position switches create timbre alterations, firstly of the lowest notes, and then of the highest notes, which are equally muted/un-muted through fast string and key (in and out of the piano) playing alternation at the end of this first phase.

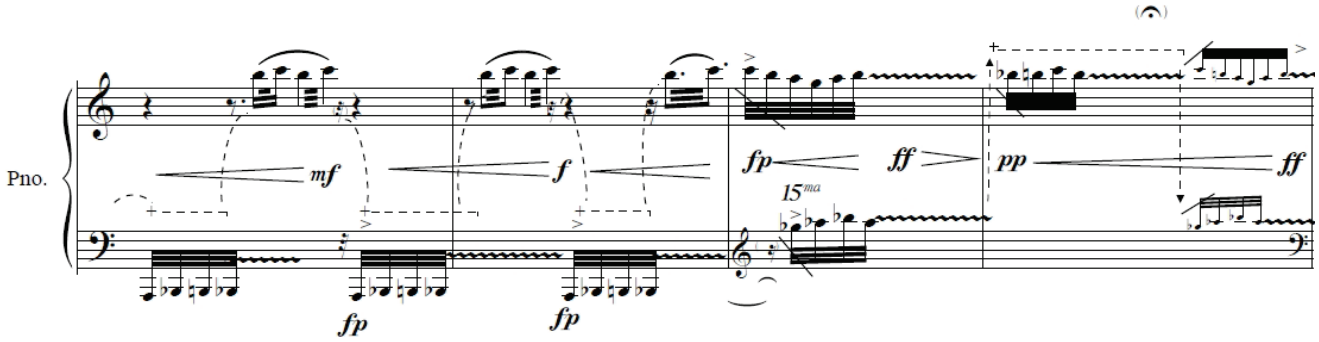


Fig.106 Virtuosity: muted strings alternation, left and right extreme 'in and out' playing (left-hand *8va bassa,* right-hand *15ma*)

In the second phase of cadenza 3 (108 to 115), the pianist stands up to reach 'deeper' filtrations and on-strings techniques. The filtration expands to the various zones of the lowest strings that the (new) standing position allows reaching. The internal parts of the piano (dampers, metal bars), act as 'reference zones' for filtration and vibration and for their notation and description. Transitions between the 'zones' create timbre-filtration 'paths' that combine with the ensemble's air – a process at the heart of movement 2 (see below).

The direct on-string vibrato is here a core technique. Challenging for the soloist, this gesture/technique develops vibration and extends resonance in spectacular fashions. The left-hand attack combines with right-hand pressure variations, creating a visually spectacular gesture and sound combination (requiring an adapted body position). The vibrato stems from the pressure applied with the right hand directly on the string(s) while the left hand creates sound 'impacts' through keyboard actions. Though ineffective in the first accessible string 'zones' (near/after tuning pegs), the vibrato effectiveness (and feasibility) increase when executed in 'deeper' zones inside the piano (behind the metal bar, behind the dampers, as in fig.107).

Right-hand vibrato pressure and release develop through precise rhythms in specific positions, e.g. behind dampers and behind the bar with changing 'rhythms' of pressure b. 112-113 (fig.107). The right-hand vibrato action on the string(s) (precisely notated) immediately follows the left-hand attack on-keys. Filtering the sound through longitudinal movements along the string(s), tremolo-crescendos (e.g. b.111) and other techniques (e.g. granulation b.113) expand this mode of playing, incorporating complex timbre based material and expanding resonance through gestural action before and/or after the impacts. This builds the second core form of virtuosity, based on extended 'intra-piano' techniques and timbre/resonance development.

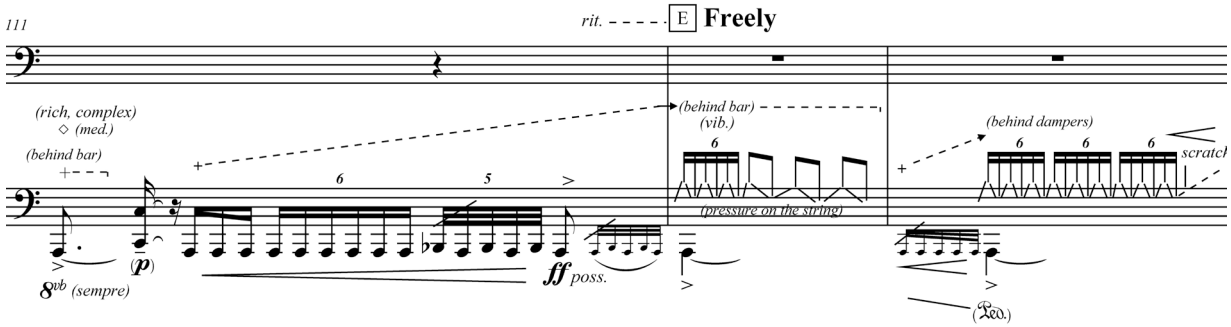


Fig.107 Direct on-string vibrato: attack/impact (left-hand), pressure variations (right-hand). Technical-physical challenges

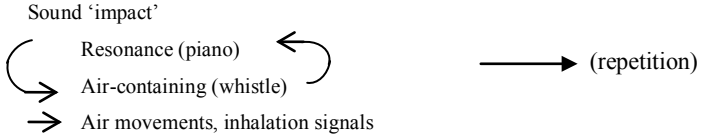
Sound impacts, resonance signals (transition to II part 1)

The transition to movement II (first part, b.115-124 p. 38-41*)* extends the cadenza techniques and develops air-resonance hybridizations, working on air 'reverberation' and vibration-related effects and phenomena. The ensemble's air (and air-containing) sounds *spring* from the piano resonance, itself a complex result of filtration techniques and 'pressure-vibratos' on and along the strings. This air-resonance dialogue expands the typology (see chap.2) through the virtuosity and 'concerto' perspectives.

The combination of string filtration and pressure-vibrato creates a wide range of resonances and reverberations nourishing and interacting with air. Air and breath (inhalation/exhalation movements, air and whistle-like sounds, strings and winds) spring from resonance, extending and merging with it – and ultimately triggering it.

The piano impacts' strong resonances are reworked using the on-string vibrato technique and left to their natural reverberation expansion. Emerging from this, the ensemble's air material builds a texture within this reverberation, gently extending and then 'growing' it through faster articulations, which peak and ultimately create a 'signal' for a new piano impact.

Impact-extension-signals: air extending-triggering resonance



For example, in the b. 115-117 developments (see fig.108 highlighting the impact-extension-signal elements), the violins' soft whistle-like sounds (bowing behind the nut) and French horn air-filled whistles (through the

reversed mouthpiece) *extend* the piano's resonance and act as linking elements with the breathing movements of the woodwind section. Filtered exhalations and inhalations act as attack/resonance *signals*. Gradually accelerating exhalation crescendos peak in inhalations, which, accentuated, act as triggering elements and 'signal' the new piano *impacts*. The latter 'respond' to it, combining with the exhalation that follows (end 116, beginning 117), generating, again, resonance, whistle/air and 'breathing' expansions. The process develops with variations (e.g. re-orchestrated in b.117), incorporating other materials (harmonics and beatings within resonance e.g. b.119) to nourish the resonance complexity and air and resonance merging and extension.

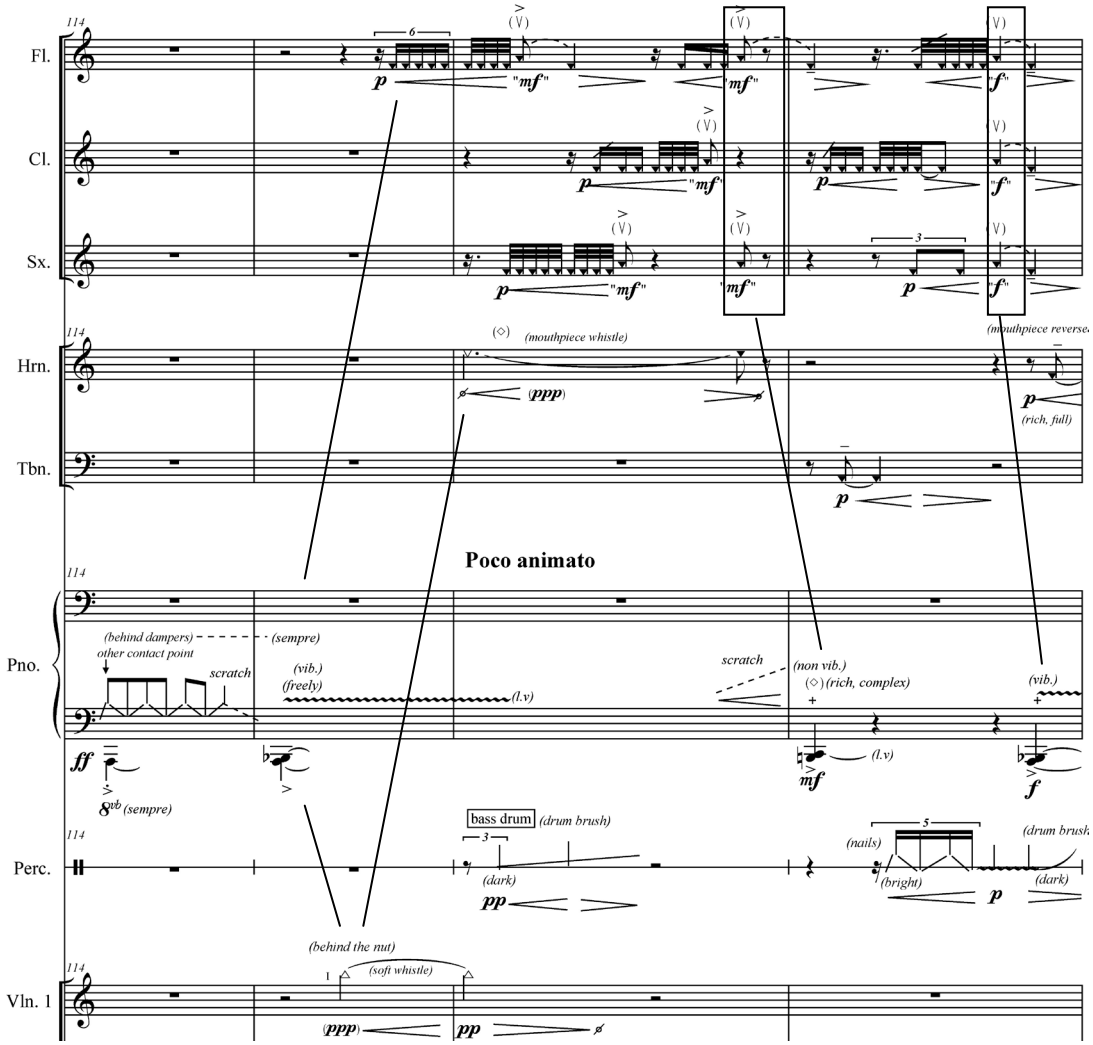


Fig.108 Air/whistle springing from resonance, extending it (whistles), merging with and triggering it (inhalation/exhalation 'signals')

'Poly-vibrating' textures: air/timbre in resonance, physical/sonic combinations, blurred transition

The last steps of the movement II transition (second part b. 123-136) also develop air/resonance hybridization processes. Crucially, and conversely to the previous examples, the mixtures of breath and air stem from the string instruments, here approached as a forming a wind section.[365] The string players blow into their instruments, holding and rotating them to create the string vibration while filtering/amplifying their voice through the f-holes (e.g. b.123). The combination of the amplified blowing sound and the physical rotation of the instruments create an 'air guero' developed at the scale of the string section (see subchapter introduction). The process generates a mix of air and air-generated vibrations, a 'poly-vibrating' texture which merges with

[365] See 3.3 for a development at the orchestral scale.

resonance and incorporates other processes/phenomena. (It combines here with a gesturally related clarinet technique, which extends the effect.[366])

Spectacular, this gesture combination and texture-building process expands as a versatile tool throughout the second movement and combines with other (air or non-air) elements (e.g. b. 147-149, 159-160.).[367]
This 'poly-vibrating' air texture allows introducing the new core element (see fig.109) in a seamless fashion and cross-fading effect – an imperceptible transition between the pitch/air-based and timbre/resonance-based material of movements I and II.

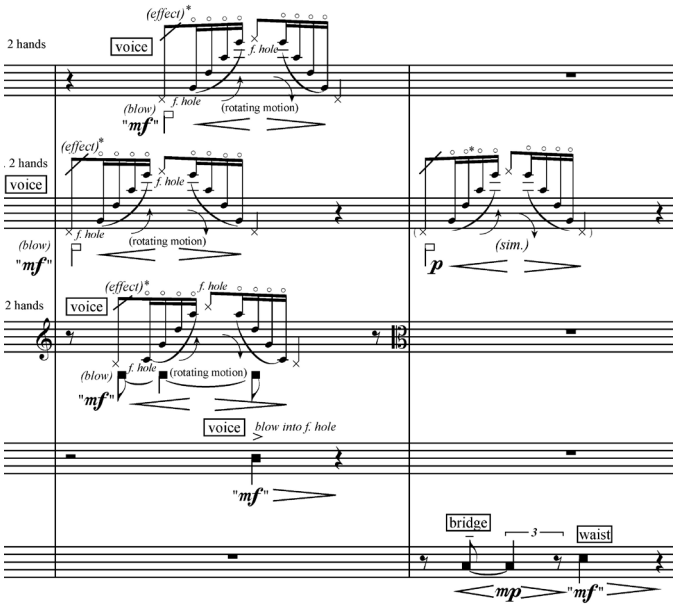
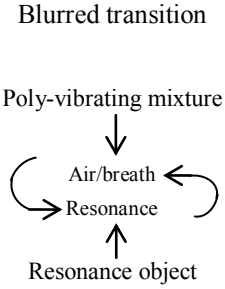


Fig.109 'poly-vibrating' air texture

The last bars of movement I (b. 134-137) are conceived to aurally and visually 'distract' attention and seamlessly introduce the main element of movement II (a complex resonance object using a combination of contact points on the four lowest strings of the piano, partially presented in b. 126 and 129). The hybrid, poly-vibrating air texture (starting b.134) expands as the soloist's 'resonance object' imperceptibly emerges within the ensemble's movements, whose multiplicity attracts, disperses aural and visual attention while the 'resonance object' is introduced into air (fading in b.137 as the ensemble's breath and air textures fade out). The added ¼ bar (b.136) rhythmically enhances the overall 'blurring' effect as the new core material (colour filtration 2, see below) appears within complex layers of air (see blurred transition process below/fig.110).



[366] See *Atma(n), Holo(s)* and *Un eco di soffio II* where these string/clarinet 'breath filtration' guiro techniques are discussed in detail.
[367] See also examples in *Atma(n)* 2.1.

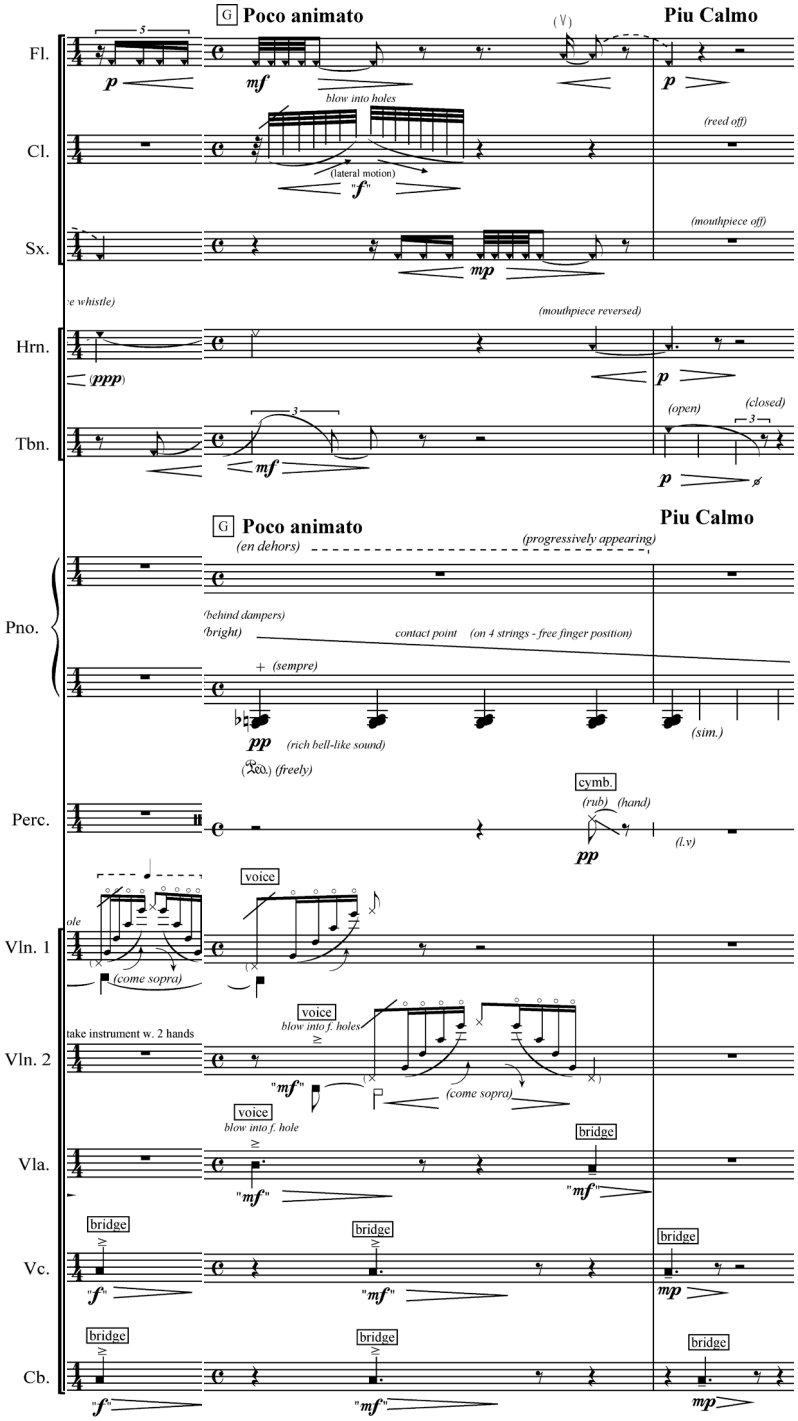


Fig.110 Blurred transition. Resonance object appearing in breath and poly-vibrating air texture

Virtuosity extended. Resonance, timbre, pulsation and air (movement II)

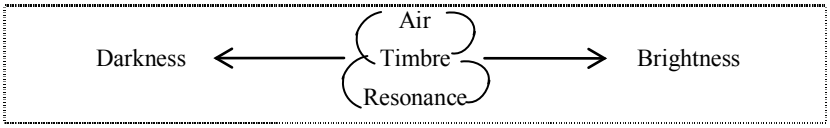
The second movement stems from a 'raw' sound material. Two main intra-piano techniques and filtration modes create the core developments. The four lowest strings are activated by on-key actions and filtered by on-string actions. While developing 'only' from the sound filtration of (and hand/hammer contacts and impacts on) the four lowest strings, this 'rough' material becomes a complex, visually spectacular and sonically rich object, and a pretext for developing a timbral form of virtuosity. As highlighted by Chion, the regular percussion of a 'complex' sound (without precise pitch) is more convincing and more rousing than regular percussion of a tonic sound, where it is the "note" that monopolizes the ear.[368] Pulsated, repeated, the double key-string action makes

[368] Chion, *Sound*, p.78.

here audible (and visible) the complex, underlying timbral changes and physical challenges, arising from a 'raw' inharmonic matter.

This *resonance object* develops as a complex timbre material through detailed pianistic filtrations. The movement investigates parallel forms of filtration between resonance, timbre and air, exploring possible similarities and complementarities. The principle of 'colour' (brightness-darkness of sound) 'affiliates' these (contrasting) elements. The brightness-darkness of air and breath (which evolves, e.g. through phonetics or friction variations) creates fruitful perspectives with the brightness-darkness of resonance and the brightness/darkness of timbre (see below). Orchestration developments 'link' these materials, which develop in parallel or echo and incorporate other inharmonic elements (multiphonics, string overpressure, granulation).

System movement II



Timbral virtuosity: filtration notation. Pluri-muting and hand 'shapes'

Two main intra-piano filtration techniques develop throughout the movement, using a specific notation which describes each position or dampening type on/applied to the four lowest strings.

The first type of filtration (*filtration 1*) revolves around three different levels of muting/damping: simple, double and triple, with one, two, and three fingers. The first intra-piano 'zone' between the tuning pegs and metal bar – where this technique is efficient and achievable – is exploited to filter the strings' sound.[369] Timbre variations are controlled by the soloist's fingers, which are carefully placed on or removed from the strings. The three fingerings generate subtle sound filtrations, which the 'pluri-muting' notation system reflects (see fig.111).

The second type of filtration (*filtration 2*) develops timbre and resonance variations. The notation indicates contact points exploiting the wide string zone that extends behind the dampers. Finger contacts filter the strings' sounds through longitudinal (downward/upwards) movements on strings, freely executed by the performer. This technique variously filters the harmonics/multiphonics that emerge from the four combined nodal points on the four lowest strings (fig.112). On-string pressure vibrato, pedal changes, attack and dynamics variations impact and rework the resulting 'bell-like' sounds.

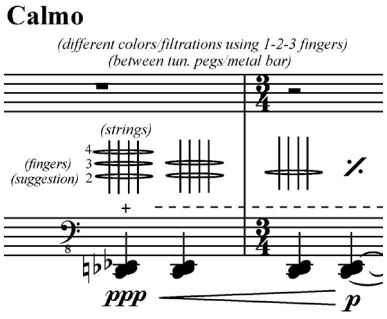


Fig.111 Filtration1 (pluri-muting system)

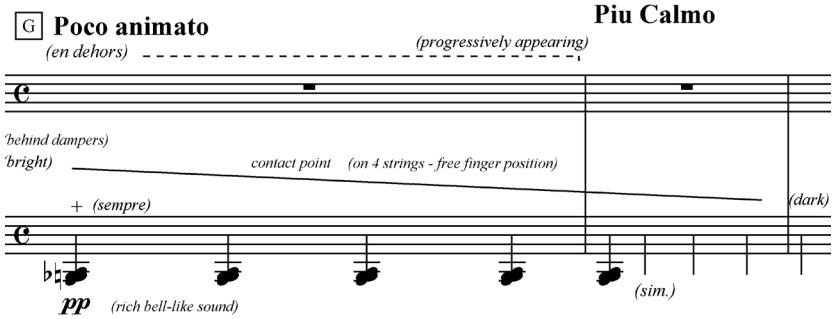


Fig.112 Filtration2 (timbre/resonance filtration)

While this second string filtration mode develops in a single overall upward/downward gesture, it expands in an 'imperfect', unparallel fashion along the strings and until their furthest regions inside the piano. A strictly

[369] The space available in this 'zone' is large enough to contain single to triple finger 'muting' positions on strings.

parallel filtration and contact on and along the four strings is indeed in this context neither feasible – particularly on the furthest filtration zones inside the piano strings – nor desirable – it would result in less timbral richness.

Part of the composition process (and performance preparation with the soloist) was therefore dedicated to the finding of combined finger positions, using hand '*shapes*'. Uneven positions of the four fingers on the strings combined with utilisation of the strings' sides (fingers 1-4 on sides and 2-3 on the top of the strings) revealed prolific 'shapes', which, combined with the application (or non-application) of finger pressure on strings and control through the pedal, develop the resonance-object in its full complexity.[370] Detailed in the score or left to the soloist's appreciation, these elements enhance timbre richness and create variations, which later extend towards granulations (see fig.113) culminating in the final cadenza (b. 189-206).

Movement II form: filtration modes alternation, virtuosity and timbre complexity expansion.
The form alternates both filtration modes, which are gradually more complex and expand overall texture density – also expanded in the ensemble (Table 13). The timbre, resonance and air interactions gradually develop, equally complexified by additional elements in the solo part (granulation, tremolo techniques, see fig.113) and in the ensemble (multiphonics, string overpressure). The resonance object – in its two filtration forms – is repeated, ultimately densely accentuated and even 'over-pulsated'. The outcome of this expansion – enriched by measure changes and texture evolution which 'break' its constant regularity – is a 'suffocating explosion' of air, timbre, resonance and granulation culminating in the cadenza section.

Form Movement II

Filtration 2 b.137 to 144	Filtration 1 b.145 to 148	Filtration 2 b.149 to 152	Filtration 1 b.153 to 158	Filtration 2 b.159 to 166	Filtration 1+ b.167 to 174	Filtration 2+ b.175 to 178	Filtration 1+ b.179 to 186	Cadenza b.189 to 206
down/up (= 4 bars) x 2 (quasi solo) orchestrated discreetly	pluri-muting (= 2 bars) x 2 (quasi solo) orchestrated discreetly (slight battuto)	down/up (= 4 bars) x 1 orchestration slightly denser (+ battuto)	pluri-muting (= 2 bars) x 3 orchestration denser (+ battuto crescendo)	down/up (= 4 bars) x 2 orchestration denser x 1 solo x 1	pluri-muting (= 2 bars) x 2 expanded orchestration very dense (+ battutto)	down/up (= 4 bars) x 1 expanded orchestration very dense	pluri-muting (= 2 bars) x 4 expanded orchestration very dense saturated	strings only string/key (solo) orchestral coda

Table 13 Form Movement II

Virtuosity in gesture and complexity in sound develop the resonance object filtrations. Initially presented in their core 'solo' forms in soft dynamics (b. 137-148), both filtration modes expand and enrich through the actions of both hands (on keys and strings) individually more and more written and increasingly complex as a whole.

Both filtration modes are gradually extended. For example, in the 'con forza' section (b. 171-174, see fig.113), the pluri-dampening system (*filtration 1*) is reworked through tremolos (left hand) and through combination with pressure 'scratches' on strings (with speed variations, right hand) that reach the furthest 'behind dampers' zone. As a whole, this sound and gesture and keyboard/intra-piano playing builds a spectacular effect which,

[370] See for ex. set of video instruction sent to the performer, showing hand shapes/positions on strings: https://youtu.be/8HU8u-Iyt7U

combined with the dynamic and texture density increase the ensemble creates (e.g. string *battuto* and over-pressure, winds multiphonics) achieve the final, intense suffocation-explosion effect (see below). The cadenza that follows – almost exclusively on strings and inner parts – comes as a spectacular contrast, unfolding in an overall soft, almost non pulsated soundworld (fig.114). Both hands are here for the first time in the piano, as the tempo suspends. The ensemble's soft breath and whistles ultimately emerge and create a transition with movement 3.

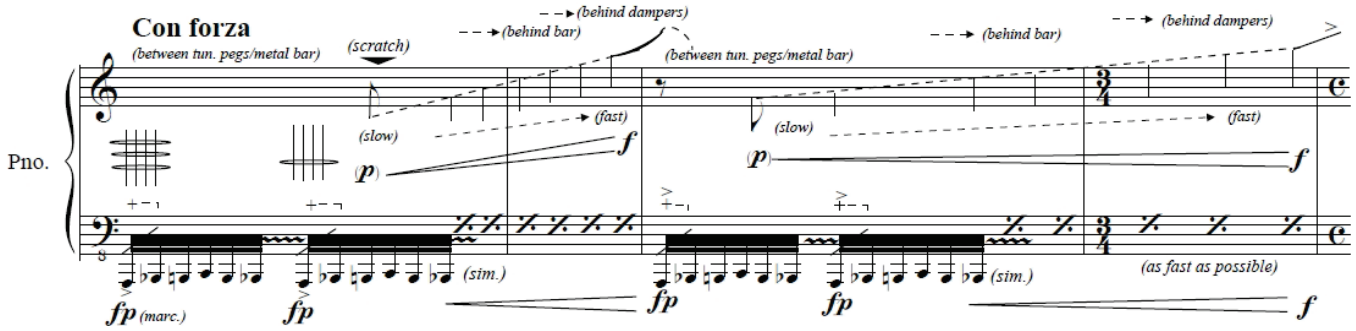


Fig.113 Timbral virtuosity: string filtration/deep intra-piano zones, pluri-muting/granulation articulation

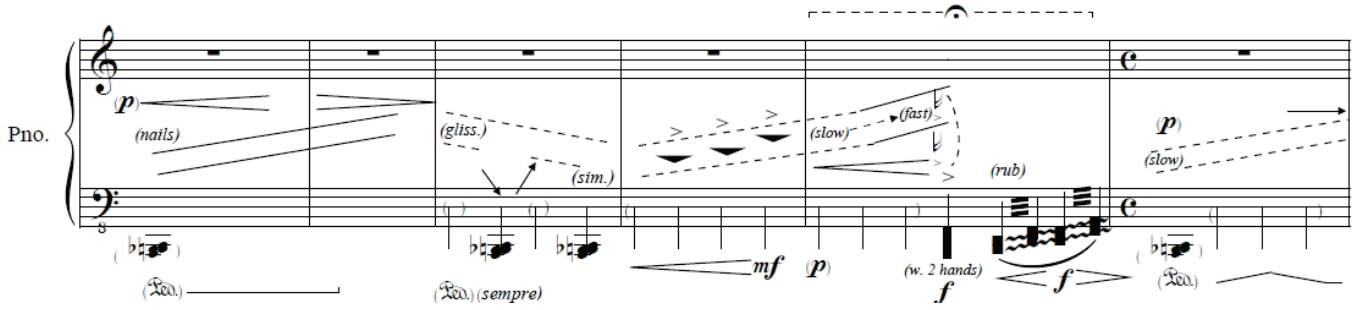


Fig.114 virtuoso filtration Strings cadenza finale

Air, resonance and timbre: parallel expansions

Air, resonance and timbre develop as parallel forms of filtration through the specific concerto perspective. In *Holo(s)* for ensemble, the resonance(s) and echoes act as underlying reinforcement elements within the texture and its movements (see orchestration system in 3.1). They enrich it, creating an overarching legato widening and 'opening' the musical space through their presence, including in unreachable registers through the use of air (souffle). Here, differently from *Holo(s),* where the resonance and echo elements are spread between instruments of the ensemble (see 'resonance poles'), the core resonance 'widening' element *is* the solo piano.[371]

The piano strings filtration and associated sound colour(s) and quality stem from specific anchor 'zones' inside the piano. For example, *filtration 2* develops from the dampers and metal frame zones until deep positions inside the piano. This filtration (and notation) principle based on instrumental 'zone(s)' allows establishing fruitful perspectives with similarly evolving sounds and techniques of other instruments (e.g. string *tasto* to *ponticello* bowing, winds closed to open phonetic filtering) to develop the air, resonance and timbre parallels.
For example, in the *animato* developments of *filtration 2* (b. 159-162, see fig.115), the winds' phonetic filtrations (bright/dark air sounds) re-orchestrate (and are re-orchestrated by) the strings bright/dark bow

[371] There is no other 'resonant' (reverberating) instrument in the ensemble. Percussions are, overall, used in a friction-based non-resonating way.

filtering (through SP/ST timbre-position variations) and 'reshaped' by other layers of friction-filtration (e.g. skin percussion dark/bright centre to edge friction) as the piano develops the 'resonance object' filtration (bright/dark, see *filtration 2* above). The overall effect is a complex, resonating and hybrid 'air' matter, fruit of a parallel, multi-layer work on the texture.

Contrasting elements are affiliated through their common colour evolution. The piano timbre/resonance evolving colour finds an 'equivalent' in the trombone's phonetically modified breath (b.141) – echoed by the clarinet's air glissandos. The low strings (cb, vc, vla) create similarly evolving timbre filtrations through bow position changes. The process expand in letter I (*molto animato* b. 175-178) where the overall filtration and texture complexity increase through the incorporation of other sound materials. In addition to the phonetically modified air (winds) and the piano's strings filtration (*filtration 2*), the dark/bright timbre evolution expands through other parameters, such as granulation (using bow speed changes, cb, vc, vla), percussion skin tension modification (also a dark/bright filtration, bass drum).

Parallel filtration system and expansion

+ Multiphonics	(Saxophone)			
Poly-vibrating air	(Violin 1 and 2)			
Air	(Winds)	Bright (open) →	Dark (closed) →	Bright (open)
Resonance	(Piano)	Bright →	Dark →	Bright
Timbre	(Strings)	SP →	ST →	SP

Table 14: *Parallel filtration system*

Virtuosity of the soloist, virtuosity of the (air) mass: merging, contrasts (timbral perspective)

The parallel filtering of resonance, phonetics, air and friction extends the concept of 'porosity' in a specific 'dual' (solo and ensemble) context. The interactions between resonance-vibration and phonetics-friction extend the air-resonance continuum. Through the triple resonance, air and timbre filtration, the air-breath based orchestral parts (and orchestration) dialogue with, contribute to and merge (or contrast) with the soloist's virtuosity.

In fig.115, the ensemble parts develop the interactions between the 'timbral virtuosity' and air expansion, combining dialogue and reinforcement functions, parallel filtrations, contrasts. The piano resonance object's strings filtration expands through right-hand vibrato and scratches (both directly on strings) as the left-hand unperturbably reiterates its 'impacts' on the four lowest notes/keys. While this pulsated (yet timbrally changing and gesturally perturbed) sound object evolves, the ensemble parts incorporate a range of complementary and contrasting techniques which expand its timbre (including in parallel fashions, see above) or compete with it.

In the first part of the example (b. 159-160), the strings' mixture of air-guero techniques and bow position changes both contrasts with and completes the piano's colour evolution. While the violins' air creates a 'blurring' effect (see also I to II transition), a form of timbre complementarity emerges from the low strings' sound colour changes. A similar development takes place within the wind section. While the trombone and clarinet air sounds and saxophone multiphonic (an air-containing dyad) create complementary (though

sonically contrasting) dynamic and colour changes to the piano part, other air elements (flute) and articulations (flute and clarinet flutter tongue, viola tremolo) add layers of 'blurring' through micro variations.

In the second part of the example (b. 161-162), the strings join forces with the piano through their 'bouncing', dark to bright *jettatos* (N. to SP with bow wood and hair), as the trombone completes the overall colour expansion through air filtration (dark to bright). Conversely to the first 'blurred' bars which include both contrast and merging elements, the resulting pulsated rhythms and texture effect expand here as mutually reinforcing 'whole' through common sound colour and/or articulation evolution.

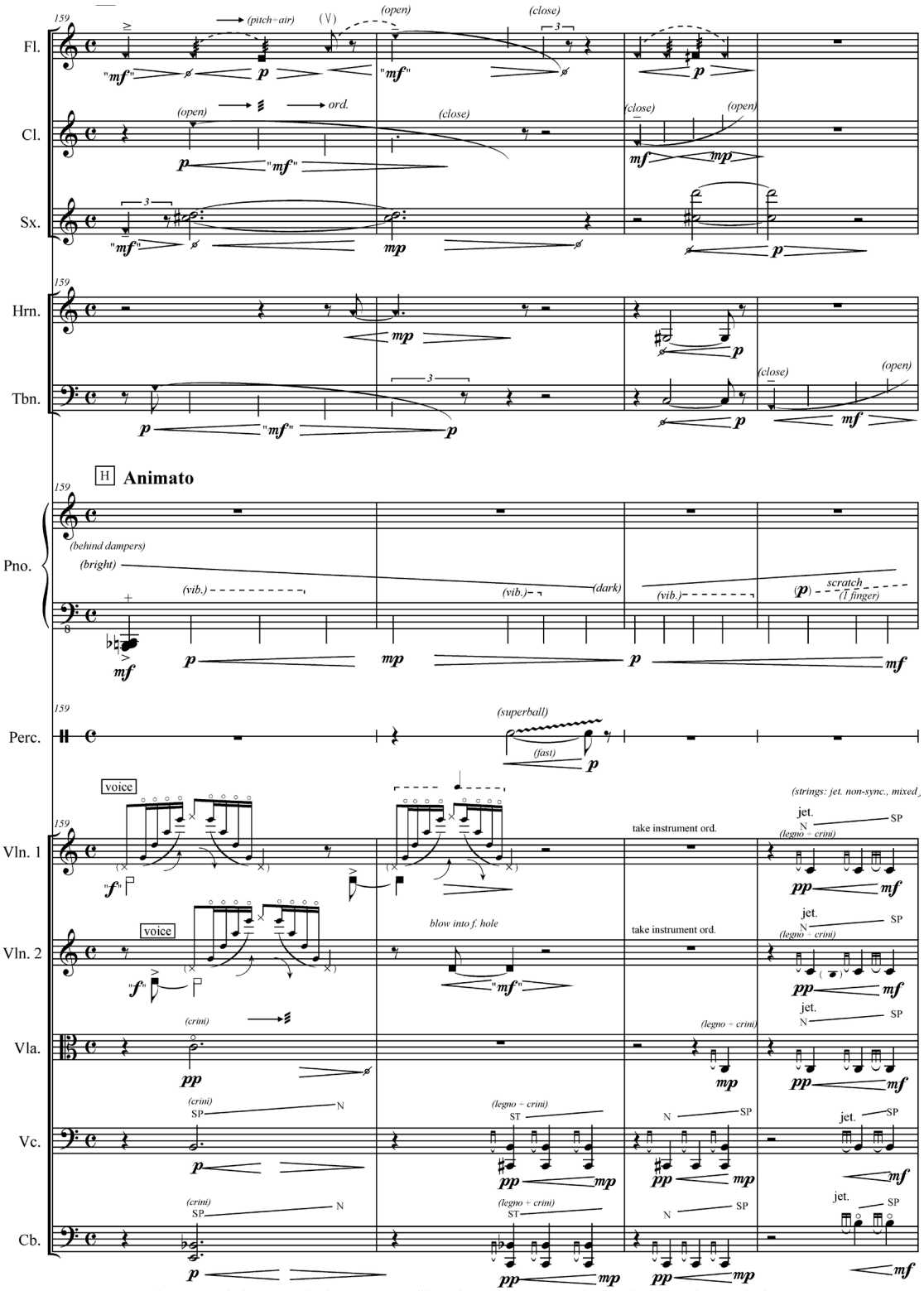


Fig.115 Dialogue-reinforcement: filtration-contrasts. Timbral virtuosity and air

Respiration and extreme pulsation: dynamic extremes. Virtuosity and air, until suffocation

As the sound texture becomes thicker and eventually saturated (e.g. through string overpressure, multiphonics, developments of piano filtrations), the winds' air sounds and inhalations/exhalations develop to their maximum dynamic possibilities and emerge as changing, background and foreground elements, adding an overall 'suffocation' effect to the general tension and saturation. This 'suffocation' process develops in two steps, which, gradually implemented, play on perception.

The first step (b.179-182, fig.116) develops air as a texturally 'spread' element, while the solo (over)pulsated resonance object material grows. Spread between the winds and the two violins, in echo and variously articulated, air (souffle) arises as an ungraspable element as the densely pulsated piano solo and low strings (vla, vc, cb) expand a timbrally 'saturated' element. The impact and 'signals' principle (see cadenza 3) links both approaches and soundworlds. For example, inhalation echoes (woodwinds b.179), signal the crescendo tip and piano impacts, which are themselves echoed by new movements of air (b.180). The fast alternation of articulated inhalation/exhalations (woodwinds in echo) and the air-colour variations (trombone) create a contraposition of air elements, an air 'sub-orchestration' of the main solo movements.

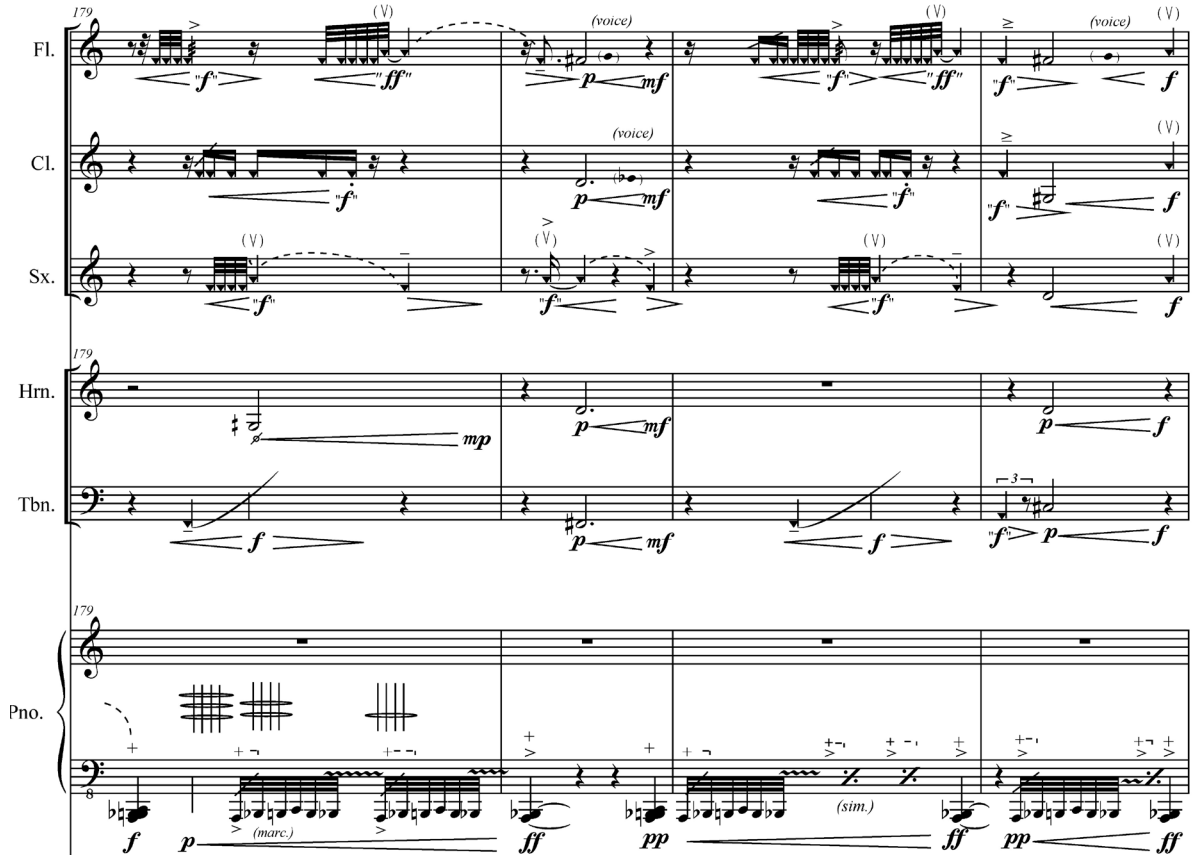


Fig.116 'Suffocation' process step1: air as texturally 'spread' element (winds), (over)pulsated resonance object/material expansion (solo)

The second step (b.183-186, fig.117) develops air as a homorhythmic material through 'block' expansions. All layers (timbre-air-resonance) expand towards the climax. As the air and sound interactions become increasingly disproportionate, respiration, as a movement, plays a key role. 'Inhaled' and filtered, air (souffle) is pushed to its extreme development. Systematically repeated and amplified through woodwinds as though 'gasping' of air, the inhalations and exhalations are still perceived, identified despite their weakness as part of an overall 'saturated' orchestration (see fig.117 and *climax 'block expansion'* below). Their presence is reinforced through the perception associations and expectations they create (see 3.1). The climax 'blast' peak effect thus

transforms into a ‘suffocation’ effect in which accentuated inhalations are not anymore signals, but *impacts* (e.g. end b.184).

In the peak expansion leading to the climax, gradual changes of colour and sound evolve through a parallel process, according to contact and material type and energy – until granulation of the sound. The expansion and filtration of air, resonance and of timbre/granulation develops here in a parallel fashion, putting these unbalanced elements in perspective and ‘competition’ towards a common goal and expansion.

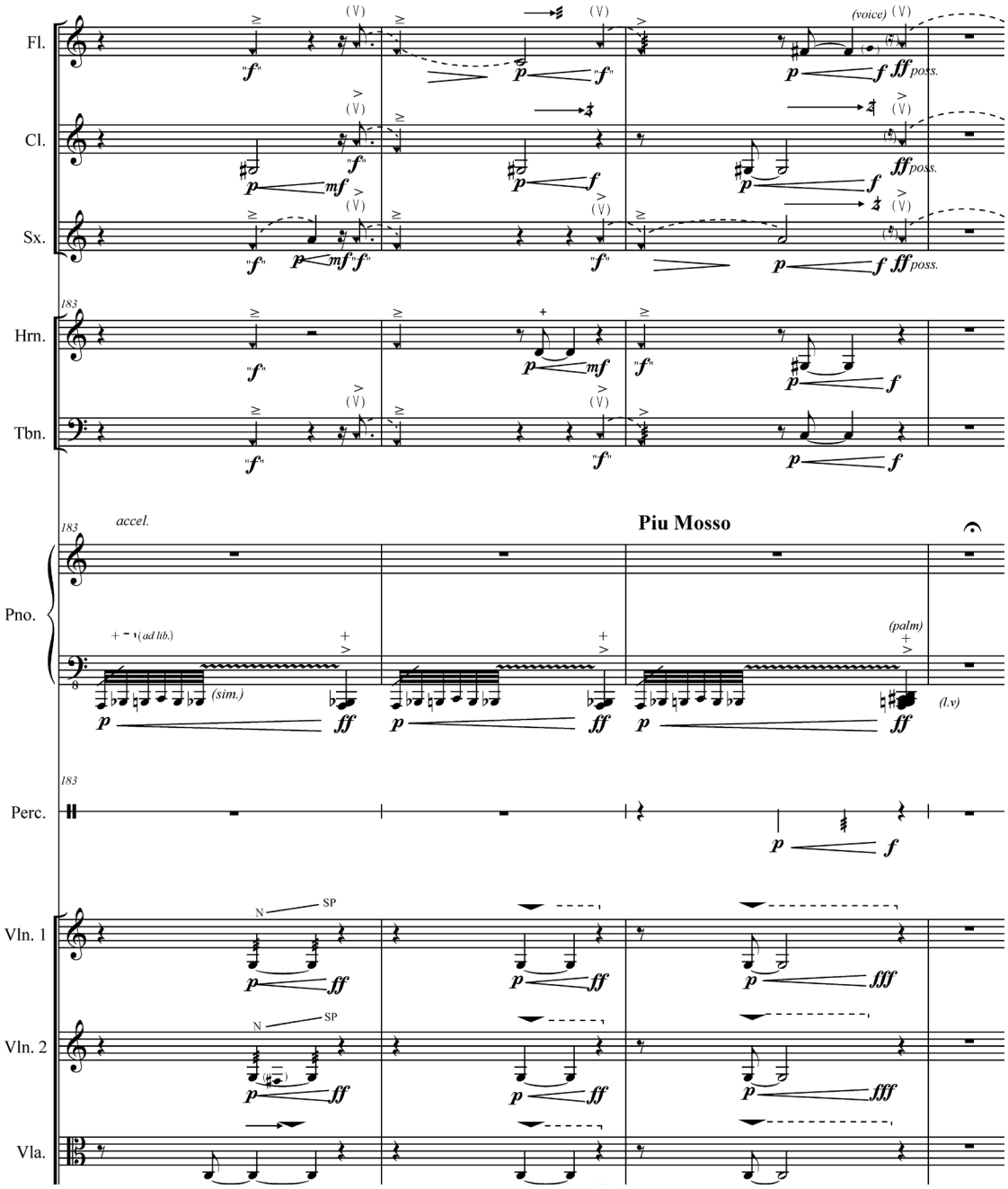
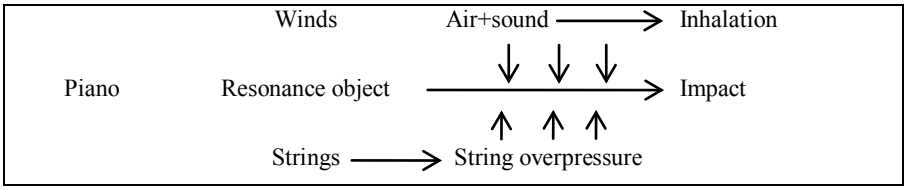


Fig.117 'Suffocation' process step 2: Climax ‘block expansion’

Climax ‘block expansion’



The climax peak and 'blast' effect then transforms into a longer, less graspable 'apnoea' effect. Using near-silent frictions (piano strings and body), the immediately following 'apnoea' cadenza develops from the resonance(s) that emerge from the 'blast' energy and materialize in echo and grain 'residues' (fig.118).

However, here, the 'breathlessness' is not an end. The 'residues' provide materials for further expansion: a third 'static' form of playing arises and builds the following movement (III) in which the 'solo' instrument resonates and 'reacts' to external stimuli – here a 'resurrection' and unexpected form of virtuosity.

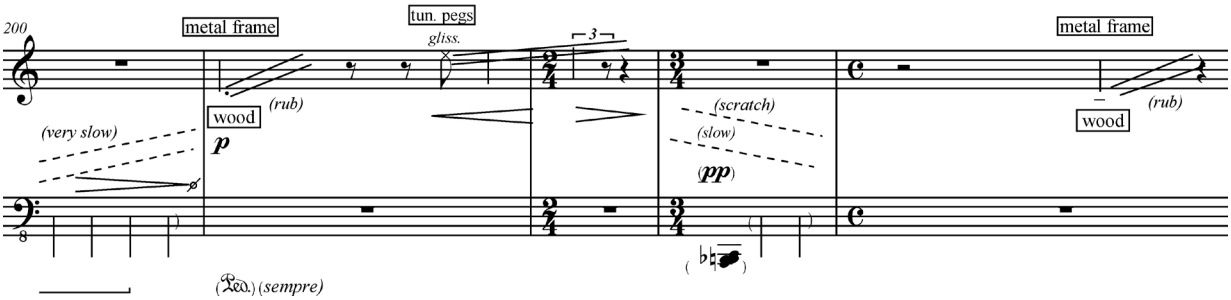


Fig.118 Piano 'residues' after cadenza

Virtuosity of the 'residues' (Movement 2 cadenza), Resonance extended and 'passive' virtuosity (III)

Resonance emerges as the 'sound' of apnoea. The resonance material stems from a fragile, hard to control combination of sounds and gestures (air evolving towards teeth-on-reed techniques, bass clarinet and saxophone). Triggering elements, the teeth on reed 'emergences' create sudden, unpredictable sympathetic vibrations which the soloist controls or leave to natural expansions. The soloist's 'silent' gestures on keys create a soft percussive material, also triggering or extending resonance through 'key-lifting' actions and soft blowing and tapping on strings (fig.119-120).

Pace highlights that one of the fundamental conceits of Lachenmann's Ausklang is the idea of the orchestra as 'an expanded sounding-board for the piano', picking up and extending the 'aftersound' of a piano note.[372]
In movement 3, this situation is reversed. The piano acts as an extended (and actual) sounding board for the orchestra.

As the movement evolves, the soloist's brief 'expressive' developments (e.g. b.237-239) inevitably return to the minimal, silent playing. The saxophone and bass clarinet triggering-material incorporates a selection of multiphonics (mostly air-containing dyads) which expands the piano resonance and its sympathetic 'response' (fig.121-122). Soft, air-filled whistling sounds (brass mouthpiece, flute whistle tone, strings behind-the-nut playing) create a soft, equally changing and fragile background to these explorations.

(See chapter introduction for a detailed discussion of the effect – and absence during the premiere performance – of this third movement section).

[372] Pace, Positive or negative 2 (see footnote 343).

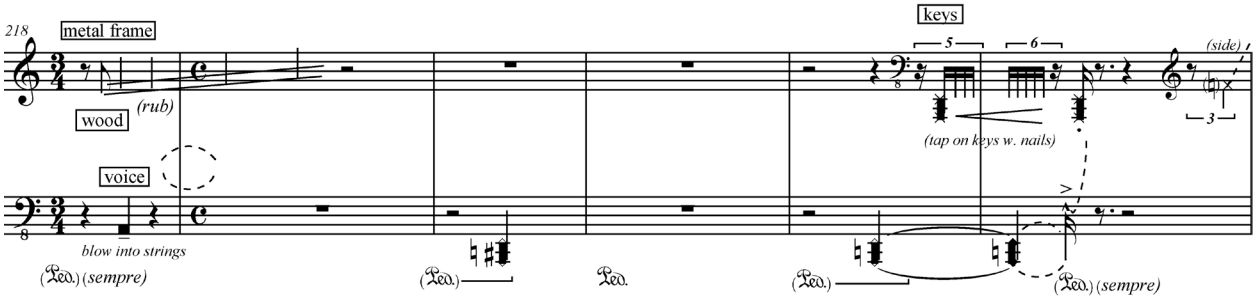


Fig.119 Piano silent-passive virtuosity

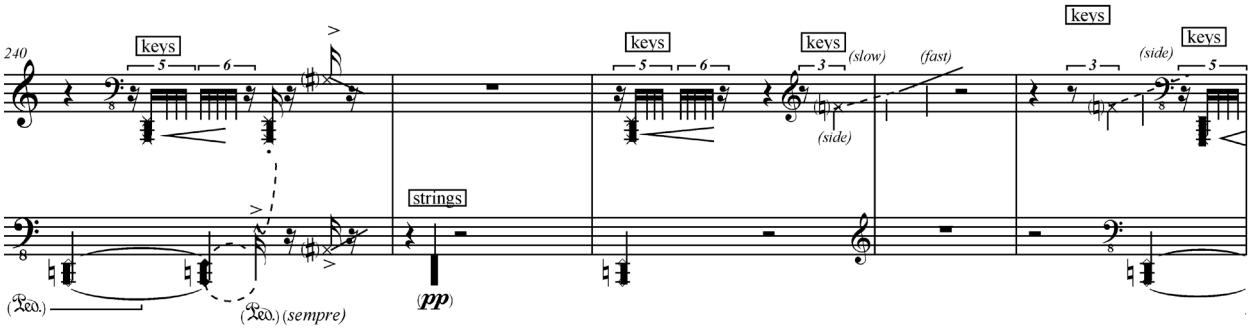


Fig.120 Piano 'silent' gestures on key

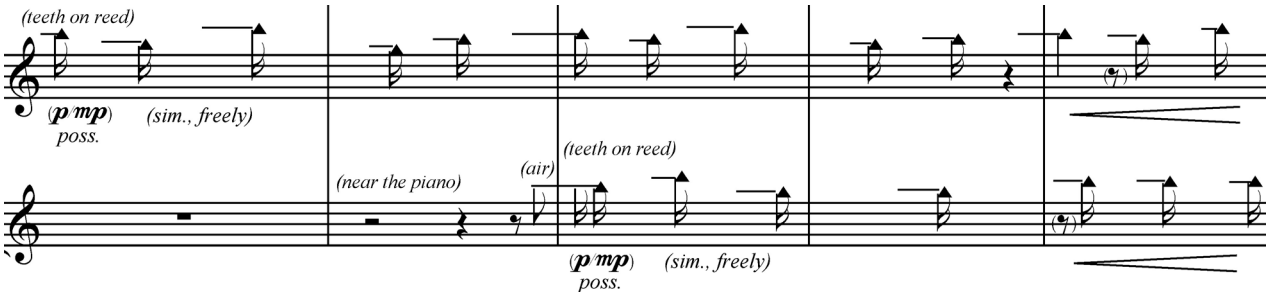


Fig.121 Saxophone/Bass clarinet – resonance-generating material (air, teeth-on-reed ‘emergences’)

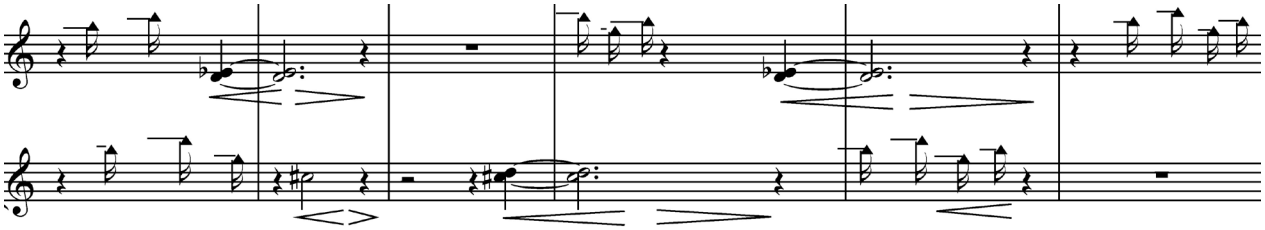


Fig.122 Saxophone/Bass clarinet – extension of the resonance-generating material (air, teeth-on-reed ‘emergences’, multiphonics)

3.3 Pulse and stasis: dynamic and mass extremes, Sha'aph (שָׁאַף) for orchestra. Overcoming inertia

This last subchapter explores rhythmical and dynamic extremes in an orchestral context. If the orchestral scale provides unamplified solutions, other questions and problems arise when composing (with) the instrumental mass while maintaining articulation clarity and rhythmic efficiency, including in 'block' orchestrations and changing tempos. As complex or self-sufficient sound objects, souffle (and contemporary techniques) may naturally *go against* the orchestral *inertia* – i.e. its nature as a mass of instruments set against the energy and self-sufficiency of unpitched or complex sounds.

Sha'aph radically develops the breath and friction (and respiration/white noise) perspectives. The work is radical in both senses. While the orchestra builds a complex mass of air, the structure and actions stem from an elementary basis developing the fundamentally binary inhalation and exhalation alternation. Furthering the inhalation/breath and exhalation/friction assimilation as two compacted/diluted temporalities and gesturalities, the work is characterized by their distinct utilisation. Differently from 3.1 and 3.2, where these two forms dialogue and merge, they succeed here to each other in their respective extended versions, and barely interact. The 'human' respiration builds (through) orchestral blocks of breath, and the 'instrumental' white noise merges frictions and other sounds. The piece systematises extreme dualities (stasis/pulsation, spread instrumentation/mass and blocks, respiration/apnoea) explored in climax phases in the previous research steps.

The overwhelming presence of air (souffle) in all its instrumental forms 'saturates' the orchestral space. Textures build from dense orchestral 'blocks' of air, or conversely diluted, near-static suspended actions. The dual vertical and horizontal articulation pushes techniques and sounds to their orchestral limits, exploring air (souffle) as a dense, percussive material or conversely thin, 'shadow' element.

The definition of *Sha'aph* (Hebrew) is inherently energetic and physical: it is the pant, the gasp and heavy breath of a human or animal, but also the destroying force, the 'crush', the 'trample upon'. This translates into the writing, creating a constant atmosphere of 'tension' exploited as a process (see 3.1-3.2). Several sections include abrupt pauses after densely orchestrated gasping movements. The souffle-based orchestration system is pushed to its extreme to address the broader question of *confronting the inertia* of the orchestra as a *mass*. What we gain in terms of thickness, do we necessarily lose it in terms of articulated energy – are compromises to be made in the writing?

Overcoming orchestral inertia: context overview

As seen previously, Lachenmann's solutions include reducing the instrumental mass for articulation efficiency and concreteness 'clarity', whereas Holliger utilises the blurring of the lines as a process. Grisey evokes a zoom effect that 'brings us closer to the internal structure of sounds', which he puts in inverse relation to time.[373] 'The more we dilate our auditory acuity to perceive the microphonic world, the more we narrow our temporal acuity, to the point of needing fairly long durations.' This harmonic complexity/time dilution intertwinement is even more relevant at the orchestral scale.[374] For example, in the works of Mark André, an extended

[373] Grisey, G. (1991) "Structuration des timbres dans la musique instrumentale". In Jean-Baptiste Barrière (ed.), *Le timbre. Métaphore pour la composition*.

[374] Grisey and post-spectral composers approached, applying in most cases the 'auditory' time dilution process/principle to develop densely orchestrated, inharmonic elements, e.g. in the works of Murail, Haas, Saariaho or Dufourt.

temporality is crucial to *compose* the orchestral density.[375] In *...hij...* (2008-10), sections are processes building textures in which individuated orchestrations are common.[376] The material richness and density require an expanded temporality. A section/process slowly develops, giving way to a second section/process succeeding to (or fading into) it. Textures expand through 'internal' variations based on an overarching technique or principle (e.g. spreading counterpoint of air, first process/section b.1-52; percussive 'grain invasion evolving into a second more static texture, b. 318-440), making us hear its complex microphonic world, here the slowly evolving inner 'life' of a densely orchestrated sound object.

If in this context enlarged temporalities are processes *utilising* the orchestral mass and inertia, the orchestral development of complex techniques and sounds in more 'compressed' temporal frames remains to be properly addressed. The time/mass interaction questions are specifically relevant to the 'saturation' approach (see 1.3). In Bedrossian's *Itself* for orchestra (2012, Bedrossian's most advanced work for Rigaudière[377]), contemporary techniques and inharmonic materials reach the highest dynamics and velocities – at the limit of the 'mass' development. Homophonic orchestration and solo entities are among solutions explored. As malleable 'solo' parts, harp and piano are densely written.[378] The piano is prepared, augmented in terms of timbre and sound. The harp is also prepared, including four strings tuned a quarter-tone lower. Densely orchestrated materials develop homorhythmically, moving forward in 'unison' (*uni-sound*) groups. Uniform or homogenous utilisation of the groups grow the mass, erasing mass inertia and 'blurring' through commonly articulated energy. However, the richness and 'concreteness' (Lachenmann's 'mechanical conditions') of inharmonic, complex or unpitched techniques tends to become secondary, undermined by the group articulation. As uniform masses, air sounds develop through wind techniques exclusively. Their impact remains secondary when combined with other materials, despite their dense orchestration.[379]

Building the air (souffle) mass: instrumental groups

Beyond inertia, the orchestral development essentially raises the question of the application of chamber mechanisms at the orchestral scale, and by extension their development through various temporalities/articulations. The section below describes the approach to each instrumental group creating concrete means for development exemplified at the orchestral scale in the next section. Previously investigated techniques and processes develop at the orchestral scale, extending to all instrumental groups to build the souffle mass and energy.

Overall, the orchestral groups do not create dialogue in *Sha'aph*. The structure/actions stem from the alternation of animated breath-blocks and suspended or 'trembling' textures, utilising orchestral density to build variously compressed or stretched/spread air *movements* (see fig.127 to 130). 'Masses' of sound alternate with suspended phases – breathing blocks to 'granulating' apnoea. The orchestration in near-systematic *tutti* generates interactions between *masses of air* and *masses of friction*. Air-stemming and air-expanding materials – coloured frictions, phonetically modified breath, hissing air-filled sounds and overpressure granulation (actual or 'mimicked', see 3.1) – expand air and dilute into 'particles' flows, resonances 'residues' and echoes.

[375] André is a prolific orchestra composer (thirteen orchestral works composed between 2000-2019).
[376] In addition to the large instrumentation (e.g. 2 harps, 6 French horns) the strings play in systematic divisi/solo throughout the piece.
[377] Rigaudière, La saturation, métaphore pour la composition? (see footnote 62).
[378] Techniques include numerous overpressure variations.
[379] E.g. air/air-containing winds *tutti* b. 10-21.

1) Strings

The *strings* combining 'tactile' explorations (chap.1) and breath filtration to build a *breathing mass* at the heart of the orchestra. Breath filtration (f-hole and bridge, rotating 'air-gueros') and corporeal sounds combine with air-like frictions (strings and bodies) to create a dense, self-sufficient element challenging the winds in terms of dynamics and sound projection.[380] Overpressure granulations, 'trembling' particle textures (bow-wood/plectrums) expand this hybrid air mass. The cello section incorporates detailed bridge 'zone' filtrations (hand muting), applying previous chamber developments to a cello mass.

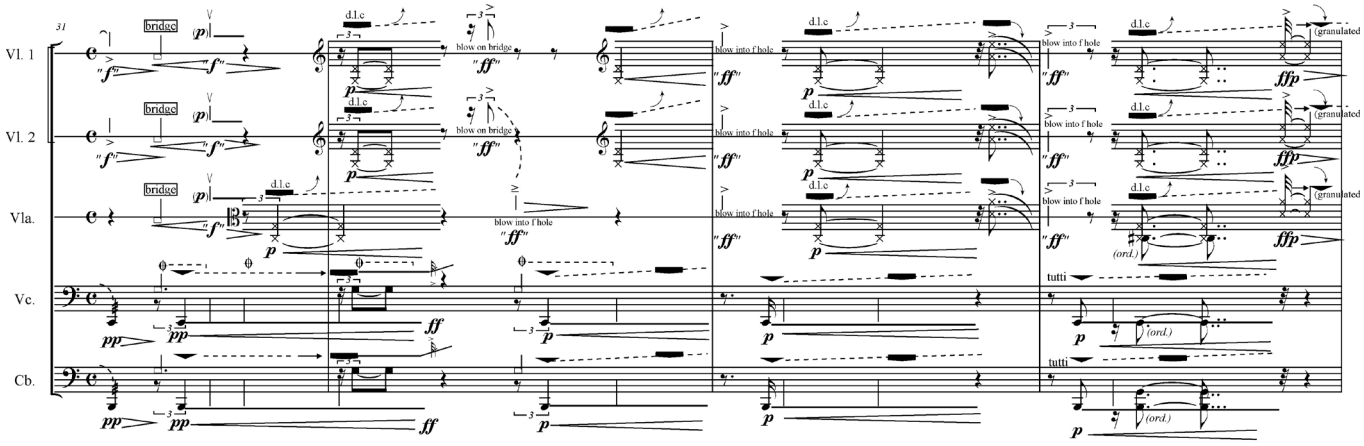


Fig.123 Building the air (souffle) mass : strings

2) Percussion

The *percussion* section incorporates friction and granulation techniques, combining rubbing implements (brushes, hands, sticks, mallets) and surfaces (skin percussion, metal) to create variations (see fig.124). Various granulations colours/qualities (e.g. granulating brush on percussion skin, rubbed cymbal ridges building soft 'whistling' harmonics, slow bell-to-edge granulated sweeping) and blown/sympathetic utilisations expand the air-like, friction-based material. Other developments include 'granulating' instruments such as rainstick, contributing to the 'trembling' texture transformation (see below).

Snare drum		*hands, brush (etc.)*
Low tom		
Bass drum	Friction ⟶	Grain
cymbals		
Tam		*mallet, brush, stick (etc.)*

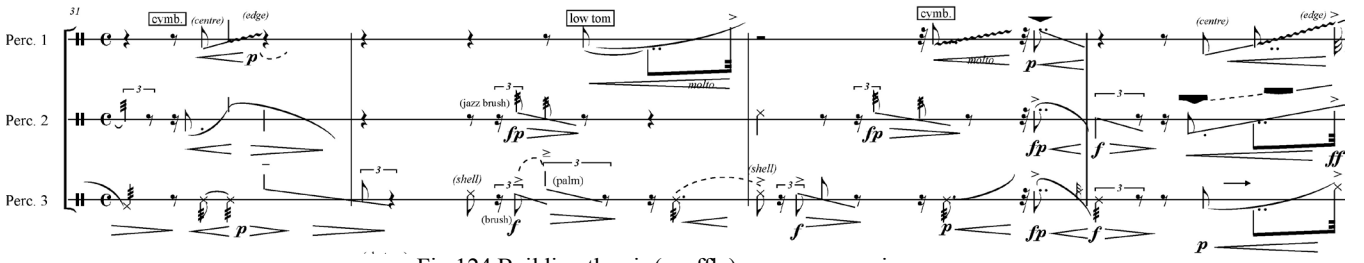


Fig.124 Building the air (souffle) mass : percussion

[380] Expanding 3.1 and 3.2 string techniques developments.

3) Winds

Beyond air sounds in their various forms, the *winds* incorporate other techniques (whistle, air/sound mixtures) exploiting the extreme registers. Inhaled and exhaled air sounds articulate 'gasping' rhythms. Instrument modifications (reedless/mouthpieceless playing, woodwinds, mouthpiece-reversed/mouthpiece-only techniques, brass) increase dynamics/projection (see 2.1) while percussive techniques (e.g. tongue ram), 'emulated' grain (e.g. oboe/bassoon 'mini-slap') and flutter-tongue and 'rattling' technique (e.g. utilising the tuba lowest register, b.45) extend/reinforce the textures. Air-containing sounds develop the 'suspended' phases, in which fragile, air-filled whistles (whistle tones, 'inhaled harmonics') build the 'dilution' effect (see below).

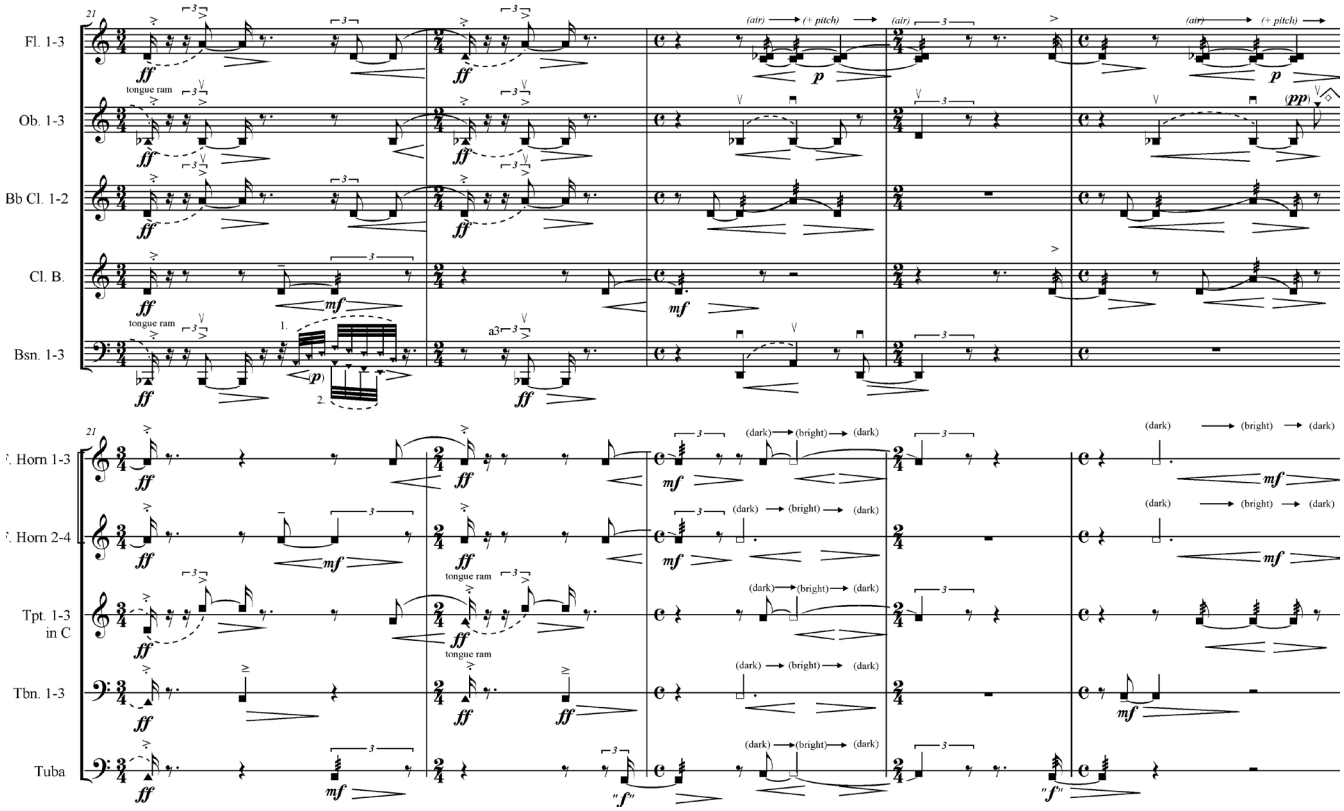


Fig.125 Building the air (souffle) mass : winds

4) Piano and harp

Piano and harp are approached as a group and as 'solo' instruments. Their utilisation as percussive/resonant bodies and friction/granulation surfaces *enhances* and *links* the different orchestral forms and sound 'states', from breathing movements to raucous grain and hissing developments. The friction and resonance qualities of the instruments' parts (e.g. piano metal frame, bright, harp soundboard, dark) are explored with different mallets/implements. Strings are scratched and granulated in gentle to over-pressed fashions, with nails and plectrums; parts are struck and rubbed with hands and mallets, in mutual reinforcements impacting overall orchestration density.

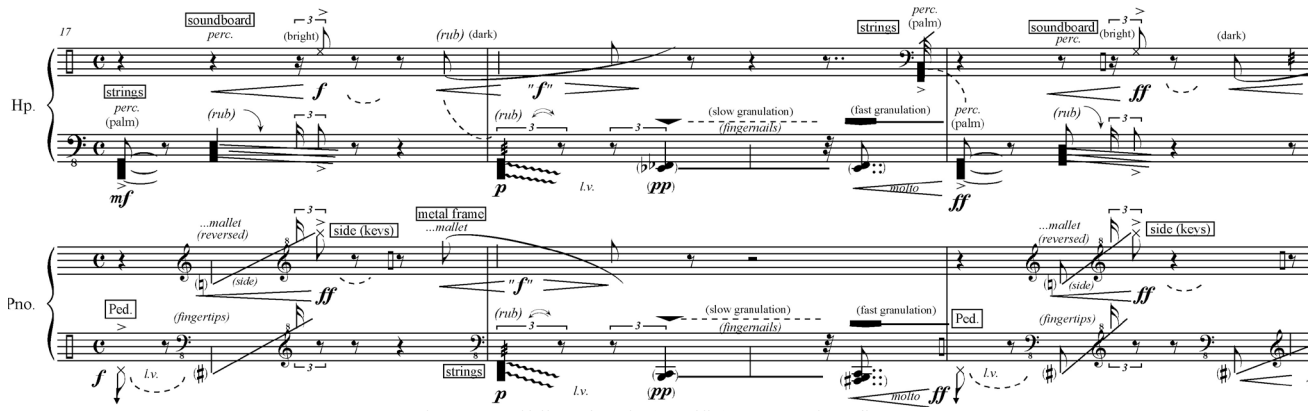


Fig.126 Building the air (souffle) mass : piano/harp

Composing the souffle mass: extended orchestration (selected examples)

The orchestral writing develops in groups, utilising affiliated/complementary actions to build the texture and articulation energy. Through the near-systematic development of *tutti* air masses, the writing investigates the limits of the souffle-based orchestration system (chap.3) and air-friction-resonance continuum (chap.2). As in 3.1,[381] percussive attacks reinforce air and air-like sounds. Breath builds the movements and phrases. Grain and echoes extend, link and merge the elements. Attacks, resonances, overpressures and 'residues' augment dynamics and density, contributing to develop the dual compressed/diluted (respiration/white noise) approach.

The form alternates animated breath-based phases and suspended 'apnoea'. Breath-based developments are densely orchestrated movements of inhalation and exhalation, alternated and texturally 'coloured'. The complexity of the orchestration, augmenting and sub-detailing air sounds and breath articulations, contrasts with the roughness of the material and its dual movement.

For example, the first breath-based phase (fig.127) develops exhalation/inhalation movements, expanding until a peak followed by an 'apnoea' suspension. Four colours build a 'shape' of air compressed in orchestral 'blocks' (see 'reduction' vs. full orchestration, fig.127) augmented and sub-detailed through multiple actions within the orchestral groups. Overpressure and grain create a *condensed inner life* and *microphonic world* reinforcing textures and linking the actions, impacting *tutti* interactions to build the *mass* result. Techniques are adapted, bended to the inhalation-exhalation colours (percussive/resonant developments, grain qualities, friction timbres, see fig.127). Corporeal breathings increase the texture, creating more tension and expectation, especially at the end of the 'gasping' phrases in which actual inhalations (e.g. strings) contribute, through their very presence, to the peak 'apnoea' effect.

'Invaded' by overpressure and percussive attacks, respiration movements reach their 'breaking' points in the second phase (fig.128) pushed by tempo changes and extreme dynamics. The expansion leads to an inhalation 'explosion' (inhalation/exhalation waves, p.8 score) which dilutes into a contrastingly soft 'hissing' resonance, here the second 'apnoea' approach.

[381] See souffle-based orchestration system description chap. 3.1, p.124-125.

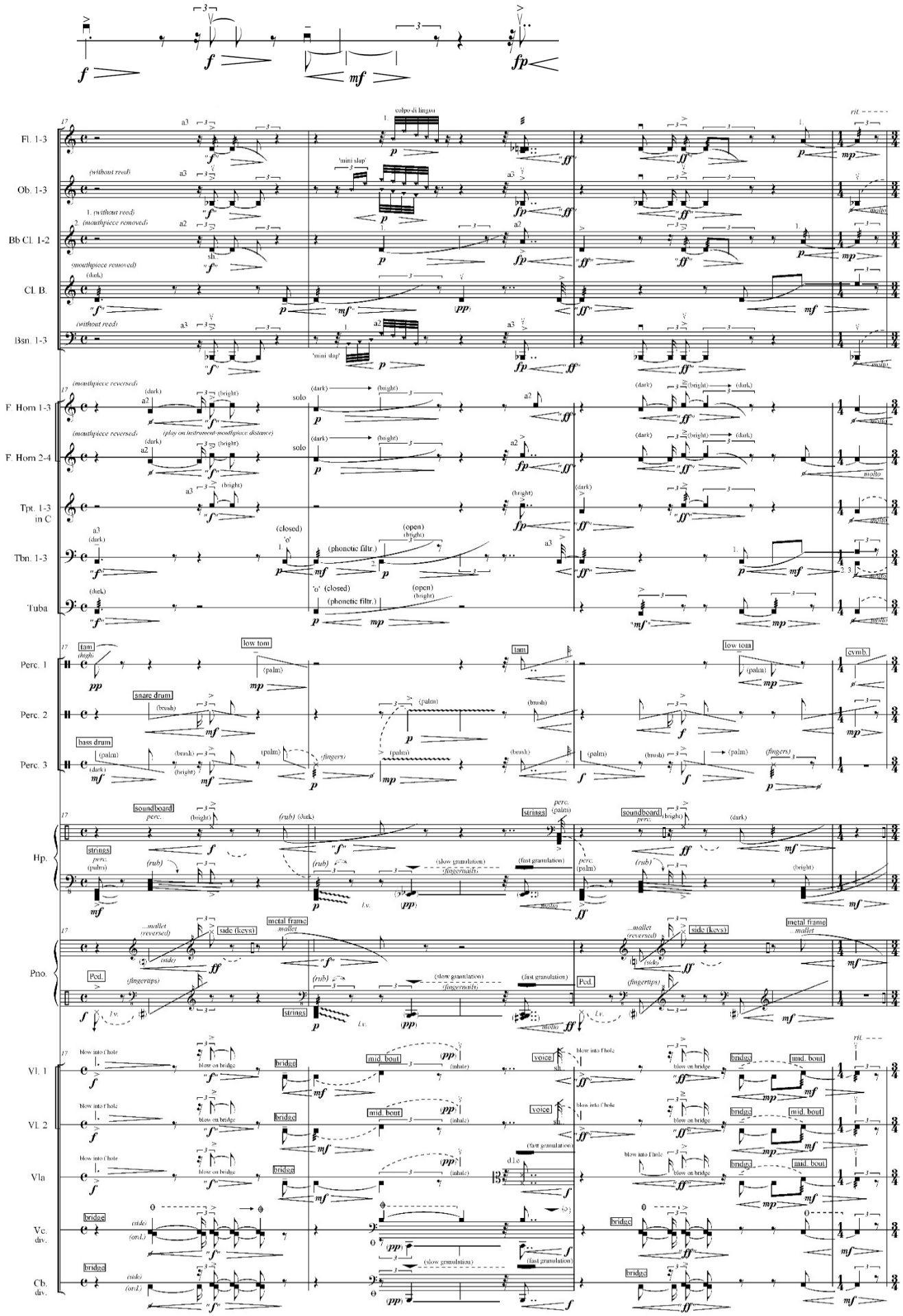


Fig.127 First breath-based phase (reduction vs. orchestration)

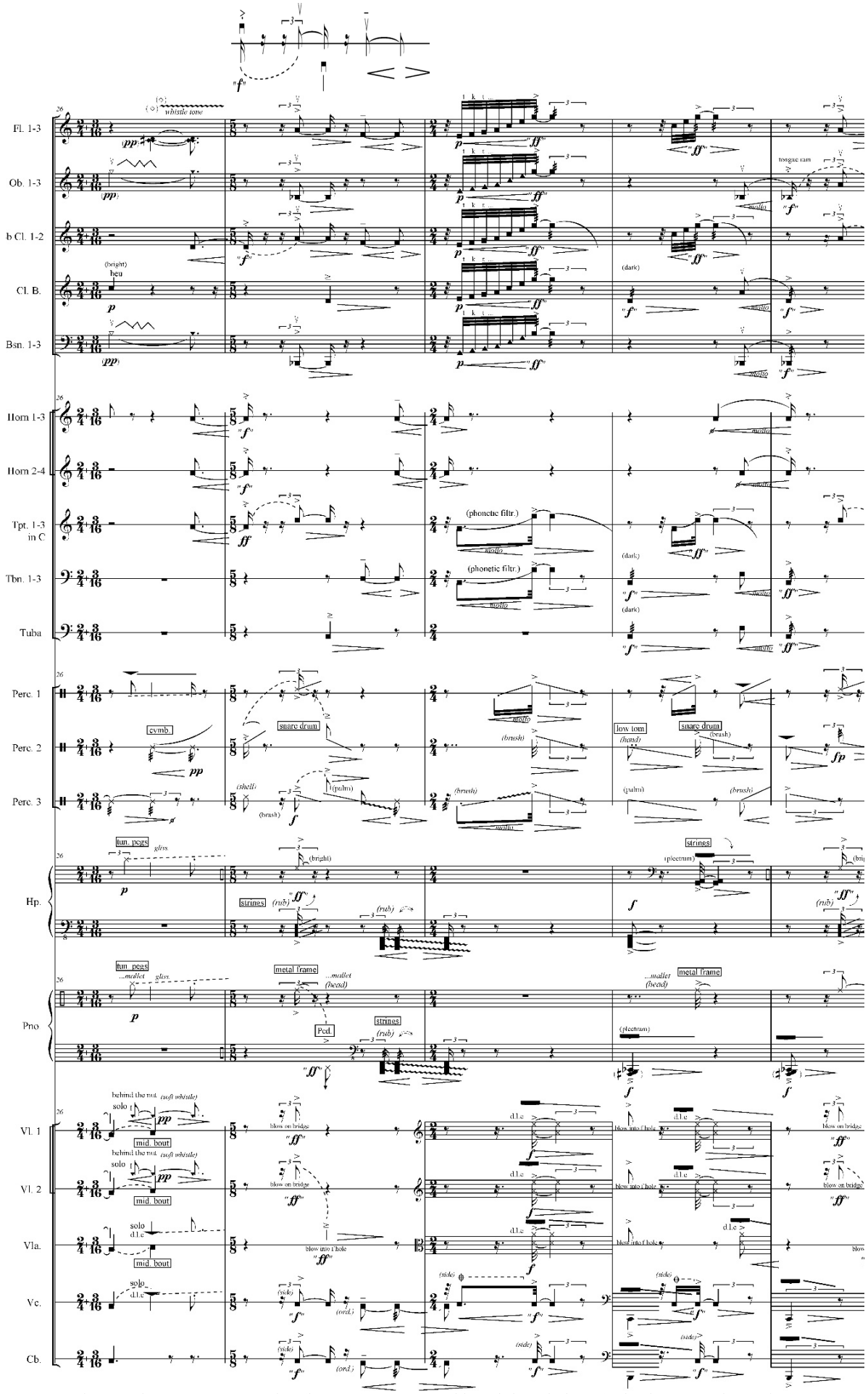


Fig.128 First apnoea suspension (b.25-26), start second breath-based phase (reduction vs. orchestration)

Apnoea sequences, whistling air and grain

A single 'diluted' action, the second *apnoea* suspension (P.9, fig.129) merges air-filled whistling sounds and soft granulation. Brushes, bows, plectrums and fingernails granulate the percussion metals and skins and instruments' strings, superimposing various qualities of grain, from the slow and deep overpressures of the double-basses (3 soloists) to the metallic, near continuous sweeping 'grain' of the gently rubbed cymbals. Physically 'reduced' (mouthpiece-only playing, brass, reedless 'inhaled' harmonics, oboes and bassoons), the winds build a second fragile, almost 'asthmatic' whistles layer merging with equally fragile 'touched' whistles. The strings section's grain-generating players (overpressure combinations) and whistle-generating soloists (soft 'hissing' sounds behind the nut) merge with the cymbal and harp 'swept' whistle sounds. Exploiting colour/register extremities, this 'apnoea' phase 'dilutes' itself into an increasingly spread, sporadic texture. Granulation and whistles vanish into a near-imperceptible exhaled and 'touched' combination: the flutes whistle tones merged with the soft friction of the piano frame, rubbed with a mallet's shaft. 'Touched' whistles and grain (percussion, piano and harp) generate a gentle resonance 'halo' during the whole sequence.

Expanding again the gasping blocks, the third 'raucous' breath-based phase (p.10) results this time in another diluted form, a trembling extension, as if the reiteration of extreme developments of respiration could only lead to physical transformations – here fragments of inhalations/exhalations. Raucous 'exhalation bounces' transform into 'particle' textures (p.11-12) in which overpressures and trembling attacks (e.g. 'tapped' pizzicatti utilising plectrums on behind the bridge, strings) create a flow that slowly expands to become another form of continuous breathing.

Orchestral air waves and particle 'grain' texture. Inhalation-exhalation circularity and orchestration

In the work introduction, a 'wave' of air merging slow, continuous air developments and inhalation and exhalation movements introduces the two soundworlds of the piece.[382] The first 'touched' air textures and frictional, 'phonetic-like' expansions of the piece (strings, percussion) are put in parallel with 'actual' phonetic actions (brass). Human inhalations (strings) incorporate in this dual action, expanding friction as reinforcing respiration/wave colours or movements. Here, again, the basis for development is a rough principle (see fig.130) which, through reiteration and orchestral augmentation, expands as a complex texture.

In the last part of the third apnoea phase (p.22), the introduction's inhaled/exhaled wave is reiterated in a new, faster and rhythmical form, invaded and 'chopped' by the 'particle' texture approach (p.12-13).[383] Underlying element at first, the waves evolve, gradually expanding into circular movement. Orchestral extrapolations of chapter 1 chamber explorations (works for cellos), the strings air-filled circular frictions and 'gasping' movements interact with the woodwinds' respirations. The fast, brushed harmonics, which create a perceptible rhythm as the bow circularly goes up and down the strings brushing them repeatedly, create inhaled/exhaled 'motions' in which air comes and goes as a porous component, gradually leaving space to fragile harmonics as the dynamics increase. The porosity of air develops here at the orchestral scale, as air-like frictions (percussion) reinforce and blur the dual 'touched' and 'breathed' fast inhaled/exhaled action, whose colour evolves through phonetics/contact points combinations.

[382] A process developed in *Holo(s)*, where friction and breath-based action gradually merge towards a single texture and idea.
[383] Expanding principles of 2.3 (e.g. accordion 'breathing' airwave 'chopped' trough electronics/tremolo effects).

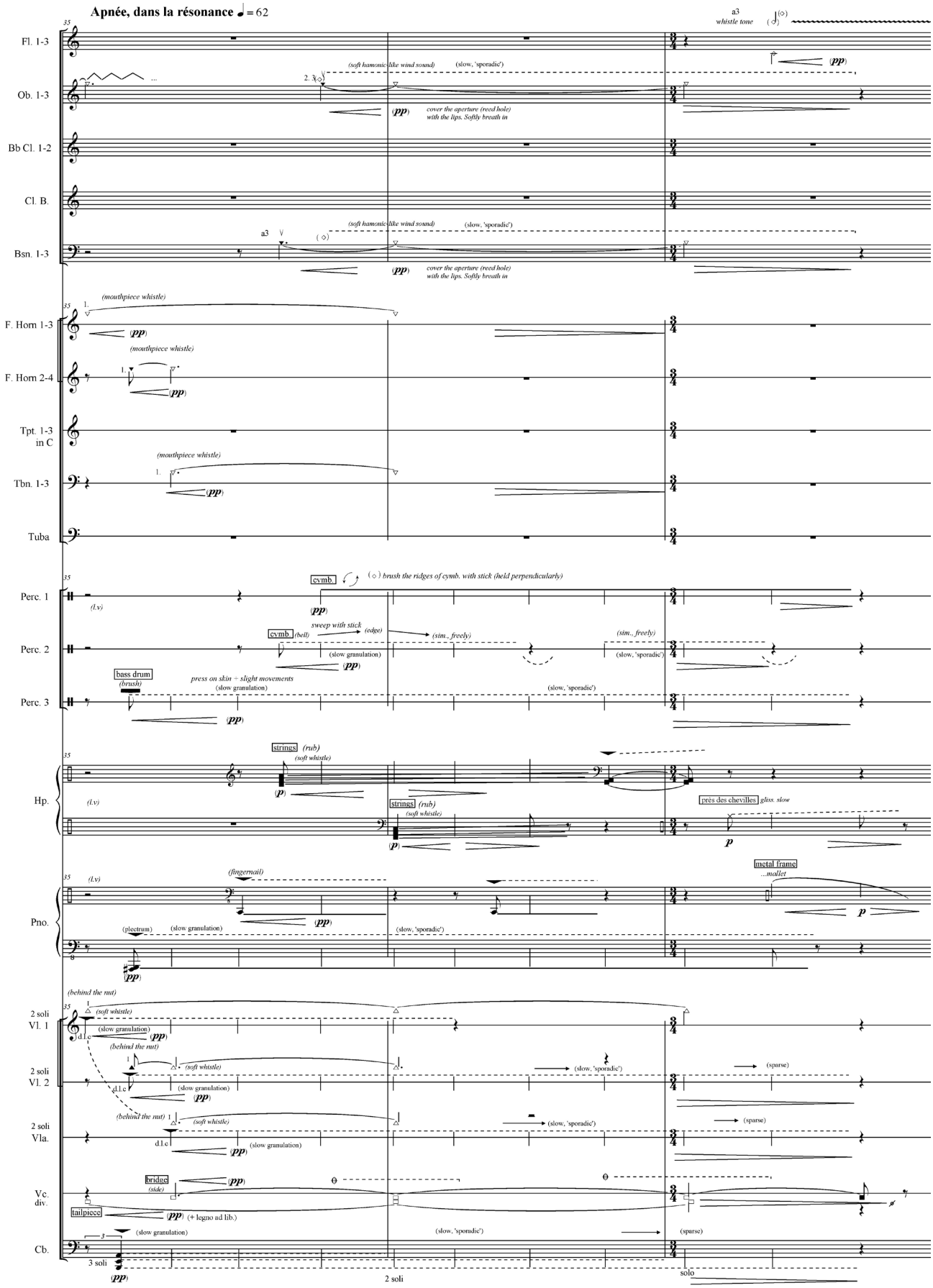


Fig.129 second *apnoea* suspension

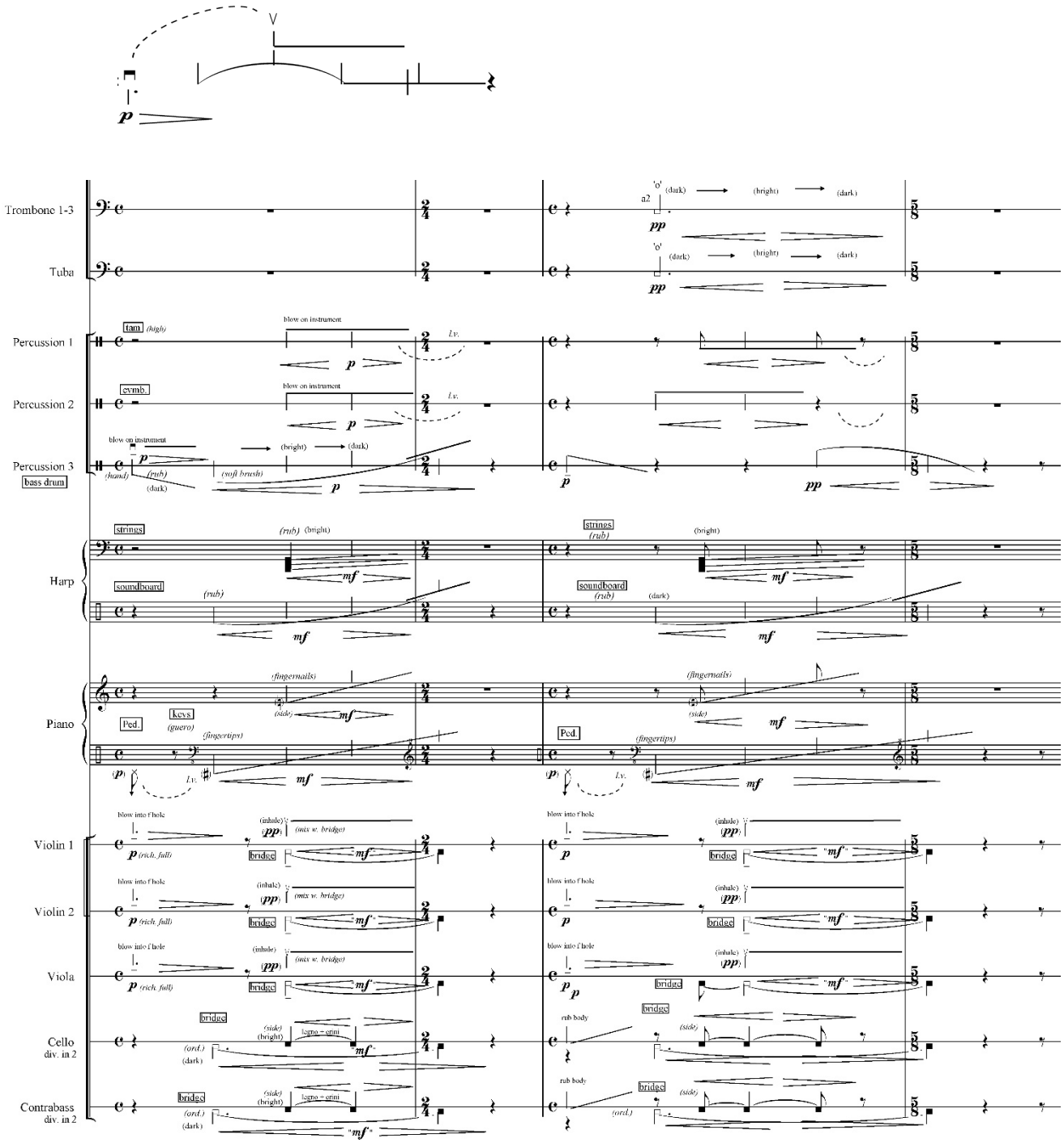


Fig.130 Introduction: wave expansion/inhalation-exhalation (reduction vs. orchestration)

Conclusion

In chapter 1, souffle was explored as a form of contact, a rich (possibly the richest) form. Air, in its tactile form – possibly even more than its (more explored) expelled form – is a porous and polymorphic element, still with lots of potential for investigation. Developed as a self-sufficient medium, the air 'tactility' possesses a fruitful transmutability, whose 'concrete' gesture/sound malleability (overpressures, subtle pathways to vibration/harmonics utilising parametric changes) opens new horizons towards other sound states and paradigms, which in turn act as reinforcements within the 'tactile' universe and as mutual enhancements with corporeal sounds – reinforced and extended through the multiple paths friction offers. The contact-form expansions led to a perspective and temporality put in contrast, dialogue or merging with the breath perspective and form. Future developments include work on friction as a *mass* by approaching large (non-wind) ensembles as hybrid tactile and wind-stimulated forces – a path drafted throughout the research – applying the porosity and 'souffle metalanguage' concepts (3.2) towards the full *extraction of souffle* through the orchestral mass.

Chapter 2 explored the fruits of the hybridization and (con)fusion with resonance. Resonance was investigated as a more complex idea and phenomenon, a development medium and even a form of air (souffle) through its dual human/acoustic understanding. This broad axis created perspectives between the tactile and instrumental/human 'air' forms the resonance(s) develop and extend. The air-friction-resonance continuum reconstructs the expelled and 'touched' forms through sympathetic vibration, spatialization and electronics, creating further (con)fusions future compositional developments can undoubtedly expand, building on the air/resonance typology of continuities and interactions, expanding the souffle spatialization and reworking instrumental augmentations (see below).

In chapter 3, the orchestrated energy and multiplicity of souffle opened to the incorporation of 'residues', secondary elements (e.g. echo, grain) that became fully constitutive of the souffle-based orchestration system. Work on instrumentation created means to expand air and breath (souffle), including in unbalanced, saturated orchestrations in which they cannot emerge as the first sound elements but can, through the powerful aspects of breath perception and human/instrumental synergies, be re-evaluated in a new prominent form. Deployed in three different contexts, the orchestration system demonstrates its potential to provide unamplified options for the souffle development, orchestrating density, creating textures of complex energies. The human and tactile approaches of the previous axes created two fruitful ideas to develop the souffle energy and multiplicity in terms of intertwined, mutually reinforced techniques and combined human and 'beyond-human' temporal and structural perspectives. The last development for full orchestra gives insight into the potential complexity the orchestration system can reach, to be developed in the next steps of my work, expanding the attack/resonance orchestral model to the attack/souffle/resonance concept.

Perspectives

If the adaptation of instrumental techniques and bodies extended the timbral development of air and breath in the various contexts of the research, a key innovation (the extended pedal, renewing resonance-control possibilities of the (intra-)piano, 2.2) offers several development perspectives within the souffle paradigm and beyond. This instrumental extension is currently being reworked, taken a step further thanks to the Art Research Fund awarded by the National Fund for Scientific Research, Belgium (FNRS). The project involves a

team of musicians and instrument builders, developing the pedal system through the composition (four pieces to be premiered in 2022-23). The souffle and resonance pathways, which led to the exploration of sympathetic resonance and the recreation of 'ideal' instrumental spaces for air and breath, will expand through the refinement of the extended pedal possibilities.[384]

The fruitful souffle composition pathways opened by spatialization (2.1 and 3.1) are currently being developed in a new hybrid work and performance, *Composer l'espace, oeuvre/concert spatialisé pour clarinettiste et flutiste en movement* (2021-2022). The work utilises the resonance characteristics of a specific, historical architectural space, *Maison du Peuple* in Brussels. The flautist and clarinettist move around on the space's impressive balconies surrounding the audience – the space's upper room, allowing a rich and detailed work on resonance and sound directionality – gradually descending onto the stage through corridors and semi-silenced glass spaces, finally taking place among the audience. Spread over more than 50 minutes, including discrete electronics interventions,[385] the work's evolving spatial configurations create an ever-changing, immersive perception of the souffle, a surrounding sound element and physical phenomenon at the borders of air and silence and of the visible and the invisible. The resonance of the breath and other complex techniques/acoustic phenomena that construct the piece (resonating beats and multiphonics, moving white noise and granulated, whistling sounds) are modulated by the space, transfigured by it – a fruitful path towards the air and breath *immersion* function.

Through its transversality, souffle offers a transcendent view, a meta-parameter and malleable sound state that transcends the musical and compositional parameters; a tool whose porous, polymorphic 'filter' can be exploited to propose a rereading of certain works and musical developments and to identify certain unnoticed aspects. Beyond the nine works of this project built with this idea, it is a view on/approach to contemporary music – of yesterday, today, and tomorrow. The various post-war works discussed highlight ways in which the souffle paradigm can allow identifying potential differences or gaps in existing works. In general, the tactile development and malleability of air (as souffle) tend to be put aside for the broader benefit of wind and voice-developed utilisations. Utilised for itself or combined with such techniques, the tactile 'energy' is a delicate element to manipulate, requiring 'reinforced' writing to develop (among other things) its transmutability. Focused approaches (e.g. Sciarrino – porosity, Lachenmann – mechanical concreteness, Holliger – contrapuntal lines) combine to form a whole the research attempted to develop through the souffle paradigm.

The interest in the human breath extends beyond the sound and action of breathing and towards an ideal, infinite and gigantic inner micro-polyphony, a fascination for the idea of a *musique intérieure*, an underlying and 'forever inaccessible model' in which the superposition of breath, blood circulation and nervous impulse contains 'all the elements until the intelligence of the world'.[386] Attempts of comprehending, grasping and penetrating of such elements will probably probe eternal subjects for composition.

[384] Among the four pieces planned, one work is for two wind players, exploiting the refined dual control possibilities of the extended pedal (new version) towards new developments of the air/breath and sympathetic vibration interactions.
[385] Utilizing the final loop of Tracer le souffle (2.3) to which the work/performance is designed to be coupled.
[386] Chouvel, J.M. (1998), *Esquisses pour une pensée musicale : les métamorphoses d'Orphée*. Paris : L'harmattan Logiques Sociales.

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