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Model and Material

Composing Sound and the Construction of Compositional Models

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Contents

1 Introduction

There is no metalanguage appropriate to artistic production.

Alain Badiou

I am interested in the making possible of music, in the relocation, transformation, and construction of the conditions of musical composition. I am interested in those historical moments in which a change in the conditions of musical composition occurs, moments which render a previous impossibility possible, shifts which let previously indiscernible elements in a framework emerge, become visible, audible, and 'composable', the creation of new possibilities. A framework, a situation of the thinkable, discernible, and 'composable' constitutes these conditions of composition. It is the task of reflective inquiries to render visible part of these frameworks, which determine our access to reality uncircumventably.

One way we can speak about and gain insight into these frameworks is by focussing on the way compositional works relate to the techniques of their production. Techniques, be they historically handed down, invented, or derived, encompass both operations which serve to construct or select *material*, as well as operations which serve to create *form*. We can then ask how these techniques stand in relation to technology, as an "externalized memory" (Stiegler, 1998), in general. I will, therefore, divide my approach into two parts: on the one hand I will focus on compositional techniques and they way we can think of compositional models of music and sound as a conscious and axiomatic method of dealing with technique and on the other hand I will focus on technology as a principal conditioning factor, which relates compositional approaches to broader, aesthetic, political, philosophical, and historical issues.

Technology forms conditions of artistic production. As Nietzsche wrote, "Our writing utensils help to fashion our thoughts," looking at technology and medial techniques will thus help rendering visible the conditions of musical composition. It is very important to me to submit the used means to a careful examination. In doing so, I will stress, however, that we are not dealing with an unidirectionally determining process, in which the framework of musical composition is entirely directed and conditioned by technological developments, such as notation, transmission, storage, and processing of sound and music, but that internal discourses of musical composition and artistic production processes have determining repercussions for technology as well.

In the late 19th and early 20th century, a radical change in the conditions of musical composition occurred, when composition ceased to be 'tone art' [*Tonkunst*]. The notion of 'tone' itself was recognized as an aggregate, as a composition of notions and disintegrated into its constituent parts. The composition of sound as such was hitherto not possible, not even conceivable, it was 'uncounted in the situation', indiscernible in the framework. It is no longer the (re)structuring of the elements, the material, as they have existed, i.e. new ways of dealing with harmony, rhythm, counterpoint, form, orchestration etc., but the very (re)structuring of the structuring of these elements themselves.

The German media theorist and literary scholar Friedrich A. Kittler sees the reasons for this change mainly in media technological developments. Among other inventions, it is mainly the phonograph, which causes the "Old European alphabetism", that is the symbolic access to sound, to be replaced by a "mathematical-physical notation". Kittler writes that, "a historical transition from intervals to frequencies," is a transition, "from a logic to a physics of sound," and thereby "the real takes the place of the symbolic"(Kittler, 1999). We can thus say that technological development has provided musical composition with an altered access to the sonic reality, in which elements which were only manipulatable within certain symbolic frameworks, had now acquired a changed ontological status.

Nevertheless, musical composition involves symbolic operations. It operates within symbolic frameworks, it is situated between the symbolic and the real. Given the altered access to the sonic reality and the disintegration of previous symbolic frameworks, the question arises how compositional symbolic frameworks need to be designed in order to ensure both an axiomatically compositional origin of their functionality and a gesturally, physically, and phenomenally justified relation to their output, which truly acknowledges the specificities of its medium. Sound synthesis models have a mediating function at the intersection point of the real and the symbolic. In my view, sound synthesis models need to be seen as compositional models and vice versa, I term this approach *compositionally motivated sound synthesis*. I believe, the conditions of musical composition can be actively transformed by the construction of compositional models. I believe, it is necessary to work on the construction of compositional models, since musical material can only be endowed with function and meaning if it is placed within a system or a context where its function is a result of its relationship to other material. If one does not want to use a given, historical context, like tonality, it is a necessity to construct compositional models. Herbert Brün wrote that, “for anything to be of relevance to something, to be of significance to someone, a system has to be created”(Brün, 1969). Systems can certainly vary as to their degree of formalization, they can be based on axiomatic sets of basic principles or they can be the outcome of involved and distributed processes of decision making, which might be hard or impossible to formalize. Although, I concur with Kittler, when he speaks of a “transition from a logic to a physics of sound,” I still want to uphold, that musical composition is bound to symbolic systems. Composition can be understood as ‘system design’. It is, since I agree with Kittler, of even greater importance to me to construct ‘logics’, if we understand a ‘logic’ as an abstract system in which relationships can be represented.

What binds all of the chapters of this thesis together is the relationship of the real to the symbolic, of the phenomenon, and immediateness, that which resists symbolization and the symbolic, i.e. the linguistic dimension of syntax an structure. Musical *material* always has an ambiguous nature, having a syntactic side and one which escapes symbolization. *Models*, the frameworks and limits within which we compose, allow us to operate and navigate within that space.

Compositional models and sound synthesis models are located between the sensible and the intelligible, and – these are different concepts – between the real and the symbolic. By discussing both compositionally motivated sound synthesis and compositional models such as *Project 2*, I am trying to show two ways of approaching these relationships. But even among the sound synthesis approaches discussed here, we can find greatly differing approaches, although they can be seen to be located around the above mentioned relationships. Whereas sound synthesis experiments that work by inscribing musical structures into the sound recording medium itself, such as done by Moholy-Nagy, are collapsing the real and the symbolic into one by starting from the real, Koenig’s *SSP* collapses the real and the symbolic into one by starting from the symbolic. While Kittler proclaims the death of European alphabetism as a consequence of the invention of the phonograph, the radical approach of seeing the physical traces of sound itself as a notation opens a shifted view on this split.

The above mentioned radical change in the conditions of musical composition has often been described as the introduction of 'all sounds' into music. In his article "The Sound of Music", Douglas Kahn describes how music in the 20th century has reacted to a "changed aurality" (Kahn, 2003) by a "process of musicalization" (ibid.), personified by John Cage and Luigi Russolo. Kahn argues that music acted, "to rejuvenate Western art music practice, expanding the material and technical base while maintaining the autonomy of musical practice" (ibid.). By the "discursive dint of associating musical sound with sound in general," music could "protect itself from sound" (ibid.).

Kahn writes that, "musical auto-referentiality did violence to a system of aural signification whereby the associative characteristics of sounds, their attendant social and imaginative domains, were reduced, trivialized, or eradicated" (Kahn, 1990). He argues that music has ignored the need for a semiotic approach to sound, which is a consequence of the "increasing sociality of sound" (ibid.). Instead of engaging in a kind of semiotic play of sounds by constructing "semiotic frameworks" (ibid.), music has reacted by ridding sound of its semiotic dimension and striving for formal 'purity', he argues.

The flaw in this argumentation lies – as I see it – in Kahn's understanding of meaning. There is a discourse internal to music, ways of creating meaning which are musical. Kahn's associations, social and imaginative domains, and semiotic frameworks, are all native to the domain of language. It is a form of meaning which is not essentially musical and not even native to sound. Kahn's description of a musical situation which would follow his idea reveals the illustrative nature of the proposed approach:

> For example, even while being crassly formal, consider a mobility of the voice as generated amid noise teased out of noise by signal, then sustained at a fevered pitch in text with three-part harmony bleeding off to a space in the body which is racked and choked in puns, overtones, and allusions of choking and so on. (ibid.)

This illustrative, metaphorical, and hackneyed image shows that Kahn's understanding of meaning is not musical, but comes from language. There is, however, a kind of musical and even generally sonorous meaning which escapes language, which is what 'sound based art' has to explore. It is not a case of self-referenciality, closed systems, or striving for 'purity', if one insists that an art form has to work with the kind of meaning which is unique to it. Koenig said with regard to 'purity' and self-referenciality:

> I think [...] that the work with rows and with 'parameters' and their forms of organization in general, should rather be understood as an intellectual

> discipline than as something hermetic or purity. Before the composer creates relations between sound events, he has to be aware of their properties and variability.[1] (Koenig, 2010)

Even if one goes along with Kahn's argumentation and aimed for composing "in a semiotic framework [...] through associative irregularities," (Kahn, 1990) the question of organization of creating "relations between sound events" would still remain. Far beyond music's "imagined mission" (ibid.) as Kahn describes it, the "constraining and constrained [...] charting of sublimity, and the providing of a Dionysian rebuff," (ibid.), and beyond the specific material with which it deals, musical composition – as "one of the oldest sciences of the artificial" (Simon, 1996) – has relevance and validity with regard to *com-posing*, structuring, developing, forming, and constructing in general.

Today where novelty of art forms, concerns with "associative" aspects of sound and music, 'critical' comments on music within music, 'political art' which leaves its own form, and aestheticized science are omnipresent tendencies, I believe the hackneyed reproach of musical auto-referentiality and formal 'purity' has become an inhibitive force. Although transgression of forms and novelty are of course important, it is nevertheless necessary to find a limited framework within which something new can be made audible and sensible. The limitations of the form need to be acknowledged.

Kahn reproached Cage and Russolo with "musicalizing" sound. Leaving aside whether Kahn's depiction represents Cage's or Russolo's intentions, the "musicalization" of sound, described by Kahn, can be seen as a way of expanding music by an inclusion of what had been external to it. For me, the question is not which music can sounds create, but which sounds can music create.

Both approaches are interested in moving along the borders of music, but I am interested in moving along these borders from the inside, from within music. The philosopher Gilles Deleuze had the desire to "leave philosophy, but to leave it as a philosopher, [...] to leave it through philosophy"(Boutang, Deleuze, & Parnet, 1988–1989). In my own work, as well as in other people's works I am discussing in this thesis, I find a similar approach. Koenig's synthesis program *SSP*, which can be said to stand at a border of music, borders of music and noise, composing and programming, is deeply rooted in the Western classical tradition. It is not the imposition of musical listening or structural organization on all sounds, but rather the continuing abstraction and evolution of mu-

[1] The quote stems from the email correspondence I had with G.M. Koenig in May 2010. The entire correspondence is reproduced in appendix C of this text.

sic's material and structuring which in itself engenders the sound, and thus, so to speak, leaves music from within.

Chapter 2 – Technology and Reproduction deals with relationships of technology, technique, sound synthesis, and technical reproduction. Some of the main references are Gilles Deleuze, Walter Benjamin, Friedrich Kittler and Agostino di Scipio.

Chapter 3 – Compositionally Motivated Sound Synthesis starts with a historical investigation of precursors of non-standard synthesis, followed by a discussion of H. Brün's and G. M. Koenig's sound synthesis systems. Finally, two sound synthesis methods which I have developed will be presented, *PV Stoch*, a spectral stochastic synthesis generator, and a generalized time-domain periodical interpolator (Gepin).

Chapter 4 – Compositional Models is concerned with the construction of compositional frameworks. I will describe my re-implementation of G.M. Koenig's composition program *Project 2*. Subsequently, I will describe two pieces of mine as examples of compositional models.

2 Technology and Reproduction

Die Art und Weise, in der die menschliche Sinneswahrnehmung sich organisiert – das Medium, in dem sie erfolgt – ist nicht nur natürlich, sondern auch geschichtlich bedingt.

Walter Benjamin

Introduction

The composition and discussion of music usually takes place via the musical material. The material as "all that the artist is confronted by, all that he must make a decision about" (Adorno, 1997), is analyzable and manipulatable. As a 'sedimentation of history' it historically situates and structurally and formally conditions musical composition. The material of electronic music is always *technologically* mediated. Even if the material is understood in a wider sense and incorporates concepts and ideas, the use of the computer (and also the use of the analog studio) "forces the composer to not only think about questions and find answers, but also to formulate them algorithmically and thereby to generalize" (Koenig, 2010). Technology affects and conditions composition, which is why we will direct this discussion towards the more general notion of technology itself.

In this context, there are two concerns which are brought into the focus of discussion, the first one is the question of technique, of how a composition is made, with which tools, knowledge, and processes. The second concern is technology in general. The questions are thus how the composer approaches the material, with which we will deal in the next two chapters, and how that approach relates to the broader field of technology as such[1], which leads us away from immediately musical questions and towards philosophical, political, and media theoretical discourses, the subject matter of this chapter.

[1] A similar division is made in (Di Scipio, 1998).

On the one hand the nature of technology and its artistic and social repercussions are subject to permanent change and undergo transformations. Benjamin's observations about technical reproducibility would not have been applicable to an earlier stage of technology. Benjamin identified a rupture, a radical change in the status of art, which was caused by technological development. On other hand, however, technology itself does not follow a linear progress of improvement, but a non-linear path in which ideas from different times are constantly being abandoned, rediscovered, and reintegrated. Technology is related to the realm of *techné*, which – as a type of knowledge with the intent of production – is not easily becoming an obsolete issue. Apart from technological changes and their repercussions, there is thus also a more consistent 'technological dimension' to art. Technical reproducibility, for example, is not a new issue in the twentieth century but one which has been central to technology from DNA as "the first instance of writing" (Derrida, 1976) to digital technology. Art has long had a rich and important relationship to reproducibility. I believe that it is, therefore, justified to look at discussions of technology which are 70 (Benjamin), 60 (Heidegger), or 20 (Kittler) years old.

However, before entering the discussion, I want to warn the reader that this discussion will not result in direct statements or immediately practical implications regarding the composition of music or directly applicable insights into the nature or role of technology with regard to art or music. The discussion nevertheless forms a background for the topic of the next chapter on sound synthesis and even informs my own electronic and instrumental compositions.

I also want to inform the reader about the gap between the theories discussed in this text and my own music. I don't believe music or art in general shall or can successfully illustrate or demonstrate theories and neither can theory, as expressed in language, actually capture the essence of artistic production.

> An informed reading of the Manifestos and proclamations of the avant-gardes must always begin with this axiom: there is no metalanguage appropriate to artistic production. As long as declaration is concerned with artistic production it cannot capture the present of that production. It is thus in the nature of declarations to invent a future for the present of art. (Badiou, 2007a)

This text is thus not an interpretation, but rather the beginning of the potential groundwork which may underly the aesthetic perspective in development.

Many of the topics and discussions we are gracing deserve a deeper and profounder examination than I am able to deliver within this context. Nevertheless, I believe the contextualization of these different thoughts on technology may serve as a starting point for further thoughts by both the reader and the author of this text.

I shall briefly outline the trajectory of the present discussion. Firstly, I want to challenge two notions of technology: the notion of technology as ‘neutral’, as being mere means with no greater influence on the distribution of power, the visibility of phenomena, and the nature of our being and the view of technology as the main or only source of development, which attributes complete and uni-directional dependence of culture on the development of technology. I will briefly present and then deliver a critique of some of the core ideas and attitudes developed by Friedrich A. Kittler. Part of the following discussion has arisen from a reading of Agostino di Scipio’s texts on the role of technology in music. Instead of limiting myself to giving an account of di Scipio’s analyses, I will rather draw on his sources and provide my own re-reading (Heidegger and Feenberg).

After that, I will take a look at several composer’s views on technology. I will draw heavily on three texts which have been presented at the 1970 conference “Music and Technology” in Stockholm. The three texts are written by Herbert Brün, G. M. Koenig, and Pierre Schaeffer and constitute three distinct and clear positions of the relationship of music and technology.

Via a brief discussion of technical reproducibility we will finally turn to the idea of copy and original in which I will present a concept from Deleuze’s earlier writings, namely the *simulacrum*, which I will try to connect with sound synthesis.

2.1 Neutrality and Determinism

In the philosophy of technics of the French philosopher Bernard Stiegler, we find a roughly three-stepped process accounting for the emergence of *technics*. At its outset is life itself, the genetic memory. It establishes a permanence of information, through reproduction. The genetic memory can thus be seen as the first form of writing (Derrida, 1976). The second step is the memory of the nervous system, the somatic memory, which is based on experience. The third step appears with the emergence of consciousness. The long-term memory and consciousness, Stiegler argues, leads to the anticipation of actions and eventually to the instrumentalization of the environment for performing the anticipated actions. This anticipation and instrumentalization of the environment leads to externalized memory (Gallope, 2006), the construction of tools for anticipated ends, based on the memory of repeated actions and the development of writing as a memory external to the long-term memory of the individual. Stiegler calls this the "technical memory" (Stiegler, 1998), in which "life is pursued by means other than life." Next to the genetic memory, writing systems form a way of passing on information from generation to generation in a non-biological way (Stiegler, 2009). The development which started with the emergence of memory through DNA seems to be about to form a circular closure. Scientists have recently developed a new technology which uses bacteria DNA as a long-term data-storage medium (Mearian, 2007).

Given the way we are embedded in technology and how culture itself, the "trans-generational experience", is passed on through technological, externalized memory, it is naturally "absurd to think technology in opposition to culture" (Stiegler, 2009). Technology can thus be said to constitute a precondition of culture. However, this view can easily tilt over into position which sees culture (and art) as a byproduct of technological development.

"The idea of the unstoppable, quasi-natural technological progress" (Zielinski, 2006) is a common and widespread understanding of technology, which we find often in today's science, art, and everyday life. It implies a subordination of art, politics etc. to technological development. Society and thereby art is seen as acted upon not as acting. Technology has effects, but its development is in itself immutable and autonomous. It thus becomes the governing force and artworks become footnotes of the history of its progress. It creates a history of improvement, from old megaphones to the telephone, from shadow images to 3-D cinema, from ceiling painting to virtual reality, this history stresses the "constant perfection of media's illusionist potential." (ibid.) The new is thus nothing but confirmation of what has already been. Moreover, tools are measured by how effectively they can realize a given end. Andrew Feenberg termed this view "technological determinism" (Feenberg, 1991).

We find – as I believe – a proponent of this position in Friedrich A. Kittler. The radical position he presents has grown out of the application of a Foucaultian discourse analysis on writing systems [*Aufschreibesysteme*] for literature, esp. of "the time of Goethe" (Kittler, 1985). Through detailed historical analyses, Kittler is trying to demonstrate the media-theoretical horizon which is uncircumventably determining our very access to reality. Means of storage, transmission, and processing are conditioning our culture fundamentally. Kittler shows at great length how media technological inventions have caused changes in the arts and social structures. While his earlier writings place media and technology within a more complex network of mutually determining factors, his later writings elevate technology to be the all-determining force.

> The media revolution of 1880, however, laid the groundwork for theories and practices that no longer mistake information for spirit. Thought is replaced by Boolean algebra, and consciousness by the unconscious, which [...] makes Poe's "Purloined Letter" a Markoff chain. (Kittler, 1999)

Kittler's vision, however, leaves little or no space for art to maneuver. In fact, it leaves little space for man to maneuver. As Hansen writes, "Kittler sees human perception–indeed human beings themselves–becoming obsolete" (Hansen, 2004). Art is essentially a supplementary byproduct of technological developments which in themselves know only one motivation, war[2]. Kittler's complete rejection of all modern art on the grounds of its futile rebellion against technical reproducibility (Kittler, 2005), fails to see that technology is only as socially and culturally determining as it is socially and culturally determined.

Despite of his insistence on technologically accurate readings, his own accounts often seem far-fetched and technically inaccurate. His interpretation of the "If-then-else" construction, as an instance in which the computer itself gains independence and can decide the further course of actions, overlooks the fact that the "If"-statement is actually a syntactic facilitation for the programmer, which might be equivalent to a "GOTO"-statment, for the compiler. As Abelson and Sussman famously formulated, "Programs must be written for people to read, and only incidentally for machines to execute" (Abelson & Sussman, 1996). Similarily, Kittler's claim that "there is no software" (Kittler, 1992), a further attempt to exorcise the spirit (*den Geist austreiben*) from science, fails to acknowledge that most of todays computer engineering is based on concepts which have little or nothing to do with machines. Object orientation, functional and logic programming, relational databases, theoretical computer science, analysis of algorithms, the study of the design of large scale software etc., are concepts which are entirely indifferent towards hardware design. With the growing abstraction in compiler construction, even the major programming languages today are indifferent to the hardware system they operate on. Today, there is more reason to say *there is no hardware*.

[2]In accordance with his theoretical position, Kittler endorsed Germany's first post-WWII war of aggression (see Article 26 of the German *Grundgesetz*) in 1999. Whereas Kittler supported the attack due to his belief in the Heraclitian notion of "war as the father of all things", Jürgen Habermas justified it as 'humanitarian aid'. We end this excursion with a quote by Slavoj Žižek: "We should therefore recognize the paradox that concentration camps and refugee camps for the delivery of humanitarian aid are two faces, 'human' and 'inhuman', of the same socio-logical formal matrix." (Žižek, 2002)

Whereas other thinkers who relocated attributes of a previously autonomous subject to external determinants, such as Marx and Freud, did in the same move open an emancipatory possibility, Kittler's move is exclusive and ultimate (Kloock & Spahr, 2000). It leads to the "computational end of art" (Kittler, 2005).

Andrew Feenberg's approach to technology is much more concerned with finding such an emancipatory possibility. In his article "The Ambivalence of Technology" (Feenberg, 1990), Andrew Feenberg sketches out a "critical theory of technology". Feenberg distinguishes three types of critique of technology, which are based on different readings of Marx. The critique which "focuses exclusively on the worth of the products" for which it is used he terms *product critique*. This type of critique assumes a basic neutrality of technology as such, it takes the complete separability of design and use for granted. The second type of critique which Feenberg describes is the *process critique*, which focusses on the repercussions of the use of technology, they way in which "the production process [. . .] shapes the mental and physical activity of workers." Although it questions technology's 'innocence', it is essentially still compatible without the product critique. The third critique relates to the design of technology itself. The *design critique* states that the very construction of technology is "distorted by hierarchical organization." Therefore, technology is always inherently political. Feenberg's design critique shows how social order, power hierarchies, structures of domination, inequality and a general cultural context are inscribed into the design of technology itself, which reproduces these qualities. The lack of design critique has thus contributed to the failure to implement socialism in the Soviet Union. Feenberg writes that, "the design critique leads to the conclusion that [. . .] after a socialist revolution technology would have to be reconsidered much like the state, law, and other institutions inherited from capitalist society."

However, the design critique also entails the possibility of reversing and thereby underminig the oppressive logic of hierarchical structures. What Feenberg proposes is a "democratic" or "subversive rationalization". A type of grassroots resistance, which unfolds its transformative potential locally and 'from within' by approaching the design of technology, in order "not to destroy the system by which we are enframed but to alter its direction of development through a new kind of technological politics" (cited in (Veak, 2000)). Agostino di Scipio transfers this strategy from Feenberg's writings to artistic practice:

> Adorno observed, too, that an artist's labor always implies a personal or

> shared "critique of technology," but it can actually only do so only by confronting and exploiting the technology without getting rid of it. [...], we can argue that, today, art can confront technology in an approach of 'subversive rationalization'. (Di Scipio, 2002)

Di Scipio draws on another source, which can also be said to be a critique of instrumental rationalization, although from a rather different angle. It is Martin Heidegger's "Die Frage nach der Technik" (The Question Concerning Technology) (Heidegger, 1977). In this text, the relationship of art and technology is found in the notion of *techne*, as a 'mode of knowing'. According to Heidegger, both art and technology are processes of unconcealment [*Entbergen*], of disclosure. However, technology's unconcealment always happens against the background of the 'enframing', the *Ge-stell*, that the "human requirement of usefulness places upon it" (Pattison, 2000). There is thus always the underlying idea of instrumentality, of 'equipment', which governs technology. The consequence is that everything, including humanity itself, is rendered into a 'resource' (*Bestand*), for technological exploitation and into objects of consumption. The exact conclusion Heidegger draws and the ontological relationships of the "essence of technology", its relation to Being, are far beyond the scope of this text. Notwithstanding that the text is tinctured with an agrarian, ultra-conservative fear of technology, Heidegger does make connections between art and technology, which can be useful to our discussion.

> [...] essential reflection [*Besinnung*] upon technology and decisive confrontation [*Auseinandersetzung*] with it must happen in a realm that is, on the one hand akin to the essence of technology and, on the other, fundamentally different from it. Such a realm is art. (Heidegger, 1977, German words added)

In discussing this 'free' relation of art to technology, which functions due to technology's and art's essential similarity and difference, di Scipio argues that the intersection point is *poiesis*:

> Both artistic creation and the invention of tools and tecniques [sic] are methods by which *poiesis* - man's faculties of imagining and creating - is revealed. To explain the separation of poiesis as revealed by the process of art and as revealed by the technical development Heidegger draws on [...] poetry. To the poet (the artist) the language (her/his material) tells, while to others it

> serves. The poet qualifies language by putting it into question - s/he shows its limitations and eventually enriches it by transforming it. That who [sic] is not a poet utilizes language within already existing boundaries, being spoken by language rather than speaking it. (Di Scipio, 1998)

In Herbert Brün's text "Technology and the Composer" (Brün, 1971) we find virtually the same idea. Brün's idea of "languages" is similar to di Scipio's interpretation of Heidegger. Brün makes the distinction between *learning from* language, that is adapting one's means of expression to a commonly understood vocabulary, and *teaching* language to say what one wants to say, thereby "retarding the decay of information", and extending the vocabulary. It is during this moment of structural change, this "interregnum", a moment in which there exists a discrepancy between the encoding of the message and the decoding of the receiver that the new emerges.

Brün stresses the ubiquity of technological considerations in musical composition. He also criticizes the view of technology as a mere means to preconceived ends. The composer needs to engage in actively designing artificial systems. Free from any ant-technological fear, Brün rather highlights the "common ground" of art, science, and technology, which he locates in the idea of the system. The differences between these disciplines are thus differences of attitude towards systems. Science, Brün says, stipulates systems which are "*analogous* to an existent truth or reality", technology create systems that "are *to function* in an existent truth or reality", and the arts create systems which are "analogous to an existence *desired to become* true or real". This underlying desire reveals the intrinsic utopian motivation in Brün's point of view. It is the desire to create an "intelligent society". Artificial systems need to be developed, for they can have "properties which man either cannot have, or does not yet have". We can indeed say, that what Brün proposes is a kind of 'subversive rationalization'.

2.2 Technology and Music

At the same conference where Brün presented the aforementioned text, Pierre Schaeffer presented a paper dealing with his view of the relationship of music and technology. In his lengthy contribution, Schaeffer discusses a wide variety of issues, most revealing for our discussion is his view on the relationship between "the artist and the engineer". Scheaffer proposes:

> [. . .] the interesting and fruitful notion of two types of creators: those whose

> job it is to generate 'musical idea', in complete independence, and those who are faced with the task of interpreting these ideas [...]. (Schaeffer, 1971)

Scheaffer's proposal describes a de facto practice in some electronic music institutions today. A harmful repercussion of this division of labour is the dissociation of ideas of sound and ideas of music. The "complete independence" of the development of the musical ideas from the medium in which they are to be realized prevents the material from unfolding its structural, musical consequences and from being further developed and supplemented by musical demands. If we bring to mind Adorno's description of material as, "all that the artist is confronted by, all that he must make a decision about" (Adorno, 1997), we see that Schaeffer's proposal splits art – the deduction of sensations from a material – apart at its very core.

Partly due to technological development and partly due to the breakdown of music's own referential systems, musical material has changed dramatically in the twentieth century, but by the end of the century we see a restorative movement in which music, which does not essentially question its own conventions is, as Douglas Kahn puts it, "rejuvenating" (Kahn, 1990) its material, but without delivering a critique of its means of production and distribution or questioning the world of expressive convention it is coming from. Often sound is equated with timbre which is equated with the Fourier spectrum which is equated with harmony.

Technological development is here seen as an "enrichment of musical material," (Murail, 2005) which takes place in an essentially conservative form. The new is thus only an improvement, improved control over the material, and the means are thus measured by how effectively they can realize a given end. The French composer François Bayle says, "a great artist can create a work of art that transcends the medium, that makes one forget the medium." (Desantos, Roads, & Bayle, 1997) Here, the medium serves the "great artist" to express his ideas of beauty. This is the path which leads to the equation of music with the results of its productive activity, where it is disembodied from its process of production, and tends to be reduced purely to the acoustic experience. Here, technology is used due to its illusionist capabilities.

An approach to sound synthesis which is characterized by an avoidance of imitation can be traced back to the electronic music of the 'Cologne School', where one assumed that in order to compose new music with a new kind of material, one has to find new ways of treating this material. If one assumes that art evolves from the examination of the means of its production, it is necessary to explore the possible ways of musical organization our means of production can provide us with, instead of searching for ways of emulating already known situations with new tools. G. M. Koenig writes that when composing electronic compositions, he has "always searched for causes in the technical conditions of the studio. [...] the machines should not only be used economically, but also musically, they should take over form building tasks."(Koenig, 1987) We can contrast this view with Jean-Claude Risset's position, which he also presented at the 1970 "Music and Technology" conference.:

> Insofar as the composer is familiar with the sounds of an instrumental type, he will inevitably find it simpler, in front of the computer, to make use of his previous musical concepts and his science of orchestration. (Risset, 1971)

Making "use of previous musical conceptions and science of orchestration" as a goal for dealing with new tools can be seen as a strategy of preventing change. I am trying to present a perspective in which technology and its function is not accepted as pre-given, as immutable, not as mere means for realizing a preconceived objective, but as something to be explored, to be determined, to be defined. It is not so much the question which desires one can satisfy with a given technology, but rather which (old and new) desires emerge from it, it is the search for possible roles of technology in music.

In his article "The Use of Computers in Composition Processes", G. M. Koenig describes the role of the computer as follows:

> The composer can pursue the question what a rule is, [...] in which way different rules influence each other. The composer teaches the computer to understand and speak; what the computer says shows the composer what he himself has understood and could express. (Koenig, 1993a)

In Koenig's conception, technology is thus rather a stimulating factor, as a fundamental change in the nature of material it can provide new musical conceptions and since it demands formalization and abstraction it can help revealing the underlying structure of compositional thoughts. Technology, thus, becomes an *Erkenntniswerkzeug* (Döbereiner, 2008b, Section 2.3.2.).

2.3 Synthesis and Simulacrum

When Walter Benjamin wrote his essay on the the work of art in the age of its technological reproducibility, he argued that the technical reproduction assails "the here and now of the work of art – its unique existence" (Benjamin, 2008). What is lost in this process is the *aura*, a term which has been subject to a vast amount of contrasting interpretations, at least partially owing to Benjamin's own wistful and nostalgic tone. The German-Russian art critique Boris Groys writes:

> "A close reading of Benjamin's text makes clear that the aura originates only by virtue of the modern technology of reproduction – that is to say, it emerges in the same moment as it is lost. And it emerges for the same reason for which it is lost." (Groys, 2008)

From my point of view, Groys's reading is highly contestable. In Renaissance painting it is not the abstract geometric construction, but rather the surface, the religious theme, which gives rise to an "aura", a fetish to be worshiped. When art became more autonomous, this level had disappeared and the artist himself, his personality or genius, takes this auratic place. Aura is not a retroactively constructed idea, gained and lost at the same moment.

If we read Benjamin's loss of aura rather as giving rise to new possibilities, then the gap aura has left should be understood differently. The technological reproducibility of sound is the *sine qua non* for sound synthesis, it is its necessary precondition. Sound synthesis is thus, in its historic position, already beyond the distinction of copy and original. As Benjamin writes, "the whole sphere of authenticity [*Echtheit*] eludes technological – and of course not only technological – reproduction."(Benjamin, 2008) Once sound could be fixed, could be 'written', could be played back, its traces also became manipulatable, it became possible to directly inscribe something which had never been recorded before and thus create something which is already a copy, but for which there exists no original. In other words, the *simulacrum* is at the beginning of sound synthesis.

In his text "The Simulacrum and Ancient Philosophy" (Deleuze, 1990)[3], the French philosopher Gilles Deleuze reinterprets the term *simulacrum*. Deleuze is trying to show what it means to "overthrow Platonism," i.e. to abolish both the world of essences *and* the world of appearances.[4] He is first describing Plato's motive for the theory of Ideas as "distinguishing between the 'thing' itself and its images," as a division of the "pure" and the "impure", the "authentic" and the "inauthentic." But it is not only the distinction

[3]also published as "Plato and the Simulacrum"

[4]It is debatable how successful Deleuze is in his attempt to "overthrow Platonism." Alain Badiou disputes Deleuze's success (see (Badiou, 1999)), especially with regard to his raising up of the simulacra,"Deleuzeiansm is basically a Platonism with a new accent." It should also be noted that the term *simulacrum* later disappears from Deleuze's vocabulary. This discussion, however, is far beyond the scope of this text. If he succeeds from a philosophical point of view is less relevant here. I am interested in using his idea of simulacrum as a view on sound synthesis and simulation.

between original and copy with which Deleuze is concerned but rather the distinction between two sorts of images, a good copy and a bad copy, the icon and the simulacrum.

> *Copies* are secondhand possessors, well-grounded claimants, authorized by resemblance. *Simulacra* are like false claimants, built on dissimilitude, implying a perversion, and essential turning away. [...] Plato divides the domain of the *image-idols* in two: [...] the *iconic copies* [...], [and the] *phantasmatic simulacra.* (ibid.)

Deleuze is arguing that Plato is repressing these "phantasmatic simulacra," on the ground that they do not resemble the Idea of the thing, they are mere semblances, "images without resemblance," and Plato ascribes a daemonic character to them. Simulacra might create the impression, the effect of resemblance, but they are, unlike the copies, not imitations which reproduce the Idea, the spiritual and internal model. Deleuze writes that the "spectator is made part of the simulacrum, which is transformed and deformed according to his point of view." In contrast to the copies, the simulacra are "produced at the very point where the observer is located." Here we might be reminded of the differences between stereophonic or other sound reproduction techniques which work with a 'sweet spot', a kind of trickery "produced at the very point where the observer is located."

Deleuze ascribes a "phantasmatic power" to the simulacrum, which is asserted when it "breaks its chains and rises to the surface," it is "the way the conditions of real experience and the structure of the work of art reunite, [...] the aggressiveness of the simulacra." The copy, or icon, creates difference in terms of similarity, the similarity is the basis, whereas the simulacrum uses difference as its basis and "similarity is a product of a basic disparity." The differences are thus what is similar and not the similarities what is different. So, what happens when we raise the simulacra, over icons and copies? Deleuze argues that the Essence/Appearance distinction disappears:

> The goal is the subversion of this world [...]. The simulacrum is not a degraded copy, rather it contains a positive power which negates *both original and copy, both model and reproduction.*(ibid.)

With the negation of this distinction we are freed from the restriction which permits anything new to emerge, because everything is 'already there'. In his text "Imitation of Nature, Toward a Prehistory of the Idea of Creative Being", the German philosopher Hans Blumenberg traces out the emancipatory development which has let art "escape from the bondage of mimesis."(Blumenberg, 1981) Blumenberg starts with the Platonic idea of a cosmic completeness and Aristotle's conclusion that there cannot be anything 'new'. "The complete equivalence of possibility and reality does not allow for man to act spiritually original. [...] Being can not be 'enriched"' (ibid.). As Blumenberg shows, it is only through a long process until modernity that "art does not want to *mean* [German: *bedeuten* also 'denote'] anymore, but wants to *be*," or as the French artist Henri Matisse said, "a new painting is a unique event, a birth, which enriches the worldview, as the human spirit grasps it, with a new form." (cited in ibid.) Similarly, Rilke writes, "the essence of beauty does not lie in its effect but in its being."(Rilke, 2001b)

Deleuze writes, "the artificial and the simulacrum are not the same thing. [...] the factitious is always a copy of a copy, which must be pushed *to the point where it changes its nature and turns into a simulacrum.*" The move from sound recording, the creation of a copy, to sound synthesis, to the etching of groves into the record without previous inscription, is this "pushing to the point where it changes its nature," and here lies the emancipatory act of sound synthesis.

Transition

Although this chapter has been mostly devoted to questions concerning technology, the whole sphere of *techne* as such, of technique and technology forms a center of my work and this thesis. The reader should keep the presented discussion in mind while reading the next chapter on *compositionally motivated sound synthesis* and the last chapter on compositional models. Although many connections often remaining tacit, discussions on technology and technique, on the meaning of how to construct, form a background, a horizon, against which not only my account and development of sound synthesis methods shall be read, but which even informs the instrumental music pieces presented in the last chapter.

3 Compositionally Motivated Sound Synthesis

3.1 CMSS and its Precursors

The technological development of sound synthesis is mostly discussed as a chronological history of technological progress. In this section, I will rather view the history of sound synthesis as nonlinear, as a history with many bifurcations in which ideas do not undergo a continuously progressing development, but in which they reappear, transform, merge, and co-exist. Nevertheless, we construct a history which is characterized by rupture, and by transformations of situations which render previous impossibilities possible.

This section aims at tracing out an idea of *compositionally motivated sound synthesis* (CMSS), by connecting the 'non-standard' synthesis approaches of the 1970s to early 20th century sound synthesis methods. In doing so, I will not strive for ideological immunity, not offer a neutral or impartial analysis, but rather defend the specific, partial position I am constructing. The idea of CMSS is prominent and articulated in early twentieth century sound synthesis experiments as well as in approaches and ideas of composers of the second half of the twentieth century, such as G. M. Koenig, Herbert Brün, and Iannis Xenakis, whose synthesis methods have been termed 'non-standard' by Steven R. Holtzman:

> Standard approaches are characterized by an implementation process where, given a description of the sound in terms of some acoustic model, machine instructions are ordered in such a way so as to simulate the sound described. (Holtzman, 1979)

The term 'standard approach' serves differentiation. Its counterpart is the 'non-standard approach', in which "the computer acts as a sound-generating instrument *sui* *generis*, not imitating mechanical instruments or theoretical acoustic models," (Koenig, 1980) and is described by Holtzman as follows:

> The non-standard approach, given a set of instructions, relates them one to another in terms of a system which makes no reference to some superordinated model, [...] and the relationships formed are themselves the description of the sound. (Holtzman, 1979)

The differences between 'standard and 'non-standard' sound synthesis methods are differences of origin of principles of sound production. 'Standard' methods are based on physics, acoustics, and psychoacoustics, whereas 'non-standard' methods are based on compositional ideas of sound and musical organization. It seems, therefore, more appropriate to call them *compositionally motivated sound synthesis* methods. The 'non-standard' systems are rooted in the belief that electronic and digital means allow "the composition *of* timbre, instead of *with* timbre," (Brün, 2004) that sound production itself can be considered a compositional activity. As Stockhausen writes, "Jeder Klang ist das Ergebnis eines kompositorischen Aktes." ("Every sound is the result of a compositional act.") (Stockhausen, 1963) Arguing from the etymology of the words *com-position* and *syn-thesis*, which are synonymous in their respective languages of origin, one may see their difference rather as a difference in time levels than in kind. Di Scipio writes, "synthesis can often be thought of as micro-level composition." (Di Scipio, 1995b) As suggested by Thomson, the 'non-standard' sound synthesis approaches can be seen as "microsound's digital beginnings," (Thomson, 2004) in their "impulse towards the atomisation of musical material and control of that material on ever-lower levels."

In a paper titled "Viewpoints on the history of digital synthesis", Julius O. Smith proposes a taxonomy of digital sound synthesis techniques. Smith divides all digital sound synthesis techniques into four groups: those based on processed recording, spectral models, physical models, and abstract algorithmic techniques (Smith, 1991). Non-standard synthesis methods fit into Smith's taxonomy as abstract algorithmic techniques. CMSS methods are also understood as abstract, algorithmic models of sound. Similarly to algorithmic composition in which rules are not established to simulate or model existing music, CMSS rather deals with the construction of abstract formulas. We can thus differentiate compositionally motivated approaches to sound in general, which might employ techniques from any of Smith's categories, and the proposed notion of compositionally motived sound synthesis by pointing at their strategies of sound production. The sound synthesis models presented here are not concerned with modeling the sound source or the receiver, but with exploring the possible musical and sonic implications of abstractly constructed rules, or as Koenig formulated it, "given the rules, find the music." (Koenig, 1980)

Xenakis's, Brün's, and Koenig's systems deal with the construction of abstract algorithms, but the relation of non-standard synthesis and abstract algorithmic techniques may be most evident in Paul Berg's ASP and Pile. By focussing on "syntactic relationships" (Berg, 2009), the idiomatic expressions of computer programs themselves, the language of abstract models, instructions such as "counting, comparing, arithmetic and logical operations" (ibid.) could become means of sonic expression and thereby fundamental compositional operations.

Smith's projection made in 1991 that, "abstract-algorithm synthesis seems destined to diminish in importance" (Smith, 1991) has turned out to be wrong. Abstract models have not lost importance, they are widely used in a vast range of musical styles and are still being implemented, developed and integrated into new software systems.

The proposed term CMSS is thus not an attempt to reclassify digital sound synthesis techniques, for it can be integrated into existing classifications. The concern here is not taxonomical. It is rather an attempt to construct and outline a position on sound synthesis, which takes the 'non-standard' synthesis systems of the 1970s as a starting point, for the development of an aesthetic perspective.

In the following three subsections we will discuss the proposed approach and look at it from different perspectives. After a brief discussion of some precursors of CMSS, we will deal with the non-standard synthesis systems of G.M. Koenig and Herbert Brün and with the idea of models of sounds.

Precursors

The invention of the phonograph and the breakdown of tonality as a referential system were the transformative events that changed the situation, the conditions of composition, for the twentieth century. Sound as such became 'visible', as an acoustic writing inscribed into the phonograph record and as a concept emerging through the decomposition of traditional models.

The development of sound visualization and recording technology plays a major part in the becoming-visible of sound. With Ernst Florens Friedrich Chladni's *Klangfiguren* from 1787, i.e. with the creation of visible patterns in correlation with acoustical vibrations, sound is for the first time associated with specific graphics. The vibrating plates that are covered with quartz dust are thus creating no arbitrary but an indexical relationship, the sound has written the graphic itself. Here we find sound as a trace and traces of sound, a form of acoustical writing (see (Levin, 2003)) which underlies the idea of CMSS. With the opto-acoustical film sound and the phonograph, the traces become manipulatable and potentially decipherable. An early proposal which deals with traces of sound and the phonograph as a machine for reading traces was made by the German poet Rainer Maria Rilke. In 1919, Rilke wrote a text titled "Ur-Geräusch" (Primal Sound), in which he imagines, triggered by remembering a physics experiment of his school days, using a phonograph needle to render audible the coronal suture of a skull:

> [...] What if one changed the needle and directed it on its return journey along a tracing which was not derived from a graphic translation of a sound, but existed of itself naturally – well: to put it plainly, along the coronal suture, for example. What would happen? A sound would necessarily result, a series of sounds, music...
>
> Feelings – which? Incredulity, timidity, fear, awe – which of all the feelings here possible prevents me from suggesting a name for the primal sound [*Ur-Geräusch*] which would then make its appearance in the world...
>
> Leaving that aside for the moment: what variety of lines then, occurring anywhere, could one not put under the needle and try out? Is there any contour that one could not, in a sense, complete in this way and then experience it, as it makes itself felt, thus transformed, in another field of sense? [...] (Rilke, 2001a)

What Rilke suggests here is in essence a form of 'sonification'. The rendering audible of otherwise inaudible structures, the "putting under the needle" of lines and shapes transforms phenomena from one field of sense into another. The phonograph thus becomes an extension of our senses, by rendering audible that which was never before recorded.

Only three years after Rilke's text, in 1922, the Hungarian painter, photographer, and professor in the Bauhaus school László Moholy-Nagy suggested another use for the phonograph. In his famous text "Production – Reproduction", originally published in the Dutch journal *De Stijl*, he argues for "the phonograph [to] be transformed from an instrument of reproduction into one of production; this will cause the sound phenomenon itself to be created on the record, which carried no prior acoustic message, by the incision of groove-script lines as required" (Moholy-Nagy, 2004). Moholy-Nagy is arguing that what he calls "reproduction" is the mere "reiteration of relationships that already exist," and that a turn to the active "production" can create new relationships. Since art is capable of actively transforming man's cognitive and perceptual abilities one should make use of the phonographs transformative potential.

Whereas Rilke's idea stresses the transfer of phenomena across sensory modalities, a re-reading of a given environment, Moholy-Nagy emphasizes the active and intentional construction of entirely novel relationships with the use of technology. However, both ideas focus on the extension of senses and refer to technical mediation, to its materiality, and to the specificity of the medium.

Rilke's text, Moholy-Nagy's proposal, as well as the work of many others in the time between the Russian revolution and the end of the Weimar Republic, can be seen as precursors of 'non-standard' synthesis. They strive to unite micro and macro time levels, they aim at the composition *of* sound instead of *with* sound, they are interested in producing a music which explores the specificities of its means of production, and believe that both technology and art actively transform human perception and cognition. By etching grooves into phonograph records and painting sound waves on film they formed a compositional synesthesia in which image, sound notation, and the physical sonic phenomenon are linked during the composition process. What emerges recognizably is the role of the medium and a preoccupation with the reality of the medium, which is not to be transcended but constitutes the real, material basis.

We might say that music discovers its medium and focuses on the exploration and exhibition of what is "unique" and "irreducible" to music, on the "limitations that constitute the medium" (Greenberg, 1982) of music. On the one hand that means to invent content where there is almost nothing, and on the other hand dismantling the relationship between the real and semblance, a reflexive approach which avoids imitation and stresses the fact that it is something made, something composed. This distancing exposes the mutual determination of real and illusion. Alain Badiou writes in his book *The Century*:

> Distancing – conceived as the way that semblance works out its proper distance from the real – can be taken as an axiom of the [twentieth] century's art, and of 'avant-garde' art especially. What is at stake is the fictionalization of the very power of fiction, in other words, the fact of regarding the efficacy of semblance as real. This is one of the reasons why the art of the twentieth century is a reflexive art, an art that wants to exhibit its own process, an art that wants to visibly idealize its own materiality. (Badiou, 2007a)

Koenig's SSP and Brün's SAWDUST

In the 1970s, a number of non-standard synthesis systems were designed and implemented, among them Iannis Xenakis's *Dynamic Stochastic Synthesis* (Luque, 2006), Paul Berg's *PILE* (Berg, 2009), G.M. Koenig's *SSP*, and Herbert Brün's *SAWDUST*. To illustrate and concretize some of the origins of the theoretical considerations presented in this section, I will take a brief and critical look at the latter two systems.

Composer G.M. Koenig designed the sound synthesis program *SSP* in 1972, although previous design plans date back to the 1960s (Berg, 2009). The system is based on the fundamental proposition that "musical sounds may be described as a function of amplitude over time" (Koenig, 1971). The program makes use of Koenig's *selection principles*, which he had developed and used for the composition of instrumental music. The selection principles are serial and aleatoric procedures, which abstract fundamental musical behaviors, such as repetition, expansion, direction, and reduction. In his composition program *Project 2* these principles were used to order given lists of parameter values. Instead of ordering higher-level properties such as dynamics, rhythm, durations, pitches etc., in *SSP* they are used to sort instantaneous sound pressure levels[1] and time values and thereby to compose the sound wave itself. The selected time and amplitude values are collected in segments and the selection principles are used to create sequences of segments. The relatively unaltered transference of principles form the macro level to the micro level and the self-containment of the system can suggest a notion of 'purity'. The search for a definition of 'purity', as it has been attributed to modernist movements, has been described by the American art critic Clement Greenberg:

> What had to be exhibited was not only that which was unique and irreducible in art in general, but also that which was unique and irreducible in each particular art. [...] It quickly emerged that the unique and proper area of competence of each art coincided with all that was unique in the nature of its medium. [...] Thus would each art be rendered "pure," and in its "purity" find the guarantee of its standards of quality as well as of its independence. "Purity" meant self-definition. (Greenberg, 1982)

It can indeed be said that *SSP* is a search for what is "irreducible" to music, and that it is concerned with "all that is unique in the nature of its medium," but instead of understanding it as an attempt to construct a 'pure' approach to synthesis, or to

[1] Koenig refers to instantaneous sound pressure levels as "amplitudes". I will adopt this terminology, although it might be technically incorrect.

maintain the self-contained 'purity' of a compositional method it should be understood as a radical subtraction, which seeks to explore the conditions of its means of production.

The 'non-standard' approaches have been reproached with being formalistic and with disregarding perceptual dimension of the musical experience. Pierre Schaeffer, for example, wrote that, "Xenakis has not taken the trouble to verify the relationships which exist between mathematical production of sonic objects and their authentic musical perception" (Schaeffer, 1971). However, such a critique neglects on the one hand the "dialectic between the *conceptual* and the *perceptual* in the musical experience" (Di Scipio, 1995a) and on the other hand Xenakis's search for a new percept by means of a distancing, a conceptualization. It also neglects that synthesis methods which are lacking predictability entail a work method which involves permanent aural evaluation.

The radical subtraction that takes place in Xenakis's and Koenig's synthesis methods, which unites structural and timbrical design and axiomatically eradicates the differences of micro and macro time levels, can be understood as a kind of *disorientation*. Traditional ways of describing musical sound are not applicable in *SSP* and the composer is thus forced to invent new ways of describing sound. The composer has to invent content where there is almost nothing. The stringency of the system is not a search for 'purity', but an axiomatic disorientation, a subtraction, which seeks to explore compositional sound descriptions.

Here we can see what the French philosopher Alain Badiou calls the "passion for the real". His example is the minimal difference of Malevich's *White on White*. It is not a passion to "unmask copies, to discredit fakes", but a "passion devoted to the construction of a minimal difference, to the delineation of its axiomatic" (Badiou, 2007a). The creation of a minimal difference in the axiomatic reduction of composition to the coordination of time and amplitude points in the construction of the waveform is the "passion for the real".

A problem which results from the treatment of amplitude and time values as compositional raw material is the lack of differentiation in the output of the application of macro-level methods to the micro level. The selection principles *alea* and *series*, i.e. random selection with and without repetition, do not produce significantly different output when applied to the sample level. The problem stems from the context-dependency with regard to the sonic significance of time values and sound pressure levels in a waveform. An instantaneous sound pressure level has in itself no recognizable identity. A result of this problem was that users of SSP concentrated on the ordering of segments, short collections of amplitude and time values. This step, the *permutation*, i.e. the selection and concatenation of waveform segments, "was as an effective generative mechanism," (Berg, 2009) and allowed the creation of distinct states and transitions. Paul Berg, who composed pieces with SSP, writes:

> The ordering of segments using tendency masks was particularly successful. A wide selection of segments would result in a noisy sound structure. Narrow masks led to unstable sounds within a confined frequency region. Masks moving from narrow to wide could produce dramatic transitions between these two extremes. (ibid.)

Herbert Brün's program *SAWDUST* is also concerned with the compositional structuring of waveforms. In the program, the composer specifies small fragments of waveforms which are then linked, merged, concatenated, repeated, and eventually interpolated, by the use of a limited number of operations. In contrast to Koenig's *SSP*, the emphasis does not lie on a rule-based approach to composition, but rather on the extension and relocation of musical material. The focus is much more the composer's work, the manual, subjective, compositional labor which takes place on the level of the waveform, the composer is "forming sounds just as precisely as the macro events of his composition" (Brün, 1969). The material and its organization are inseparably interlinked. As di Scipio writes, "this represents a thoroughly constructivist approach: nothing in the music has the status of something that exists prior to the composers work, not even the so-called 'sound material' "(Di Scipio, 2002). Brün is often stressing the importance and necessity of compositionally exploring the specificities of technology and his dislike of simulating synthesis methods:

> There is one dignified way, by which the computer might be made a musical instrument, without making it a redundant simulator of orchestral treasures. A computer, that can be programmed to generate acoustical phenomena, that the existent instrumental body could not generate, would be an asset. (Brün, 1964)

In contrast to Brün's emphasis of the unique possibilities of the computer, his compositional praxis and use of his own program *SAWDUST* is especially concerned with serial organizations of pitches. Indeed, his sketches reveal that he was constantly linking waveform lengths to tempered pitch scales and even producing twelve-tone rows and chords for the organization of waveforms.[2]

[2]The author has extracted this information from Brün's compositional sketches stored in the Herbert-Brün-Archiv of the Akademie der Künste Berlin.

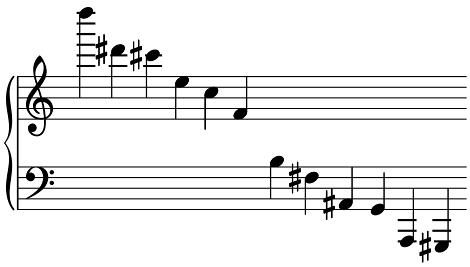

Figure 3.1: Basic pitch series used in *more dust* (1977)

In an interview with Curtis Roads, G.M. Koenig criticizes composers transferring well established ways of composing, such as twelve-tone techniques, to new tools. Although, this is surely not a critique of Brün's approach, it displays a discrepancy between Koenig's and Brüns positions:

> I'm very annoyed with composers using the most modern tools of music making [. . .] and making twelve-tone series [. . .], or trying to imitate existing instruments. That has, of course, its scientific value, but not necessarily a creative value in new music making. (Roads, 1978)

Although non-standard synthesis systems, such as *SAWDUST* and *SSP*, are characterized by a rejection of harmonic and acoustic models, they operate within a physically conditioned medium. Moreover, the sound representation they are based on, the time-domain, is an acoustic model. The disregard of the inherent conditions and structures of the medium within a model operates entails a limitation of the functionality of the model. Synthesis models such as Koenig's *SSP* tend to overlook physical and phenomenal consequences and constraints by their concentration on a purely symbolic, compositional level. A consequence of this reduction is that the conceptual differentiations of the system's operations are not always properly reflected in its output. On the other hand, we can see them as experimental starting points, which seek to explore borders of music and musical material, operating from within music. In contrast to approaches in which the sound material is given and then to be processed, shaped, and compositionally structured, the synthesis methods of Brün, Xenakis, and Koenig form frameworks in which the sound material itself emerges in the composition process.

Models of Sound

A sound synthesis method is a formalism and one can conceive of such a formalism as a model. A common and predominant understanding of models is one which presupposes a separation between an empirical reality and a formal modeling of that reality. The assumption is that we are on the one hand neutrally observing the facts and on the other hand actively producing a model. It is a confrontation between a real thing and an artificial reproduction, it is an opposition between reality and thought and it essentially boils down to nothing more than the opposition of 'culture' and 'nature'.

In his first book *The Concept of Model*, written in May '68, the French philosopher Alain Badiou quotes several passages from Von Neumann and Morgenstern's *Theory of Games and Economic Behaviour* exemplifying the aforementioned understanding of models. Von Neumann and Morgenstern state that models "must be similar to reality in those respects which are essential in the investigation at hand", and that "similarity to reality is needed to make the operation significant."(cited in (Badiou, 2007b)) Badiou argues that what Von Neumann and Morgenstern deny is that science is a "process of practical transformation of the real" and that in their conception science is nothing but the "fabrication of plausible images," (ibid.) and if, as Claude Lévi-Strauss writes, "the best model, will always be that which is true, that is, the simplest possible model which, while being derived exclusively from the facts under consideration, also makes it possible to account for all of them," (cited in ibid.) isn't science in this understanding nothing more than a functional simulation, an imitative artifice? Badiou writes that Von Neumann and Morgenstern's view "effaces the reality of science being a process of production of knowledge," (Ibid.) and denies sciences historicity, and its internal discourse. We find a similar positivist philosophy underlying the way in which Julius O. Smith, one of the leading proponents of physical modeling, speculates about the future of synthesis models:

> The most straightforward way to obtain interesting sounds is to draw on past instrument technology or natural sounds. [...] The best way we know to understand a sonic transformation is to study its effect on the short-time spectrum, where the spectrum-analysis parameters are tuned to match the characteristics of hearing as closely as possible. Thus, it appears inevitable that sampling synthesis will migrate toward spectral modeling. If abstract methods disappear and sampling synthesis is absorbed into spectral modeling, this leaves only two categories: physical-modeling and spectral-modeling. This boils all synthesis techniques down to those which model either the source or the receiver of the sound. (Smith, 1991)

It is interesting to note that the "source" is pre-existing the model in Smith's view, the synthesis model thus aims at imitating an existing behavior, it is not understood as generating a unique sonority nor is a sound synthesis model understood as actively transforming listening habits.

The concept of ‘anticommunication’ by the composer Herbert Brün is virtually the exact opposite of Smith’s idea of “modeling the receiver”. We can see Walter Benjamin’s understanding of the nature of perception as transient and historically conditioned as a presupposition for Brün’s idea of ‘anticommunication’. Benjamin writes that, ”just as the entire mode of existence of human collectives changes over long historical periods, so too does their mode of perception” (Benjamin, 2008). ‘Anticommunication’ is an attempt to say something through a channel which is not yet available, not yet established. In this way, one can ”retard the natural decay of information,” the process of meaning assignment. ‘Anticommunication’ provides the possibilities for non-trivial connections to occur. Brün writes, ”communication uses the order and the law that is meant to be recognized by the receiver as the receiver’s own; anticommunication creates the order and the law that is meant to be discovered by the receiver for the first time.”

Knowledge is thus not seen as a compilation of empirical data, but as actively constructed by cognitive processes. As Heinz von Foerster, long-term colleague and friend of Herbert Brün, famously formulated, “the environment as we perceive it, is our invention” (Foerster, 2003). The emphasis is thus not placed on the consensus a model engenders, but the possibilities of action it creates. The listener is not seen as a passive system, which is fed with a certain input, but the relation to the music is rather like a perturbation of the receiving system causing structural change in it. Julius O. Smith’s modeling of the receiver, as well as much research in psychoacoustics and music psychology, constrains and conditions music once it becomes an ‘aid’ for composition.

The goal to ensure ‘comprehensibility’, to tune the music to the receiver is a strategy of preventing change, as Brün says, “insistence on communication ultimately leads to social and physical violence... Anticommunication ultimately leads to the insistence on composition and peace.”

Julius O. Smith couples his description with the classical concept of simplicity and exhaustiveness, when he writes that the “fundamental difficulty of digital synthesis is finding the smallest collection of synthesis techniques that span the gamut of musically desirable sounds with minimum redundancy. It is helpful when a technique is intuitively predictable” (Smith, 1991). If we assume that art is essentially not occupied with the generation of function, but with the generation of sensations, then music can indeed reflect on and deal with function, but neither “minimum redundancy” and predictability nor the modeling of pre-existing sources and the listener (here “receiver”) are in essence relevant to music composition or 'sound art'. In Smith's view, music can be said to be reduced to being the empirical proof, the verification, of the model.

So, how can sound synthesis models be of interest for music composition? Models allow a very particular access in that they define operations. These operations, however limited they might be, are fundamental to the composition process. In CMSS, the synthesis model is also a model of composition, or at least forms the basis of models of composition, like a sort of machine language into which the higher-level compositional model is to be compiled. On the one hand, it abstracts and generalizes the multifaceted layers of a reality, it is a formalism and forms something *intelligible*. On the other hand, the model is descriptive and productive of something *sensible*. What is particularly interesting about sound synthesis models, is that we can understand them as working at the intersection between the sensible and the intelligible and not to belong exclusively to one of them. The approaches presented here understand sound synthesis models both as models of sound and as models of composition, thereby seeing models as *productive* rather than imitative and emphasizing the intersection of the *intelligible* and the *sensible*.

3.2 Two CMSS Models

PV Stoch

Introduction

PV Stoch[3][4] is a generator for frequency domain stochastic synthesis. After having worked at the generalization of "non-standard" synthesis (Döbereiner, 2008a), the development of *PV Stoch* was driven by an interest in extending stochastic synthesis; an interest in testing the transferability of its principle workings and reapply them in another area, the frequency domain. In this section, we will discuss the first result of this investigation.

Transferability

Iannis Xenakis used stochastic functions for the generation of sound after having used them on a higher-level before. They have been compositional tools to him. The step to synthesize the sounds themselves using probabilities, as well as the introduction of them in musical composition itself, follow the belief that a method which has successfully been employed on one level or one domain may successfully be transferred to another.

[3]This subsection is based on a previously published paper (Döbereiner, 2009).
[4]The source code and examples can be found on the accompanying CD.

> Any theory or solution given on one level can be assigned to the solution of problems of another level. Thus the solutions in macrocomposition (programmed stochastic mechanisms) can engender simpler and more powerful new perspectives in the shaping of microsounds. (Xenakis, 1992)

Overview

Firstly, the synthesis method itself is described. The individual parameters are presented, as well as brief descriptions of their aural effects. It shall be noted that the descriptions are somewhat simplified and most of all, the control parametrization is not congruent with their multi-layered perception. Although, the perceptible effects of each of the parameters is briefly addressed, their inter-dependencies and trans-active nature is far too complex to be properly outlined here.

Subsequently, I will give attention to *PV Stoch*'s relation to the 'non-standard' synthesis approaches discusses above. Although *PV Stoch* does not fulfill all the criteria to be classified as 'non-standard', I am trying to demonstrate that it does indeed comply with and even extend some fundamental notions present in these approaches and can be seen as a *compositionally motivated sound synthesis* model.

Furthermore, some of the challenges and features I have encountered in the practical work with the generator are discussed by means of the description of a 96-channel composition which was realized exclusively with *PV Stoch*.

Implementation

PV Stoch is a phase vocoder unit generator (UGen) for SuperCollider (J. McCartney). SuperCollider features a robust and efficient framework for the design of frequency domain operators. As the development of *PV Stoch* has been a rather experimental investigation, SuperCollider's flexibility and real-time controllability proved to be crucial. The implementation framework is straight forward and the UGen can be combined with a variety of already existing UGens and control mechanisms.

PV Stoch takes the following parameters, which are explained below. Except of **nBps** and **lambda**, which only have effect during the initialization, all parameters are dynamically controllable:

```
PV_Stoch(buffer, nBps, lambda,
         phaseSwitch, specDec,
         interpBase, range,
         offset, deviation)
```

Figure 3.2: The parameters of *PV Stoch*

Basic Functionality

PV Stoch is a frequency domain stochastic synthesis generator. Although, it operates on a FFT buffer, it does not process an analyzed sound, but rather synthesizes sound without input source.[5] The created spectra have an envelope, or spectral contour, which is constructed of interpolated breakpoints. The positions of these breakpoints deviates from frame to frame, similar to the time domain breakpoint deviations in Xenakis's *Dynamic Stochastic Synthesis*.

When the UGen is initialized, it generates an initial spectral envelope. The distribution of the breakpoints follows controllable probabilistic laws – an exponential random distribution – and the interpolation function may vary over time. Frame by frame the positions of the breakpoints, and thereby the spectral shape, deviate. The amount of deviation is dynamically controllable. The created spectrum can also be dynamically frequency shifted or stretched, which are familiar frequency domain techniques. Furthermore, the phase spectrum generation has three states and it can be interpolated between them.

The Envelope

The initial envelope has a big effect on the resulting sound. Initially, its shape is determined by three parameters: the number of breakpoints (**nBps**), a random variable controlling the spread of an exponential random distribution which determines the horizontal (frequency) position of the breakpoints (**lambda**), and the base of the interpolation function (**interpBase**). If the base is 1, the interpolation is linear, if it is bigger or smaller than 1, the interpolation is exponential, resulting in concave and convex curves respectively.

A higher number of breakpoints (**nBps** > 20) results in more defined and more complex spectra, a lower number creates sounds similar to more simply filtered noise. If **lambda** is smaller (**lambda** <= 1.0), the resulting sounds are more distinguishable and

[5]One exception is the phase, which is explained later in this section.

the deviations are clearer, if the random variable is greater, the sound becomes more static, the changes less drastic. A more concave interpolation curve (**interpBase** < 1.0) articulates the attenuated frequency regions more clearly, whereas more convex shapes create blurrier noise regions.

The vertical (amplitude) positions of the breakpoints are determined by a beta random distribution. Additionally, the magnitudes of the whole spectrum are also scaled by an exponentially decreasing shape, whose steepness is variable (**specDec**).

Shifting and Stretching

Figure 3.3 illustrates two additional – and well known – operations which can have a drastic effect on the sound: frequency shifting and stretching/compressing. As can be seen, the entire spectral shape can be shifted (**offset**) along the frequency axis (in both directions) and stretched or compressed (**range**). Since the spectral shape is expressed by interpolated breakpoints whose position along the frequency axis does not need to coincide with the frequency grid imposed by the frame size, shifting and stretching or compressing occurs smoothly without making the frequency resolution audible. The shifting and stretching is similar to techniques presented by among others Trevor Wishart (Wishart, 1994). Although Wishart's approach is regarded as 'standard' synthesis, it is surely a compositionally motivated approach to sound synthesis.

Deviation

Figure 3.4 shows the deviation principle. The breakpoints deviate frame per frame from their previous position by a random amount, the maximum of which is controlled by the parameter **deviation**. Thus, similar to *Dynamic Stochastic Synthesis*, the breakpoints undergo random walks, however, only in their vertical position (amplitude).

Dealing with the Phase

There are three basic settings for the phase. It can be interpolated between them. The phases can be set zero, in which case the results are closer to additive synthesis using sine waves, the phase values can be generated randomly, which creates sounds closer to filtered noise, or they can be derived from an input source. Although *PV Stoch* has not been designed to process analyzed input sources, this phase setting was introduced in order to add 'articulation' stemming from external sources. It was primarily used with frequency modulated impulses.

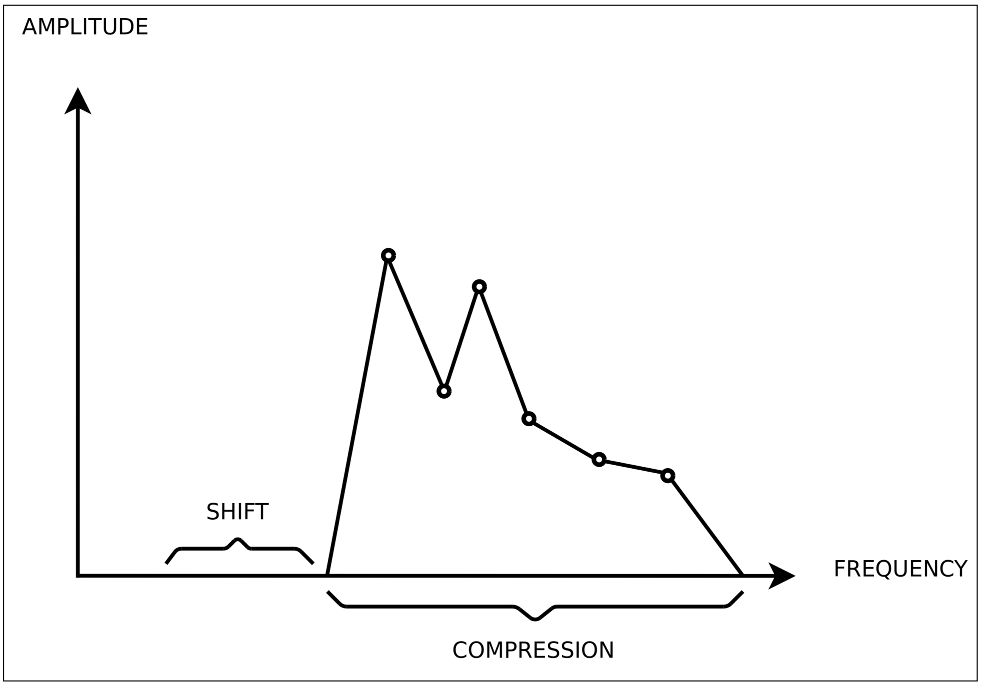

Figure 3.3: Shifting and compressing the created spectrum

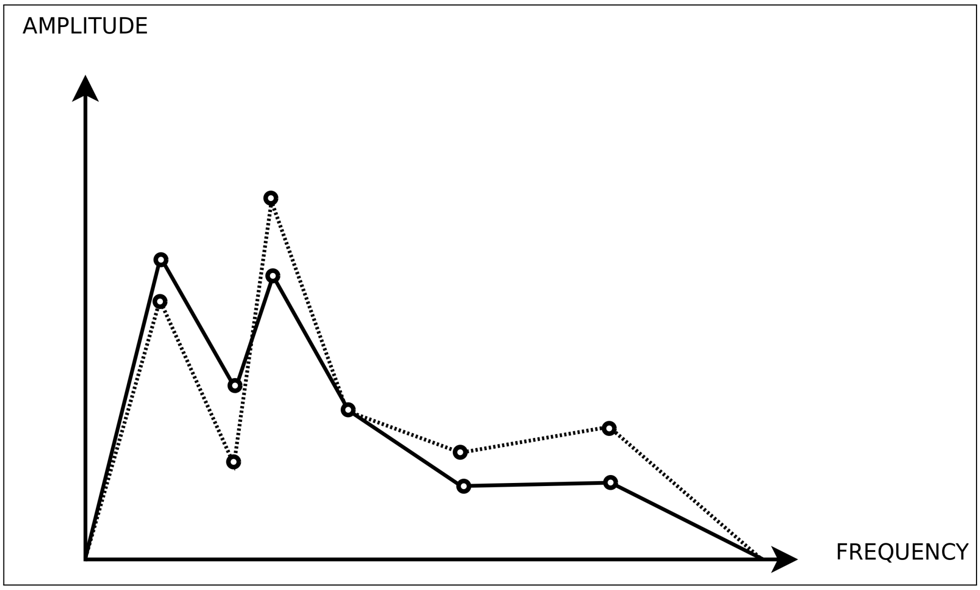

Figure 3.4: The deviation of breakpoints in two successive frames

PV Stoch as Non-Standard Synthesis

The starting points for the development of *PV Stoch* have been the so-called ‘non-standard’ sound synthesis (Holtzman, 1979) approaches, especially Iannis Xenakis’s *Dynamic Stochastic Synthesis*. The systems subsumed under the term ‘non-standard’ have in common that they do not adhere to any superordinate acoustic models.[6] Instead, the models of sound are derived from compositional models. Sound synthesis is understood as the development of processes organizing the low-level units, as “microtemporal *compositional* processes” (Di Scipio, 1996). *PV Stoch* takes up this idea of deriving higher level structural properties from the description of lower level processes. Here, the distinction between sound and music is blurred.

For different reasons, however, the ‘non-standard’ approaches rejected the frequency domain. Xenakis heavily criticized the use of harmonic analysis for the synthesis of sound. The results he deemed uninteresting, the approach “inadequate”. He ascribed the problems to the “synthesis by finite juxtaposed elements”-principle. “It is as though we wanted to express a sinuous mountain silhouette by using portions of circles” (Xenakis, 1992), he writes. Curiously, Xenakis’s UPIC system is based on the very principle he had been criticizing so vehemently, it is a form of additive synthesis.

Perhaps, due to its mathematical nature and popularity among the more simulating sound synthesis methods, the frequency domain was considered inappropriate for a uniquely digital music. It seemed to be a concept which was not very well suited for answering the question, “what means of expression are idiomatic to computers?” (Holtzman, 1994) For Xenakis, the reason for his rejection may rather have been his association of additive synthesis with the electronic music of the Cologne studio.

In fact, the so-called ‘non-standard’ sound synthesis approaches are all characterized by the use of concepts which are initially alien to the description of sound. With SSP, for example, G.M. Koenig uses methods which he had developed for instrumental composition for the structuring of audio sample values. Similarly, Paul Berg’s programs ASP and PILE derive musical and sonic relationships from instructions present in programs for numerical computation.

There is, thus, an element of transfer, of reapplication, in ‘non-standard’ synthesis. The sound organizing principles arise from a compositional interest, the compositional idea is embodied in the ‘sound material’, it is not imposed on it.

In this line of thought, *PV Stoch* can be seen as an attempt at creating frequency

[6] Oddly, the time domain is usually not considered an acoustic model in the descriptions of ‘non-standard’ synthesis.

domain 'non-standard' synthesis. Although, this may stand very much in contrast to the rejection of superordinate acoustic models, it follows Xenakis's idea of transferability of concepts.

Instead of aiming at the (re)creation of specific sounds, it is rather a search for the remains of an organization principle, for the traces the prinicple may leave in the sound and through another representation.

An Application: Space Study 1

Space Study 1: Order From Noise is a fixed medium (tape) piece for 96 independent channels which was I have composed in 2009. The piece was specifically composed for the wave field system system currently located in Leiden. Instead of using the wave field system itself, however, only the physical system is used without the simulative software engine it was designed for.

For the sound production *PV Stoch* was used exclusively. Due to the immense amount of data and coordination necessary for the independent composition of 96 tracks, it became unavoidable to automate many processes in the production of the piece. A consequence of the automation was the necessity of clear distinctions, of parametric configurations on the one hand and strategies of transitions and transformations of the other hand.

The piece consists of four sections which undergo a similar macro-level development, there can be seen as variants of a common higher-level description. For the most part, the synthesis settings are the variable element among the sections. The four sections are briefly described:

1. Impulses whose frequencies follow exponential curves, and ranging from 1 to 100 Hz thus creating rhythm and pitch, serve as the input for the phase values. *PV Stoch* initially creates "resonances" and gradually the phases become more random, the impulses are thus replaced by noise and the "resonances" become the central sound itself.

2. The phases alternate between noise, impulses, and zero, thus creating clearly distinguishable types of events. Instead of gradual change and slow transitions, the different timbres are clearly opposed to each other.

3. Blocks of quickly deviating bursts form gestural units. The deviation is high, lambda is low.

4. Finally, the phases are set to zero. The section is rather soft in volume and the spectra act as clusters, slowly shifted in frequency and space.

Each of the sections creates its own timbre space. When the phases are derived from impulses, the generator creates "resonances", when it is random, the deviation is high, and lambda is low, the random walks are most audible and the output strongly resembles time-domain stochastic synthesis. Since, all the timbre states are outcomes of the same process, they can easily be related to each other.

Possible Improvements

Peter Hoffmann writes about Xenakis's GENDYN:

> The key idea of stochastic synthesis is its nonlinear waveshaping, where the waveshaping function changes stochastically from period to period. Consequently, it is not the waveform as such that defines the aural result [...] but rather the dynamic behavior of its deformation over time. (Hofmann, 2000)

PV Stoch behaves similarly. It is not the specific spectrum created but rather the way it changes from frame to frame that determines the aural quality of the result. The behavior is also what is most controllable. Since the initial envelope has a big effect on the resulting sound and since it is not completely predictable from the parameter settings, several instantiations of the same parametric configurations can result in a great variety of different sounds. The generator is thus not very well suited for the purposeful creation (simulation) of pre-conceived sounds. By controlling deviations, "spectral definition", pitch and noisiness, types of sounds and types of sonic behaviors can be created.

Several improvements and additions suggest themselves and need to be tested regarding their musical effectiveness. The deviation may be further refined. Since the dynamic behavior of the system is the perceptibly most significant element, it should be further developed.Similarly to Xenakis's models, second order random walks could be included and the breakpoints could move on the frequency axis as well. Furthermore, the number of breakpoints should be dynamically variable. The impact of different random distributions on the various stochastic processes should be investigated.

Gepin

The generalized periodical interpolator *Gepin*[7] is an external unit generator for SuperCollider written in C++. I had initially developed it in 2008 and realized, among others, the tape piece *Piz Argient* with it. It underwent significant changes until the last piece realized with it, *K2*, a piece for piano and electronics described in section 4.3.

The basic idea behind *Gepin* was to generalize Xenakis's *Dynamics Stochastic Synthesis* model. Instead of fixing the control of breakpoint values and distances to random walks with different random distributions, I wanted to design a general model, which allows for arbitrary input signals to control breakpoints and their distances, which could serve to explore and implement are wide variety of different synthesis models. The model has also some similarity to the Variable Function Generator of the voltage controlled studio of the *Institute of Sonology*.

As figure 3.5 shows, the *Gepin* UGen has three parameters: the frequency, which determines the period length, a freezing value that determines whether the waveform will continue updating or be 'frozen', and an array of breakpoints and their distances. The frequency is read once for each period. Given the period length, the breakpoints are read from the array of input signals and distributed according to their distances. The distances, which can also be variable signals, are thus proportional and not absolute values. The exact position of the breakpoints is thus a result of multiplying the distances by the division of the period length and the sum of all distances. The number of breakpoints cannot be changed dynamically, but the size of the array, and thereby the number of breakpoints, can contain any (even) number of input sources.

```
Gepin.ar(frequency,
         freezing,
         [  breakpoint1, distance1
            breakpoint2, distance2
            ...
            breakpointN, distanceN ]
        )
```

Figure 3.5: The parameters of *Gepin*

Another important feature of the implementation is that the period lengths and positions of the breakpoints are not fixed to the sample grid. I have already described a

[7] The source code and examples can be found on the accompanying CD.

similar ‘improvement’ of stochastic synthesis in my previous implementation in my composition program *CompScheme* (Döbereiner, 2008a). The waveform, the period length and the position of breakpoints, is thus calculated in an un-sampled space, the sample grid is only superimposed in the very last instance.

The freezing of the waveform was initially introduced to have additional control over the periodicity, or pitchedness, of the result. If the input value is greater than 0, the waveform does not update, otherwise it updates. This feature was inspired by the use of tendency masks for the selection of segments in SSP, which allowed for a gestural control over periodicity by controlling the probability and length of repetitions of waveform segments.

As stated above, the goal was to develop a variety of synthesis models, based on one general model. So far, I have used it in three distinct ways. If the input signals are random walks or interpolated low frequency noise sources, the output is naturally rather similar to Xenakis’s models. Another way in which I have used it was to use low frequency step noise and to control the freezing value by a variable probability source which is sampled with a sample-and-hold. In this way, groups of repeated cycles and groups of non-repeated cycles with variable group size and probability of occurrence could be produced. The output is more similar to that of SSP. A third type, which I have produced, was to use very low frequency sine waves to control both distances and breakpoint values. If these sine waves’s frequencies have complex ratios, the period length of the total outcome is very high. This method resulted in very slowly yet complex, timbrally evolving textures.

4 Compositional Models

4.1 Introduction

In chapter 3, I spoke about models of sound as working at the intersection of the sensible and the intelligible. I have also stated that the term *compositionally motivated sound synthesis* should imply a bringing together of models of sound and models of music. In this chapter, I will discuss compositional models, their construction and their results. I will first deal with my re-implementation of Koenig's *Project 2* (PR2) and then with two compositions of mine, *K2* for piano and electronics and *Description WIthout Place* for ensemble.

Otto Laske said that Koenig's composition programs *Project 1* (PR1) and *Project 2* (PR2) represent first steps towards an "artificial intelligence view of music" (Laske, 1981). From my point of view, both programs are neither concerned with modeling intelligence nor with making computer programs more intelligent. I see PR2 rather as a compositional model in the sense that it is a description of a framework, a set of limitations or a "network of relations within which the composer [...] can move more or less freely" (Koenig, 2010).

I understand models here not in a strictly formal sense nor in the sense of theoretical models, but rather as a view of composition which is concerned with rendering conscious the determining and condition constraints and limitations of the composition and its production process. Compositional models thus define operations and determine possibilities, they are a way of thinking about the construction and the global framework of a composition.

Model thus takes the place of mediating representations. These can range from graphical notations to the formulation of algorithms. Sharon Kanach writes with respect to Xenakis's use of intermediate notations that, "graphical, non-musical representation offers Xenakis the immediacy of visually observing his own creative process and thus renders conscious and analyzable ‘what lies beneath’ [Intuition]” (Kanach, 2008). Kanach’s text includes a copy of Xenakis’s graphical representation of Frédéric Chopins *Nocture op.9, No 1*, made in 1964, in terms of periods of interpolated breakpoints. Xenakis is also tracing the deviations of breakpoints from cycle to cycle. The drawing shows a clear similarity to his *Dynamic Stochastic Synthesis*. We can see compositional models therefore not as the anti-intuitional ‘formalization’ of music, as striving for formal ‘purity’, but rather as a way of enhancing one’s intuitive decisions by subjecting them to a systematic analysis through notation and algorithmic formulation.

If the model in *Description Without Place* will only be made visible in its rough contours, it is mostly because the amount of detail required to fully describe the piece’s realization process would make for a tedious and tiresome reading and would not necessarily enrich the readers understanding of it. More importantly, however, – and that is one of the main reasons for speaking about models with respect to the pieces discussed here – the model, the arrangement of laws and constraints, the conditions of possibility change within the pieces. Instead of exhausting the model and presenting all its possible results, I have tried to compose a development of the possibilities, changes of state, which expand and redirect the possibilities of the piece itself.

In PR2, there is the structure formula, the basic data and rules which form the idea of a musical structure which might be manifested in a virtually infinite number of concrete musical results. A structure formula can be said to constitute a model. Above this level, however, there is a more general level, the level of the program itself, which forms a meta-model. In *K2*, there is no such meta-model, each section is independent and there is no general framework. Algorithmic methods were rather used to generate material than to describe a field of possibility. Koenig has described this difference to me with respect to PR1:

> I myself have never experienced Project 1 as a model, except during its design, but rather as a generator with which a canvas and at the same time a material is being created, with which one can, so to say, ‘embroider’ it. (Koenig, 2010)

In *Description Without Place*, however, I have tried to construct a general meta-model, each section would then be a special case of a more general model. This model arose in the composition process and was not fully given at the outset.

4.2 Implementing PR2

General

G. M. Koenig's *Project 2* (PR2) is a composition program he designed in the 1960s. The program, which has been initially intended for the composition of instrumental music, calculates *structure variants* based on a *structure formula*, which consists of basic data and rules supplied and selected by the composer.

There has not existed a working implementation of PR2 for several decades. Since January 2009, I have been working together with G. M. Koenig at a re-implementation of PR2. Besides several changes in functionality G.M. Koenig had devised, the main goal was to improve usability through a graphical user interface.

In this section, I will describe the new features of PR2, the basic workings of element selection and parameter interdependence, how the XML-format turns the structure formula from a conceptual metaphor into a well-formed formula, some of the implementation details, and some general observations I have made during the implementation of PR2. Although the reader may receive a general impression of the new PR2 program and some of the implementation details, a precise understanding is impossible without being acquainted with the basic workings and terminology of PR2. Since there exist detailed descriptions of PR2 (Koenig, 1970), I will not reiterate its details, but only give a very general description of the process of selection, in order to point out some of the more noteworthy implementation tasks.

I will not so much summarize Koenig's ideas and conceptions relating to PR2, as he has explained them in numerous texts, but rather describe my implementation and a few observations made during the implementation. For detailed information on the implementation, I refer the reader to the source code, which can be found on the accompanying CD.

Changes in PR2

The original PR2 implementation's user interface was a questionnaire of 60 questions or more, which all had to be filled out by the user correctly. Without a precise understanding of the internal workings of the program, it was quite likely to input inconsistent data. The need to supply detailed data for all parameters and settings made the program difficult to access and cumbersome to work with. The main change in the new PR2 implementation is the graphical user interface and the introduction of default data, which allow the user to concentrate on specific parameters without having to be concerned with all settings. Parameters can be excluded from the calculation of structure variants and instruments do not need to be defined explicitly.

Another new function, which has not yet been implemented, is the freezing of parameters. Any sequence of produced values of a parameter can be ‘frozen’, i.e. the chosen sequence remains unaltered, despite of changes in depending parameters.

The main novelty in the internal functionality of the program is the introduction of a further level of selection. The selection principles which select the final values for the *ensemble* can now be changed per *layer* or *variant* using higher level selection principles.

Structuring Symbolic Spaces

The fundamental procedure of PR2 is selection. The composer’s task consists in selecting rules and basic data. There are thus selections made by the composer him/herself and selections which are made with the help of rules (selection principles). Koenig writes that, “The roots of my composition programs can be found in serial thinking, which – in my understanding – seeks to structure symbolic spaces” (Koenig, 1993b). These symbolic or parametric spaces are described by data sets. The set lists the possibilities which form the basis of further selection processes. Koenig has also called this later procedure of establishing a reference between data set and concrete musical values “interpretation”, “The interpretation requires a reference system and an instruction, which assigns one or several positions in the reference system to every single datum.” (ibid.) The set itself is thus pure order, the reference system are the concrete musical or sonic values. All operations are applied to the order, not the values themselves, the selection process can thus be seen as a generalization of earlier serial methods. The selection principles in PR2 clearly discriminate between the material and its order. The numbers operated on do not refer to themselves, they are pointers. Selection principles do not produce concrete musical values, but instead produce indices referring to indices referring to concrete values. We can discern three separate entities which play a role in the selection process:

1. The **reference system** as a list of concrete (musical) values by the composer. (pitch classes, registers, time values, dynamics, etc.)

2. The **data set** as a list of indices referring to the reference system by the composer.

3. Selection of indices from the data set and **assignment** of the values from the reference system they are referring to with the help of algorithms (selction principles).

This shows the basic workings of selection and the so-called *List-Table-Ensemble-Principle*. In my implementation, selection principles, table groups, reference system and the "interpretation", i.e. the assignment of indices to concrete values of the reference system are implemented in separate modules[1], but brought together in one module. The module provides not only the possibility of associating a chosen index with a concrete value or table group, but also references back in the opposite direction. This feature has proven especially useful in the implementation of compatibility checks.

Interdependence

One of the most central ideas in PR2 is that of a hierarchy of parameters. A position in the hierarchy is assigned to each parameter, which determines the order of execution and precedence of parameters in case of conflicts among produced values. The hierarchy, however, is only meaningful where parameters depend on each other. The instrument parameter is both the most constraining and the most constrained parameter, depending on its position in the hierarchy, but all parameters – with the exception of the rest parameter – are linked to the instrument parameter. In my understanding, one of the most important decision the user has make is whether the instrument will be the last (or one of the last) or the first parameter. When the instrument parameter is last in the hierarchy (and provided there are a variety of differently defined instruments and possible parameter values given), the program has to find an instrument that matches all the constraints set by the chosen values. In other words, the program is orchestrating a given structure. If it is the case that the instrument is the first element in the hierarchy, the choice of instrument precedes and conditions all subsequent selections. In that case, the orchestration is given and the rest of the structure has to follow its possibilities[2]. There are of course other parameters which depend on each other such as register and harmony or entry delay and duration.

One way of implementing the mechanism to solve possible conflicts and deal with interdependencies would be to list all possible cases and implement ways of dealing with

[1] The PR2-machine (see below) is implemented in *OCaml*. Although the language supports object orientation, I have not made used of the object system. A *module* is a high-level abstraction similar in use and functionality to a class in object oriented programing languages.

[2] In my piece *Description Without Place*, described in section 4.4, I have approached the composition in this second way. Implementing PR2 has helped me realize the difference of these two approaches.

them at the places in the logic of the program where they might occur. Instead of dealing with it in this specific, case-by-case way, I have rather tried to generalize and program one abstract mechanism which can solve all conflicts and interdependencies. In a module called `compatibility`, a function is defined, which takes (among other arguments) the possible candidate value, the involved selection principles, and a function which allows for testing possible values as its arguments. The test function is a predicate, i.e. a function which returns true or false, which is composed by the calling parameter. This function contains all the conditions which have to be fulfilled. The function in the `compatibility` module then searches for a possible value which matches the predicate. A precondition for this mechanism to work is of course that the selection principles themselves can be 'asked' for alternatives. Each selection principle can produce a list of all legitimate values in its current state and can even be rewound to any previous state. The search function searches for a combination of legitimate values which fulfill all requirements and subsequently informs the selection principles about its selection. The selection principles alter their state so as to adapt for the chosen value.

From Structure Formula to XML-File

Conceptually, PR2 can be divided into two parts: the *PR2-machine* and the *PR2-database*. The machine calculates the structure variants from the given data and rules stored in the database. In the new implementation, I have decided to write a separate program for each of the two parts. The two programs are written in two different programming languages. The machine is a command line program written in the functional programming language *OCaml*, in which I had already written my composition language *CompScheme* (Döbereiner, 2008a). *OCaml* is an efficient and portable language which can produce small native executables for various platforms. The graphical user interface was written in *JAVA*, which includes a cross-platform framework for the development of graphical user interfaces. The two programs communicate through XML, a generalized markup language on top of which languages can be developed and for which there are existing XML-parsers for *JAVA* and *OCaml*.

The *structure formula* contains the structural characteristics as expressed in the input data, chosen rules for the selection of elements and for the hierarchy of the parameters. The formula can thus be seen as an idea which can manifest itself in a virtually infinite number number of variants, each expressing (slightly or very) different characteristics inherent to the idea and thereby "revealing its ambiguity" (Koenig, 1993b). By implementing the communication between machine and database through an XML-based format, the "formula" is turned from a conceptual metaphor into a well-formed formula, a formal language. I have generally tried to keep the technical design of the program as close as possible to its conceptual design. By adhering as closely as possible to the conceptual structure, the structure of the implementation can, as a manifestation of the concepts, serve to draw conclusions about the concepts themselves. Thereby, I have made the experience that technical difficulties or problems have often revealed conceptual problems, or complex conceptual interdependencies. Figure 4.2 shows the data flow between machine, database, and XML-file and figure 4.1 shows an excerpt of a structure formula as an XML-file.

```
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<structure comment="" metrical-subdivs="2, 3, 4, 6, 8" ppo="12" seed
    ="12345" tempo="60" title="default" varnum="1">
  <blocking/>
  <structure-duration list="10.0">
    <sequence>0</sequence>
  </structure-duration>
  <layers leadingparameter="inst" union="union">
    <number><alea/></number>
    <order><start-sim/></order>
  </layers>
  <vertical-density type="instrument"/>
  <parameters>
    <par-instrument combination="false">
    <supply type="instrument">
      <instrument-definition chordmax="" chordmin=""
              durmax="3.0" durmin="0.1"
              dynamics="40, 60, 80, 100, 120"
              modes="normal" name=""
              pitchmax="801" pitchmin="201"/>
    </supply>
    <table><list>0</list></table>
    <alea/>
    <orders><alea/></orders>
    <none/>
    </par-instrument>
   ...
  </parameters>
   ...
</structure>
```

Figure 4.1: Excerpt of a structure formula as an XML file

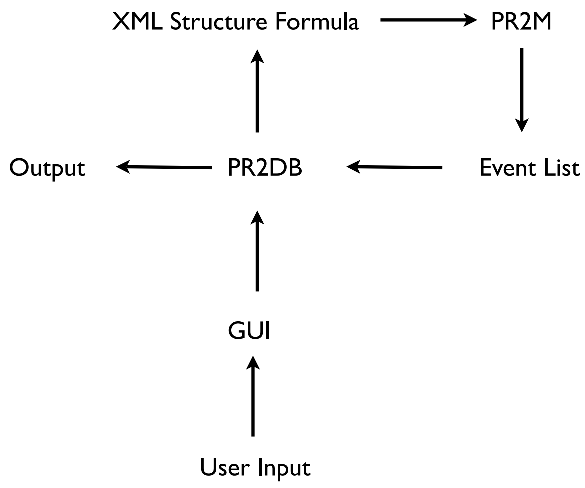

Figure 4.2: The data flow between machine, database, and XML-file

Status and Future

The new PR2 program is a stand-alone application and has been tested on Microsoft Windows, Mac OS X, and Linux. Almost all functionalities of the PR2-machine have been implemented. The only major functionality that still remains to be implemented is the freezing of parameters. Minor features that are not yet implemented are the integration of percussion instruments for pitch 0, and the blocking of intervals and pitch classes in the interval principle. The graphical user interface is mainly missing context help and documentation.

4.3 K2

K2 is a piece for piano and electronics. A piece for electronics and an acoustic instrument is inevitably always also concerned with the relationship of the two. Among the many possible approaches, some a very common. Works composed for electronics and acoustical instruments often try to achieve a timbral fusion of the two. Works composed for live electronics and acoustical instruments often either present the performer with a system which acts interactively or acts as an extension of the instrument. *K2*, in a way, suspends answering the question of how to relate the two.

The synthesis methods I had developed and worked with until then did not lend themselves for the imitation or processing of acoustic instruments. I was faced with the question of how to relate piano and electronics without forming a fusion, interactive or reactive electronics, or an extension of the instrument. The problem of how to relate both parts was reinterpreted to become its solution. Instead of insisting on a particular relationship, the potential of relationships, and the 'impossibility' of relating both was used to articulate form. Both elements in their timbral and sonic distance should rather converge on a structural and behavioral level than on a timbral or sound level. The degree of coordination was supposed to become a central parameter.

The piece is thus trying to consider the question of how to relate the elements, not to answer and thereby dispose of it. Instead of trying to fuse both parts into one, it is rather their difference which is emphasized. Drawing distinctions is favored over enforcing commonality. Here appears the construction of "similarity as a product of a basic disparity," (Deleuze, 1990) not to create difference in terms of similarity, where similarity is the basis, but to use difference as the basis.

Among the many pieces which have directly or indirectly exerted and influence on the composition of *K2*, I want to mention three. More than the material of these pieces themselves, it was rather their ways of approaching the piano and the juxtaposition of different types of sound which has been influential. The relationship of piano and brass instruments in Iannis Xenakis's *Eonta* for piano, two trumpets, and three trombones, as well as the piano material have had an impact on the beginning sections of *K2* especially. Here it is the idea that the musical development is driven by changes of context rather than by development of material only. When the brass instruments enter after two minutes of solo piano, they create a change of perspective, a horizon against which the material of the piano appears changed.

In section 2 to 4 (rehearsal marks B, C, and D), the piano part consists of three stochastic fields of increasing vertical and horizontal density. Underlying the distribution of events there is are changing metric grids with specific probabilities attributed to points in the grid. The electronics start with a single pitch and move towards a noisy texture which functions similarly to the accumulating resonance resulting from continuously keeping down the sustain pedal in section 4 (rehearsal mark D). Finally, at the end of section 4, the electronics end with a repetition of the ending of section 1, the solo section at the beginning. The idea of changes in perspective was important here. Beginning the piece with a solo electronic section was supposed to present the 'premise' of the piece, on the one hand showing the 'impossibility' of unifying the two elements, by starting as far away as possible from the piano, and on the other hand the setting up of a sonic context within which the piano is not the timbral center. We can find a somewhat similar contextual change in Herbert Brün's *Non Sequitur IV* for ensemble and tape. By disrupting the instrumental texture suddenly, he is not only creating a temporal incision, but it can even be seen as a sound transformation of the instrumental part. By suddenly expanding the space of possible sounds, he alters the way one hears what comes afterwards. Although there is no sudden rupture in the beginning of *K2*, the entrance of the piano rather disrupts the electronic texture, the acoustic instrument is the sudden change in the space of possible sounds. When the end of section one is repeated at the end of section four, the changed context has changed its function and appearance.

Whereas the sections 2 to 5, and 7 were written with a great distance to the instrument, i.e. the results of a symbolic organization are translated into instrumental gestures, towards the end of piece I have tried to move closer to the instrument itself. A piece that has influenced my way approaching the piano towards the end of *K2* was Helmut Lachenmann's early piece *Wiegenmusik* for solo piano. What has been interesting to me in this piece, is that it approaches the piano from virtually the opposite side of Xenakis's approach in pieces like *Eonta* and *Herma*. Instead of a symbolic organization which is translated into instrumental gestures, it is rather the instrumental gesture itself and the sound phenomenon as such which constitute the point of departure. Different resonances, attacks, durations, decays, and dynamic possibilities of the piano form the basic decisive factors for the piece's structure.

As stated above, there is no overall model in *K2*, the global parameters which hold the sections together are the coordination and relationship of piano and electronics and the approach (distance, proximity to the instrument) to the piano.

4.4 Description Without Place

Description Without Place[3] is a piece for flute, (bass) clarinet, trumpet, violin, cello, and double bass. The starting point of the piece was the question of how a variety of different kinds of relationships among the instruments could be created and organized. This grew out of my previous electronic pieces and *K2*, the above described piece for piano and electronics. In most of my electronic pieces, I have used a single sound synthesis method. While I have used layers of musical material and tried exploring simultaneous structures, the pieces have essentially always been *one sound*. My approach has been similar to how Koenig once described the concept of SSP: "to describe the composition as one single sound" (Koenig, 1980). The synthesis methods I had developed gave me the possibility to compose a piece by composing a single sound, but on the other hand they also impeded the construction of non-uniform structures, even the layering of independent structures

[3]The title is taken from the homonymous poem by Wallace Stevens.

usually resulted in a fused, single entity. With *K2*, I was in a position to deal with distinct elements. While *K2* was inevitably about two elements and their relation, with *Description Without Place*, I was able to elevate this newly discovered fundamental, 'ontological' level of the music to a variable parameter. The 'ontological state' of the piece was to be organized along a scale, which had 'pure multiplicity' at one end and 'the one' at the other, expressed through the relationships of the instruments to each other.

One of the main musical goals of the piece was to create a whole whose identity is perpetually changing, dissolving, and reassembling. This is supposed to be achieved through a constantly changing combination of instruments and materials, grouping and juxtaposing of instruments and materials. In each of the five sections of the piece the instruments relate to each other differently.

A basic element which connects *Description Without Place* to my previous electronic pieces is an attitude which does not try to project a higher target sound or idea onto the material means, but rather tries to derive, to deduce ideas and sounds from the material means themselves. Here, I see a similarity to the first of Badiou's "Fifteen Theses On Contemporary Art", "Art is not the sublime descent of the infinite into the finite abjection of the body [...]. It is the production of an infinite subjective series through the finite means of a material subtraction" (Badiou, 2004). The attitude of the Cologne studio composers that "everything is material" and form is a "consequence of the treatment of material" (Koenig, 1987) can be related to this approach. In *Description WIthout Place*, there is no descent of an independently and transcendentally existing form into the material, but rather a process which starts with the basic material and derives sound and form from it. Although there are overall formal decisions made, ideas and anticipations, it is always the concrete reality of the material, here the instruments and their relationships to each other, which forms the starting point, and not a preconceived idea of sound which is to be projected onto the ensemble of instruments.

As aforementioned, the relationships of instruments are ordered according to the degree of correlation/union they form. The piece starts in a state of multiplicity and ends in state of union.

Section 1 – Multiplicities (mm. 5 – 29)

The first section forms the basis of the entire piece, the instruments are largely independent of each other and presented in all combinations of the sizes two, three, four, and five, a permanently regrouping multiplicity of situations is created. The section consists of four parts. In the first part, all combinations of two instruments are used in an order which does not allow an instrument to occur in consecutive combinations. In the second part, this procedure is repeated, but with three instruments, here, an instrument cannot occur in more than two consecutive combinations. This procedure is similarly repeated for all four and five instrument combinations. Figure 4.3 shows the distribution of material and the combination of instruments. The material of this section reappears throught the rest of the piece, but is here presented in a reduced form, reduced to the minimum which defines its identity.

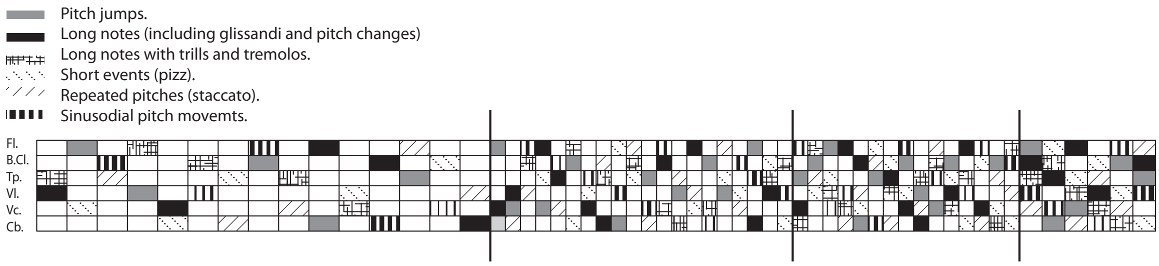

Figure 4.3: Distribution of material and instrumentation scheme of section 1

The pitch materials used in this section go through four successive stages. Figure 4.4 shows the first two pitch sets used in the section. The third stage is no longer a pitch set, but a random walk with four different step sizes (quarter tone, minor second, minor third, and tritone) in both directions. After the basic sequences of pitches was produced, it was filtered so as not to contain pitch class repetitions within a window of seven successive pitches. The fourth and final stage of the pitch material, was a distribution of all 24 quarter tone pitch classes over the entire pitch range.[4] The four stages of the pitch material constitute an overall densification of the pitch grid. Finally, a rhythm of short rests was superimposed onto the entire section.

Section 2 – Groups (mm. 33 – 53)

In the second section, the amount of coordination both among the instruments and regarding the succession of material is increased by forming groups of instruments and groups of material. There are four types of materials present: short pizzicato notes, fast passages, long steady pitches, and silence. The materials are played by groups of two

[4]In case of the sinusoidal movement, the pitch material is used to determine the turning points, the pitches in between turning points are a result of the interpolation and do not necessarily belong to the basic pitch material.

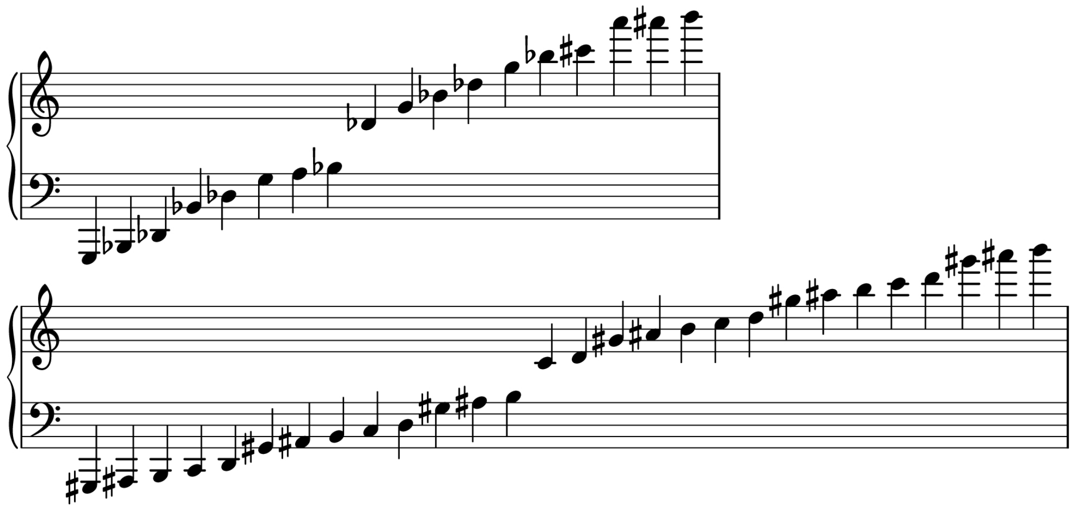

Figure 4.4: The first two pitch sets used in section 1

instruments and appear in 15 different orders. Within each of the 15 groups, each of the four types of materials appears once. The material thus undergoes permutations of the order of its appearance and permutations of instrumentation. However, in the course of the section there is a continuous increase in overlap, which finally renders the original order of the material unrecognizable. Furthermore, each material undergoes a different development: the short pizzicato notes grow desynchronized, the fast passages expand until they become similar to the center material of section four, and the long notes transform into the periphery of section four. This section thus ends with an anticipation of section four.

Figure 4.5 shows the symmetrical shape controlling the registers. It starts narrow around C4, moves to both extremes, then the shape moves back to C4 and finally covers the whole range. Within the active pitch regions there is a pitch distribution which changes over the course of the entire section from a logarithmic to an exponential 'warping' of the pitch space.

Section 3 – Transitions (mm. 56 – 86)

While in section two coordination was introduced by forming constantly reassembling groups, it is increased in section three by forming groups of instruments which remain identical throughout the section. As in section two, there are three different types of materials used in section three. From the six materials of section one, the three materials not used in section two are used in section three. These are: interpolated shapes, quick

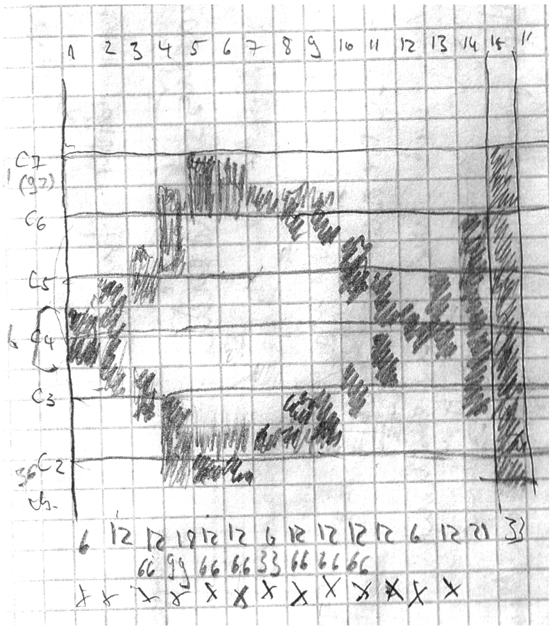

Figure 4.5: Register structure of section 2

note repetitions forming square-wave-like patterns, longer notes with trills and tremolos, including short grace note groups.

There are two groups of instruments which remain constantly the same throughout the section. One group is formed by violin, flute, and trumpet and the other group consists of bass clarinet, cello, and double bass. The sequence of three instrument combinations from section one is reused in this section. Figure 4.6 shows the distribution of pitches from a basic pitch sequence over the instruments.

The two groups form independent transitions between the three types of material, but eventually meet in the 'square-wave' material around measure 69, a first moment in which the activities of all instruments are roughly the same. From measure 72 onwards, an originally dense structure was reduced in density by removing groups of successive notes. The probability for removing groups, which have the lengths of 6, 12, and 24 notes, is increasing towards the end of the section. The violin, however, is excluded from this process and thereby emerges as the central voice forming a transition into the following two-measure violin solo.

Section 4 – Center and Periphery (mm. 89 – 139)

In section four, there are two groups of instruments. One group forms the center of activity and the other group forms a periphery. It is a periphery in several senses: it is

Figure 4.6: The pitch sequence and its distribution in section 3

dependent on the structure of the center, it is dynamically mostly in the background, and it is generally surrounding the pitch space of the center without entering its range. The center consists of changing pairs of instruments. The order and selection of pairs is taken from the first part of section one.

The Construction of the Center

The two instruments forming the center are following pitch shapes. The shapes are constructed by using a set of breakpoints, or in this case turning points, and a half-cosine interpolation function. The interpolated breakpoints are placed within a pitch space which is the intersection of both instruments's pitch ranges. Table 4.1 shows the basic data used for the construction of the center.[5] The whole section is split up into 15 subsections, i.e. one subsection for each instrument pair. The second column

[5]In the final versions of this section, there are a number of significant deviations from the original data. Some have been introduced due to reasons of playability, some have been made to explore potential situations, which have emerged through the methodical construction, but have not been fully exhausted or unfolded their potential. The deviations are greatest in the beginning and the end of the section.

in table 4.1 lists the durations of these subsections, which are growing exponentially smaller. The third column shows the average density of breakpoints, i.e. turning points, for each subsection. Three permutations of the five different densities are used. Given the duration and the turning point density for each subsection, the number of actual turning points per subsection can be calculated and is shown in column four. There are three possible ways of distributing the turning points within the subsections, their frequency can exponentially increase, decrease or remain constant, which results in the exponential acceleration, deceleration or constancy of the speed of pitch fluctuation. Column five shows the distribution of the three types over the subsections. Another important parameter in the construction of the center are the slopes of the shapes. After the turning points have been distributed, the maximum possible slope for each subsection is determined. Given the maximum possible slope, i.e. the maximum possible slope which can be reached between all consecutive breakpoints within a subsection, a mean slope value is determined. There are five possible types: 100%, 77.5%, 55%, 32.5%, 10% (of the maximum), which are arranged in three permutations as shown in column six. The lines of one of the instruments is constructed as described, the second, however, is derived from the first line, in three possible ways: by reversing the whole shape (retrograde), by mirroring the shape at its center (inversion), by reversing and mirroring it (retrograde-inversion), or by simply duplicating the shape (parallel).

Subsection	Duration (secs)	Bps./sec	Bps.	Bp. dist.	Mean slope	Line 2
1	12	1	12	acc.	55%	inv.
2	11.28	1.33	15	dec	32.5 %	ret.-inv.
3	10.6	2	21	const.	77.5%	ret.
4	10	0.5	5	acc.	100 %	parallel
5	9.36	0.66	6	acc.	10 %	ret.
6	8.8	0.5	4	const.	32.5 %	ret.
7	8.28	1	8	dec.	55 %	inv.
8	7.78	2	15	acc.	100 %	ret.-inv.
9	7.31	0.66	5	const.	32.5 %	ret.
10	6.87	1.33	9	dec.	77.5 %	parallel
11	6.46	0.66	4	dec.	100 %	ret.-inv.
12	6	0.5	4	const.	77.5 %	parallel
13	5.7	1	6	dec.	32.5 %	ret.
14	5.37	1.22	8	const.	10 %	ret.-inv.
15	5.05	2	10	acc.	55 %	inv.

Table 4.1: Basic data for the construction of the center

Figure 4.7 shows the construction of the center lines of the two subsections three and four. The figure shows all of the basic elements described above. Although the interpolation here is linear, the interpolation used for the final result was a half-cosine interpolation.

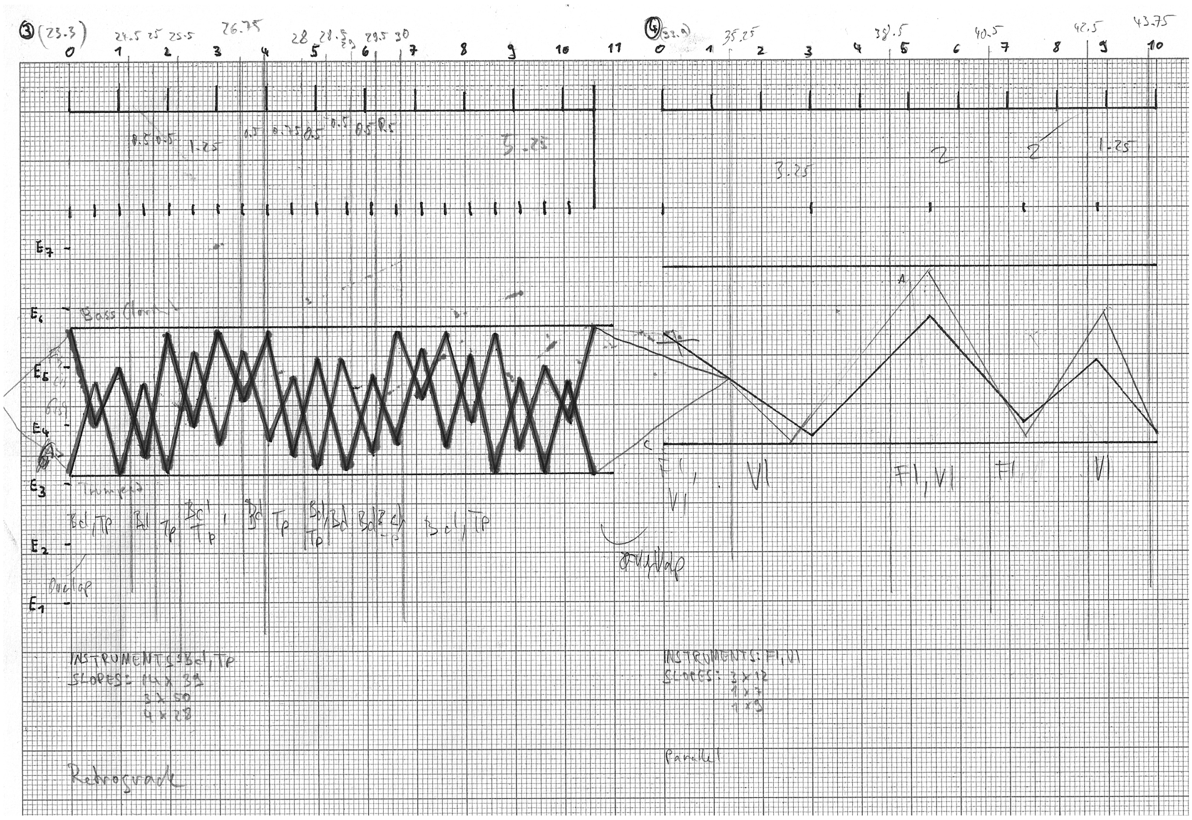

Figure 4.7: Composition of the center lines of subsections 3 and 4

Another structural level, which determined phrase lengths and coordination points of the center and the periphery was superimposed onto the described 15 subsections. In figure 4.7 these points are indicated by vertical lines drawn across the pitch shapes. There are seven possible phrase durations: 0.5, 0.75, 1, 1.25, 2, 3.25, 5.25, which are arranged in four *cycles*. Within each cycle the value 0.5 occurs ten times, the value 0.75 six times, 1 occurs once, 1.25 occurs three times, 2 two times, 3.25 two times, and 5.25 once. These durational values are sorted from long to short, thus resulting in a roughly exponential reduction of the phrase durations and an increase in the coordination of center and periphery. Table 4.2 shows the four cycles of phrase durations.

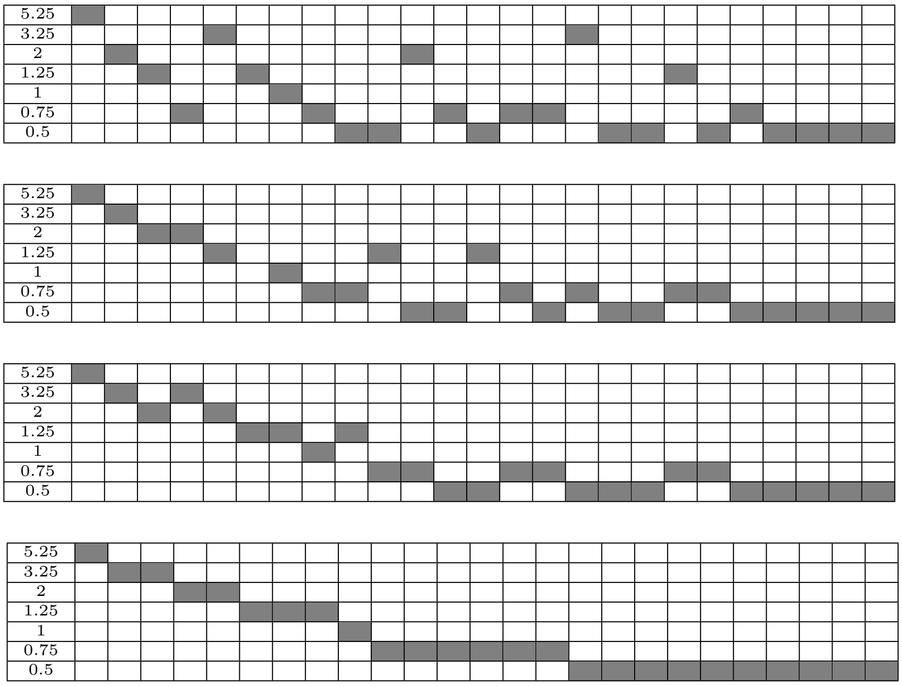

Table 4.2: The four cycles of phrase durations

The Construction of the Periphery

Figure 4.8 shows the end of measure 103, measure 104, and measure 105. The end of measure 103 contains two phrases of length 0.5 seconds and a phrase of 5.25 seconds (here rounded to 11/8, i.e. 5.5 seconds in total). Each of the peripheral voices is assigned a grid. A grid is constructed by dividing the total duration of the phrase into a number of equidistant sub-durations, which are possible onset points for the peripheral voices. In figure 4.8, the flute's grid is five, i.e. the entire duration of the phrase is divided by five, the violin's grid is two, the cello's is three, and the bass's is four.

Since all the peripheral instruments have different grids, they only coincide very rarely. The principal moments of coincidence are the phrase beginnings, or coordination points. At these points the peripheral voices play the same pitch class (± 1 semitone) as one of the center instruments.

The assigned grids can be momentarily suspended and peripheral instruments double, in rhythmic unison, a short phrase played by a center instrument. Figure 4.9 shows four instances of center material taken up by the periphery.

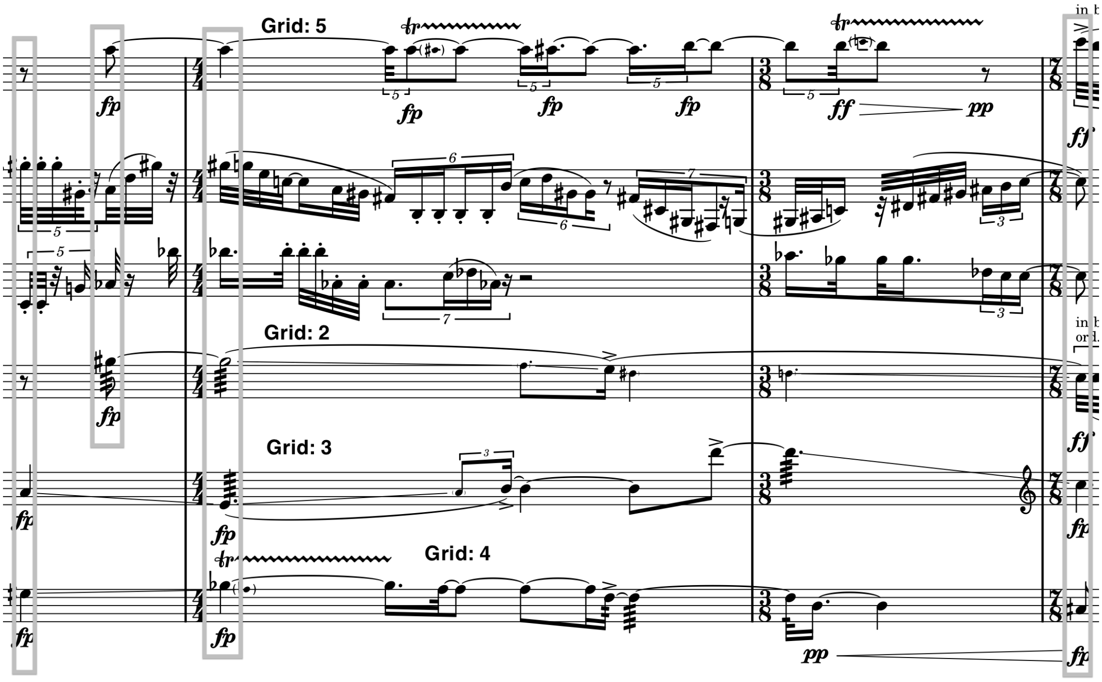

Figure 4.8: Measures 103 – 105

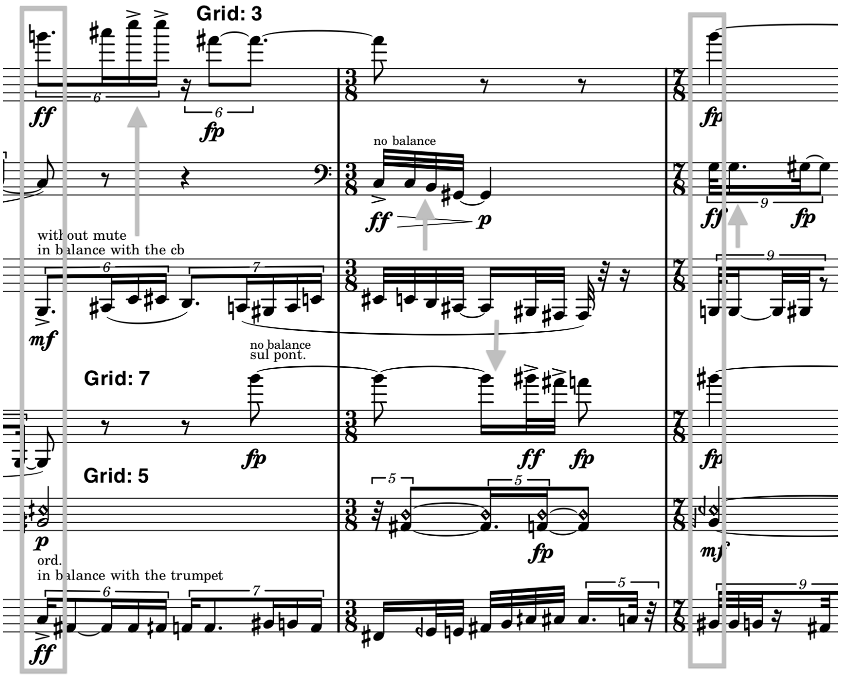

Figure 4.9: Measures 119 – 121

Section 5 – One (mm. 141 – 171)

In section 5, the pitch material is reduced to pitch class D. The section consists of three subsections. In the first subsection (mm. 141 – 147), all instruments are centered around D4 and alternate between sustained notes and short 'garland'-shaped deviations. In the measures 147 to 158 six types of materials (quick staccato repetitions, 'garland'-shaped deviations, glissandi, trills and tremolos, short notes, and long notes) are shared by all instruments. Each instrument, however, plays the six materials in a different order. Each instrument changes its material at a different regular interval. The flute's interval is the duration of a whole note and a quintuplet, the bass clarinet's interval is two and a half quarter notes, the trumpet's interval is three quarter notes and three eights, the violin's interval is five quarters and a sixteenth, the cello's interval is two quarters and four quintuplets, and the double bass's interval is three quarter notes. From measure 159 until the end of the piece the same distribution of material is repeated. Four transforming processes are applied to the repeated version forming a disintegration, the pitches spread out over several octaves, increasingly more material is removed (the same process as in section three), rests are inserted (similarly to sections one, two, and three), noisier playing techniques are introduced.

The Solos

Before and after each section there are short solos, which act as introductions and transitions. Their durations grow shorter. The first solo is played by the flute (16s), the second by the cello (11s), the third by the bass clarinet (8s), the fourth by the violin (6s), the fifth by the trumpet (3.5s), and the sixth by the double bass (1s).

Concluding Remarks

In the beginning of this section, I have said that the idea of form as a consequence of the treatment of the material has been an influential idea for the composition of this piece. After having briefly described of each of the sections and the way they have been constructed, I will try to explain in which way the form is a consequence of the treatment of the material.

All the basic material of the piece is present in the first page of the score. But instead of using that material to express a pre-conceived form, I have rather tried to develop it within several networks of instrument relationships and fundamental rules. These networks and rules, which form a meta-model and of which each section is a special case, create form through transforming the material and presenting it in constantly changing contexts. There are, of course, overall form determining factors such as the sectioning of the piece itself, but meaning and function does not stem from a pre-existing superimposed form, but rather from the specific lower level operations and schemes used to transform and re-present the material. In other words, the resultant form does not precede the material process.

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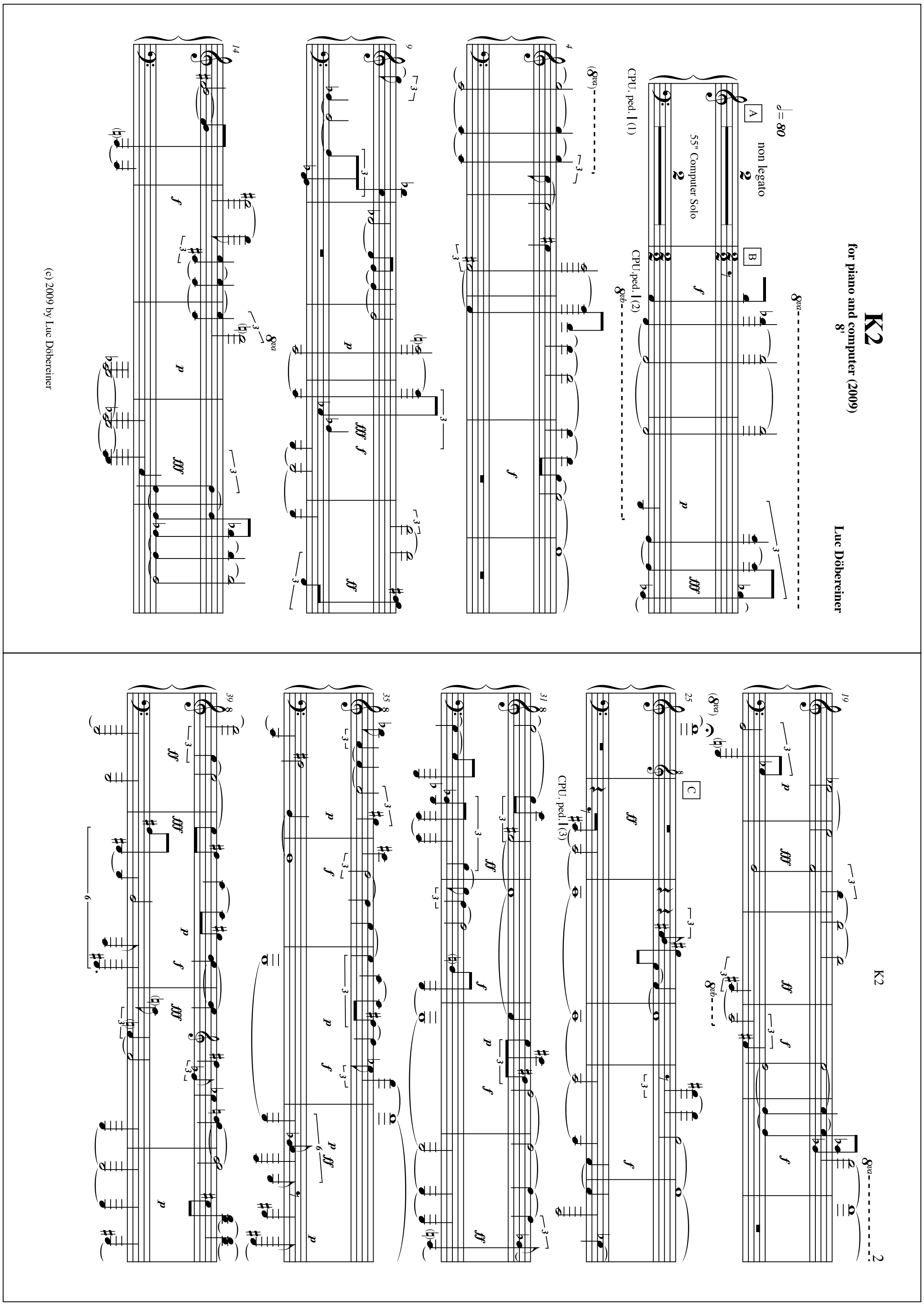
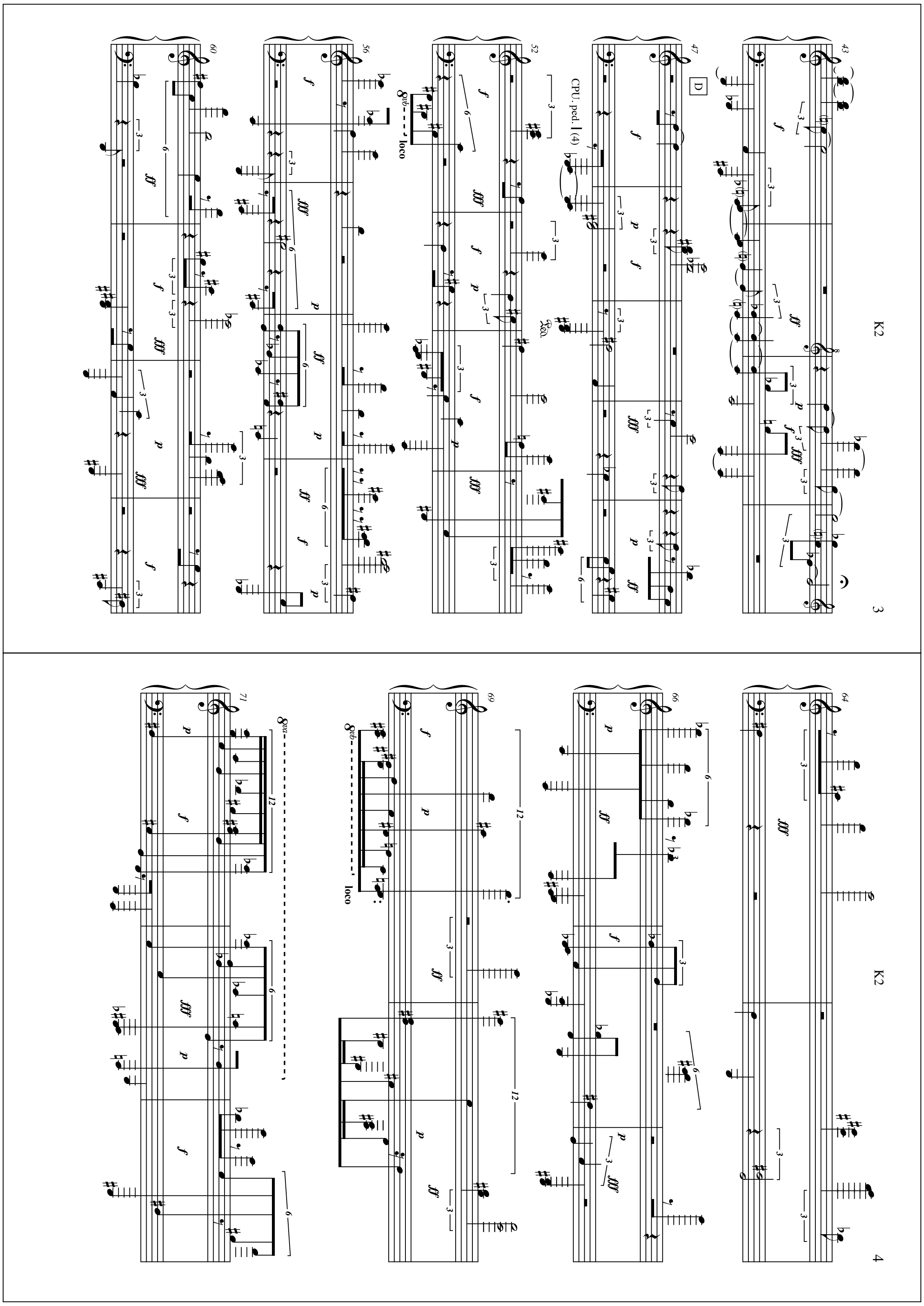
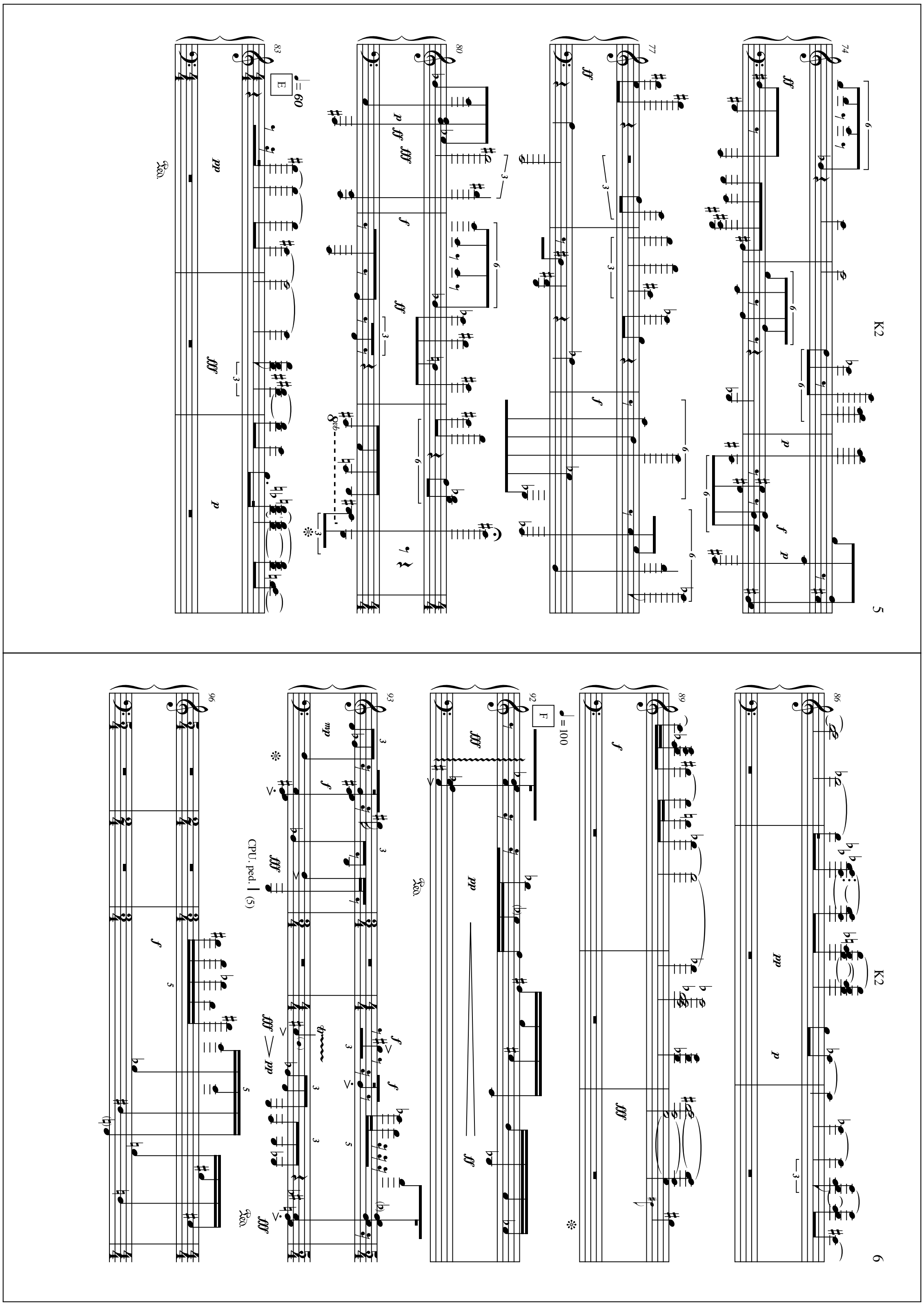
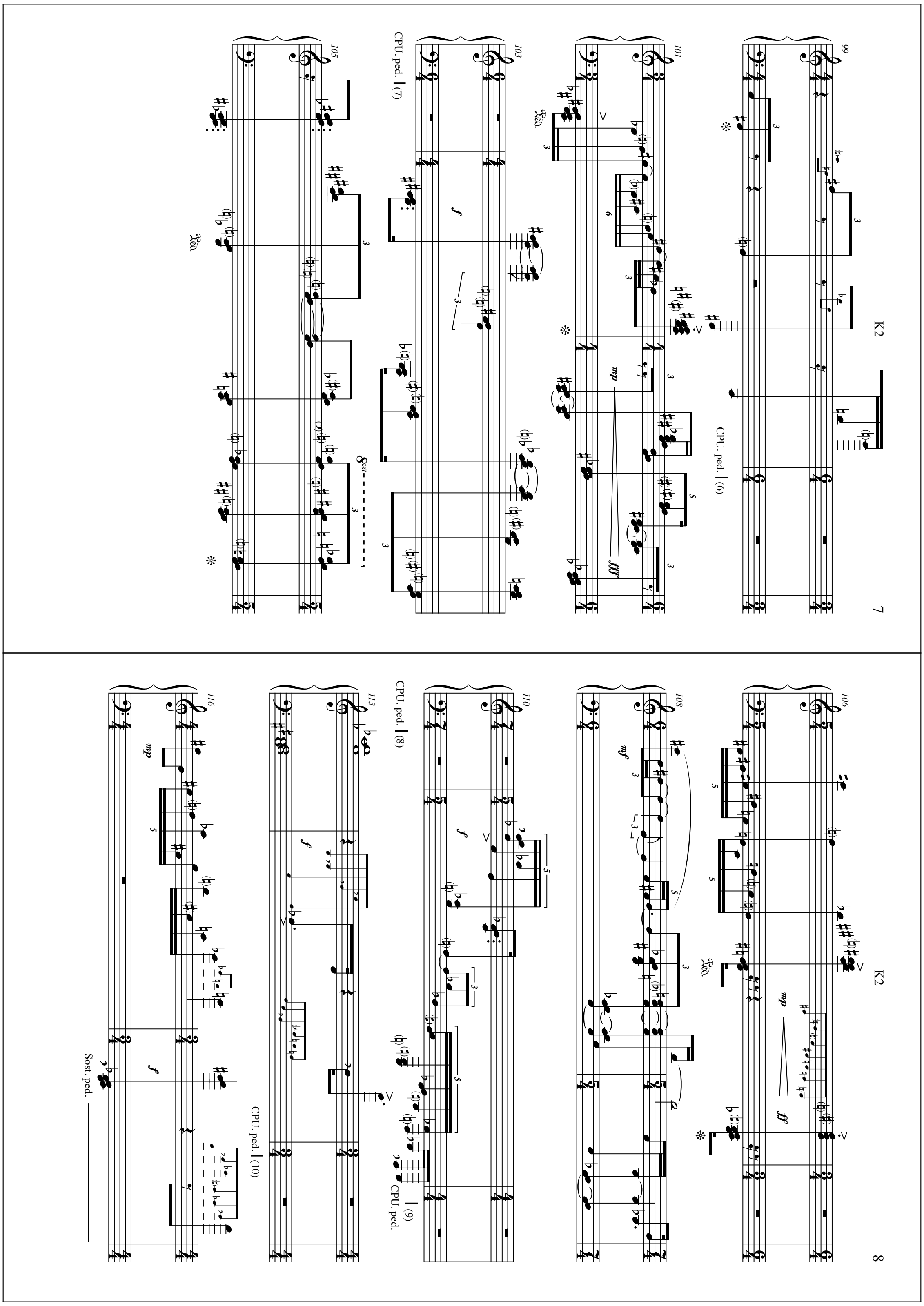
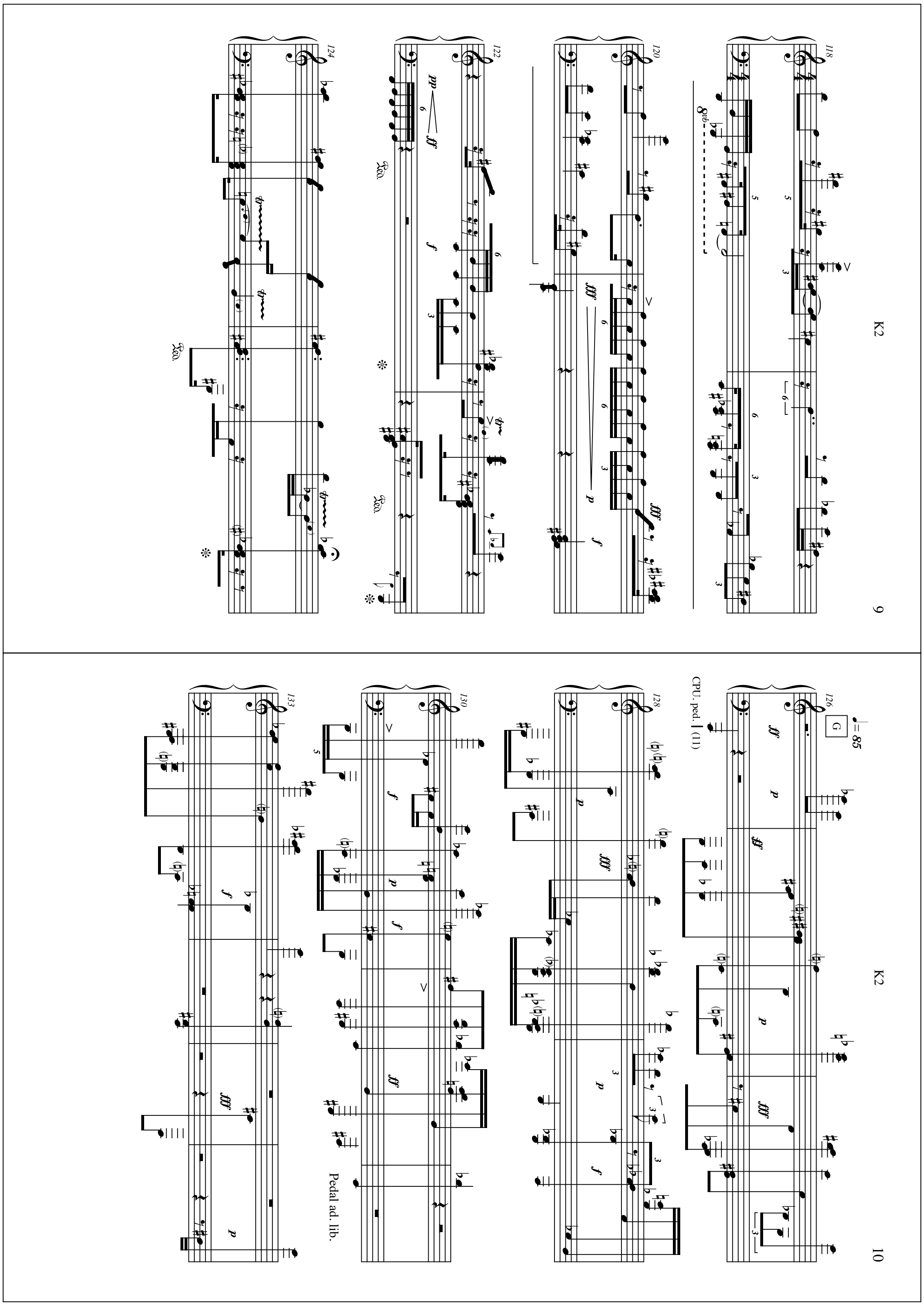
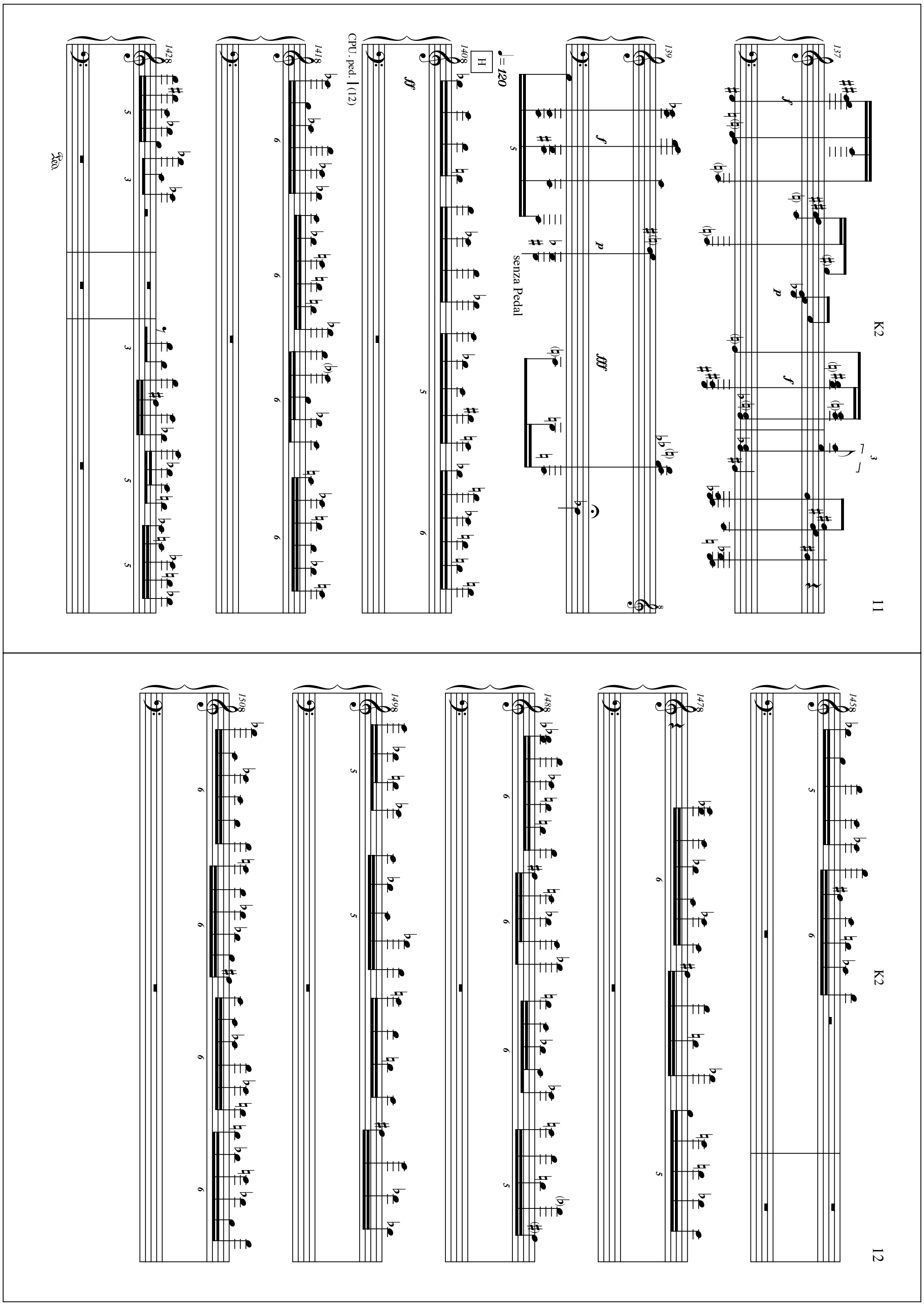

K2
for piano and computer (2009)
8'
Luc Döbereiner
♩= 80
non legato
55" Computer Solo
CPU: ped. | (1)
CPU: ped. | (2)
CPU: ped. | (3)
(c) 2009 by Luc Döbereiner
K2

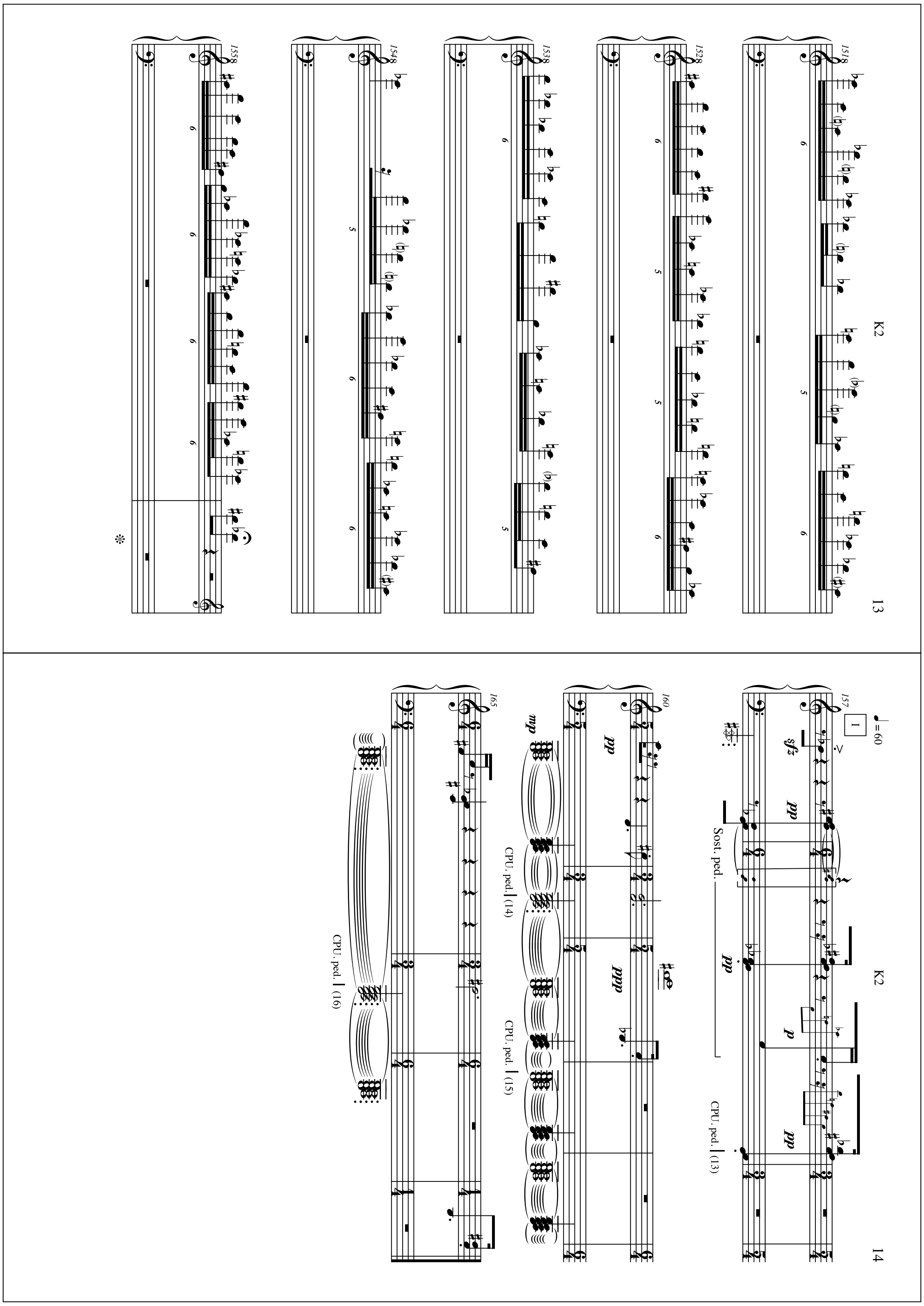

K2
3
D
CPU: ped. 1 (4)
loco
K2
4
loco


K2
5
6
E
♩ = 60
F
♩ = 100
CPU. ped. (5)


K2
7
99
CPU, ped. (6)
101
mp
fff
103
CPU, ped. (7)
f
105
8va
K2
8
106
mp
fff
108
mf
110
f
CPU, ped. (9)
113
CPU, ped. (8)
f
CPU, ped. (10)
116
mp
f
Sost. ped.


K2
9
K2
10
Pedal ad. lib.


K2
11
senza Pedal
H
CPU, ped. (12)
K2
12


K2
13
14
♩= 60
Sost. ped.
CPU. ped. (13)
CPU. ped. (14)
CPU. ped. (15)
CPU. ped. (16)

Luc Döbereiner

Description Without Place (2010)

for Ensemble

Performance Notes

General

accidentals	Accidentals are printed again if the same note appears later in the same measure — except if the note is immediately repeated. Cancellation marks are printed also in the following measure (for notes in the same octave) and, in the same measure, for notes in other octaves.
in balance with ...	Stay in dynamical balance with the given instrument.
no balance	Short for: no longer in balance with ...
trills	Trills are to be executed as fast as possible

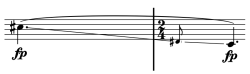
Winds

with air	ca. 50% air, 50% pitch
more air than pitch	very little perceptible pitch

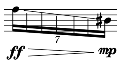
Flute

Tongue pizzicato
This effect is produced by fingering a specific pitch and producing a hard "T" with the tongue.

Strings



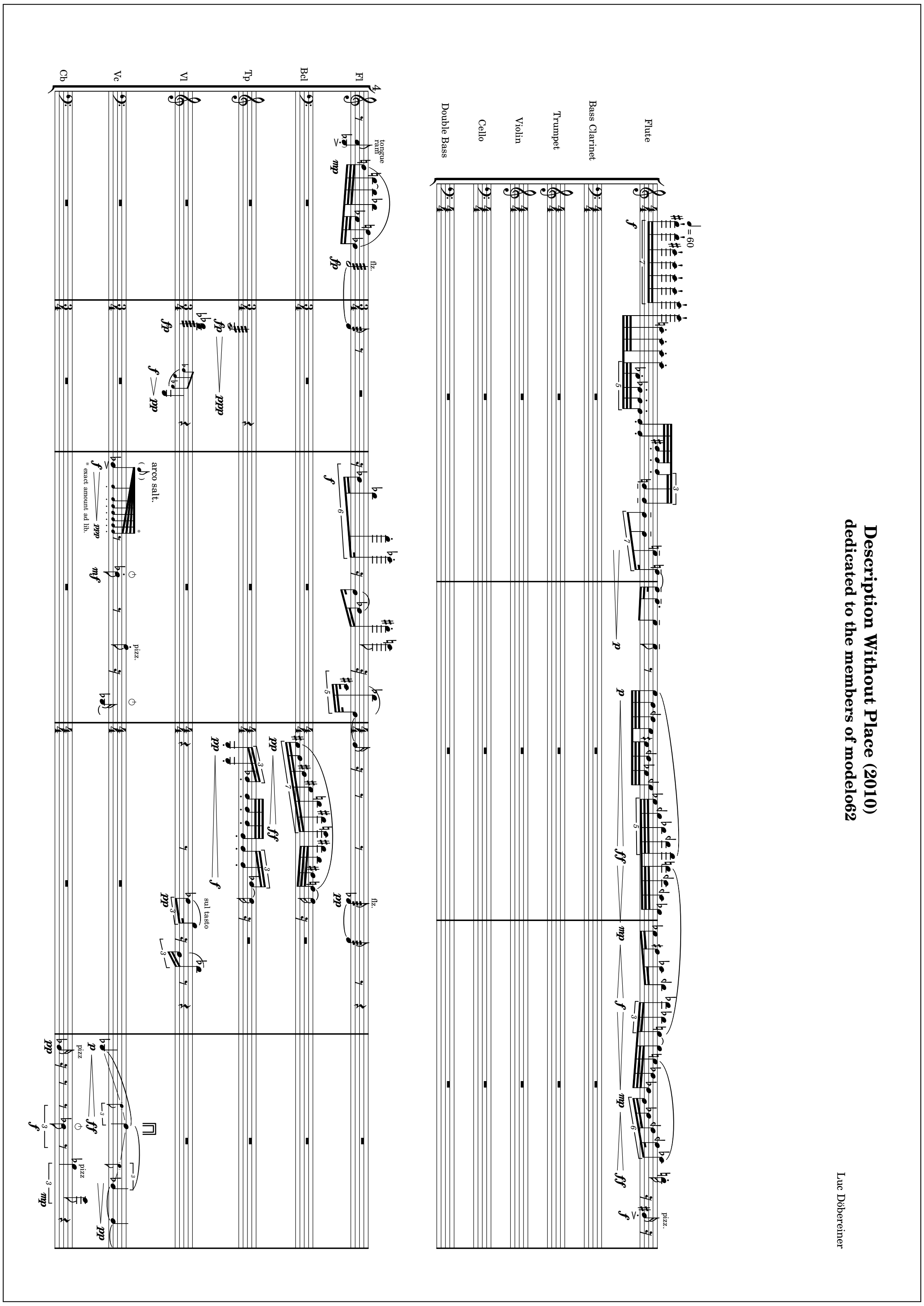
The smaller notes are not to be bowed, but merely indicate the approximate pitch during the glissando at that moment. For clarity, these glissandi are also slurred.

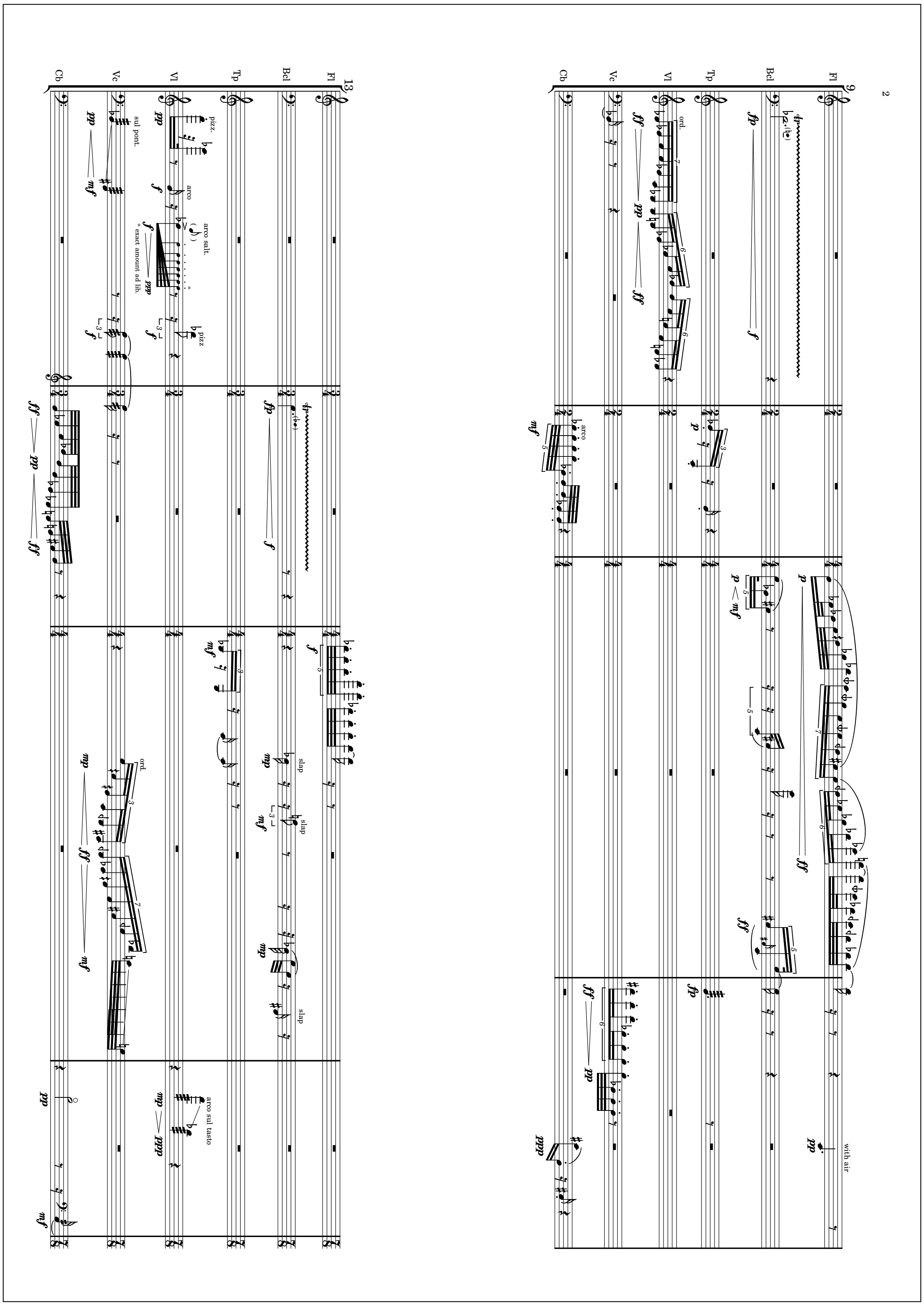


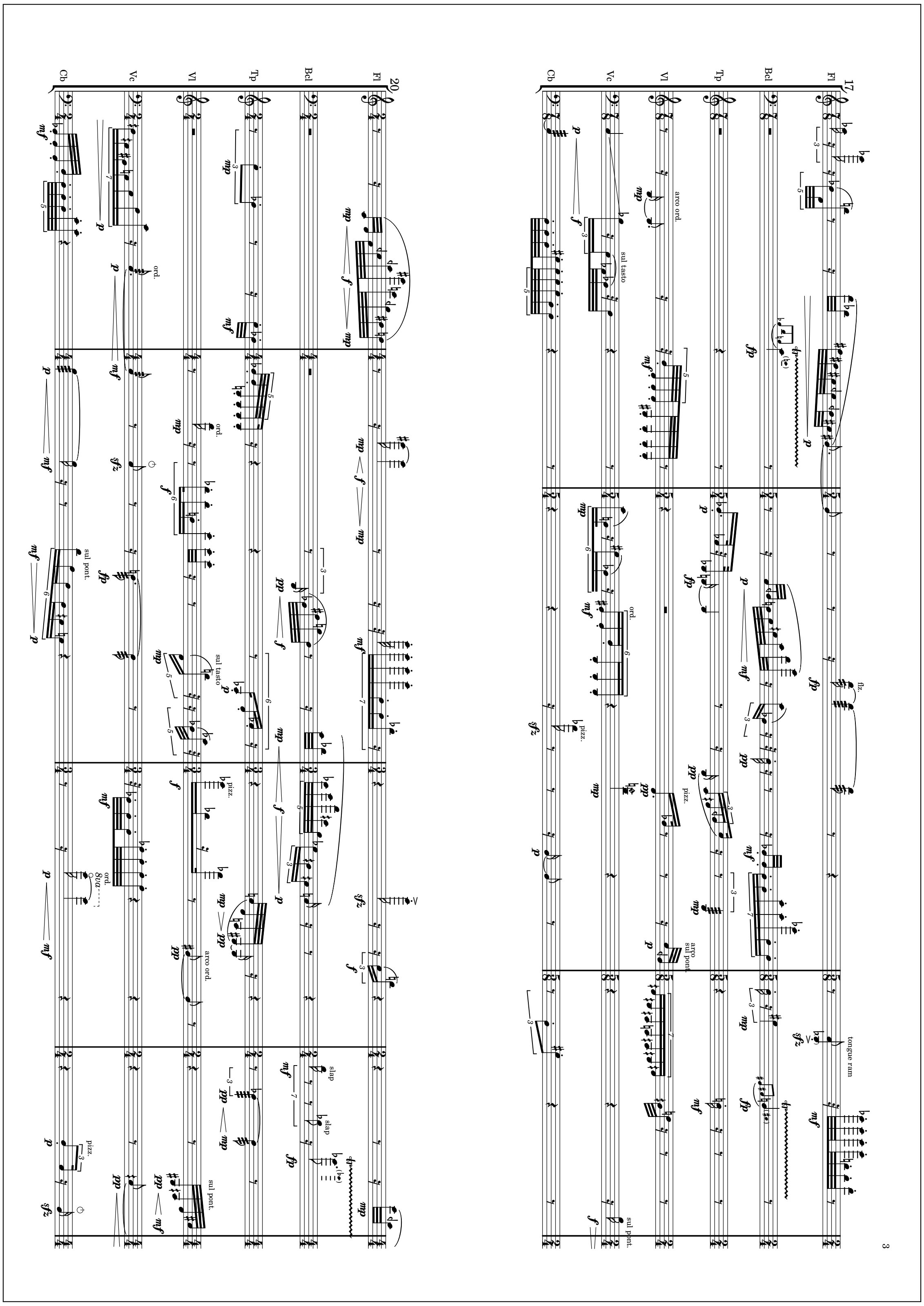
Each headless note is to be accented resulting in a fragmented line.

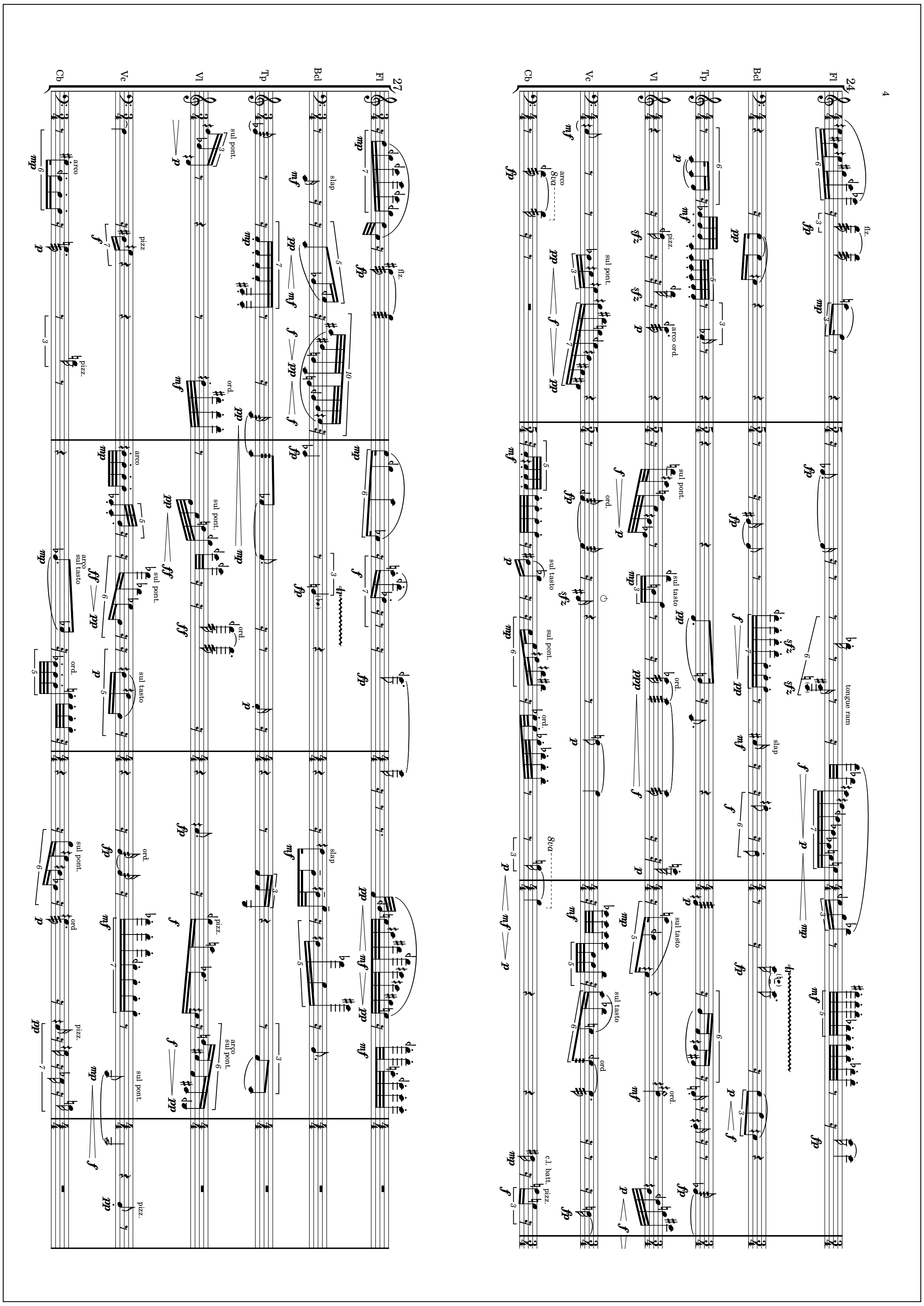
Very high bow pressure, but only on the attack.

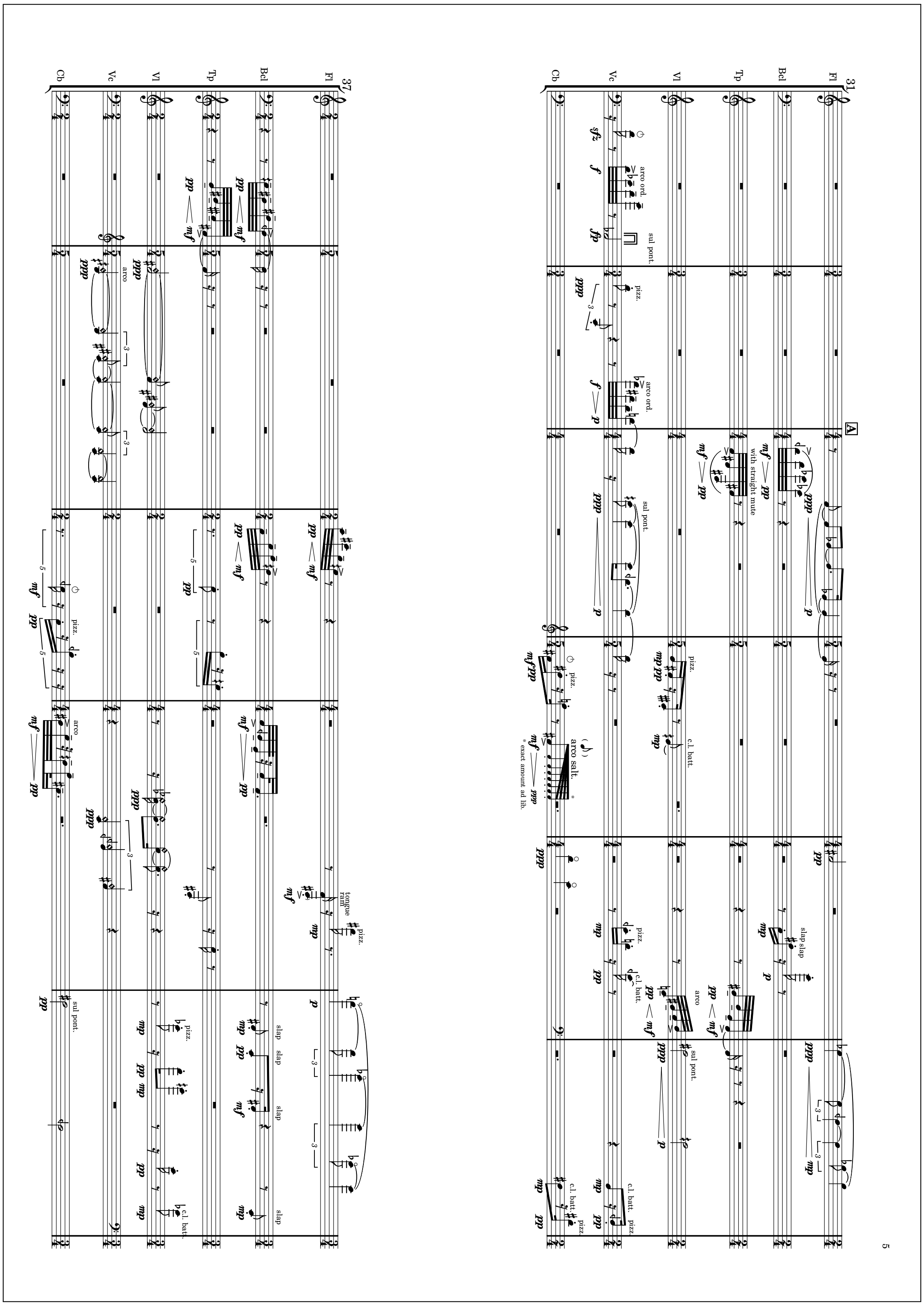
Duration: 9 Minutes

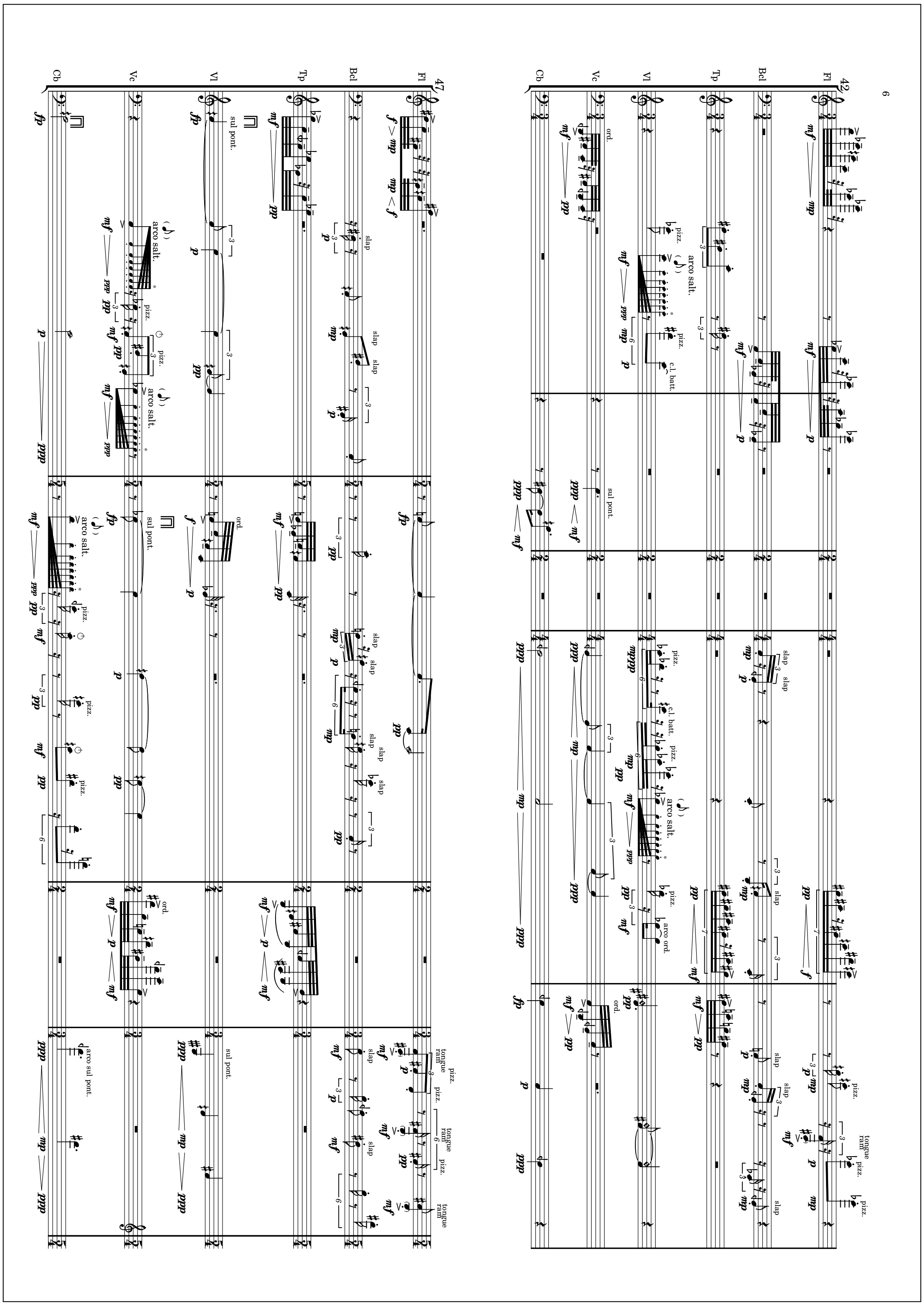

Description Without Place (2010)
dedicated to the members of model62
Luc Döbereiner
Flute
Bass Clarinet
Trumpet
Violin
Cello
Double Bass
= 60
tongue ram
flz.
arco salt.
* exact amount ad lib.
pizz.
sul tasto
Fl
Bcl
Tp
Vl
Vc
Cb

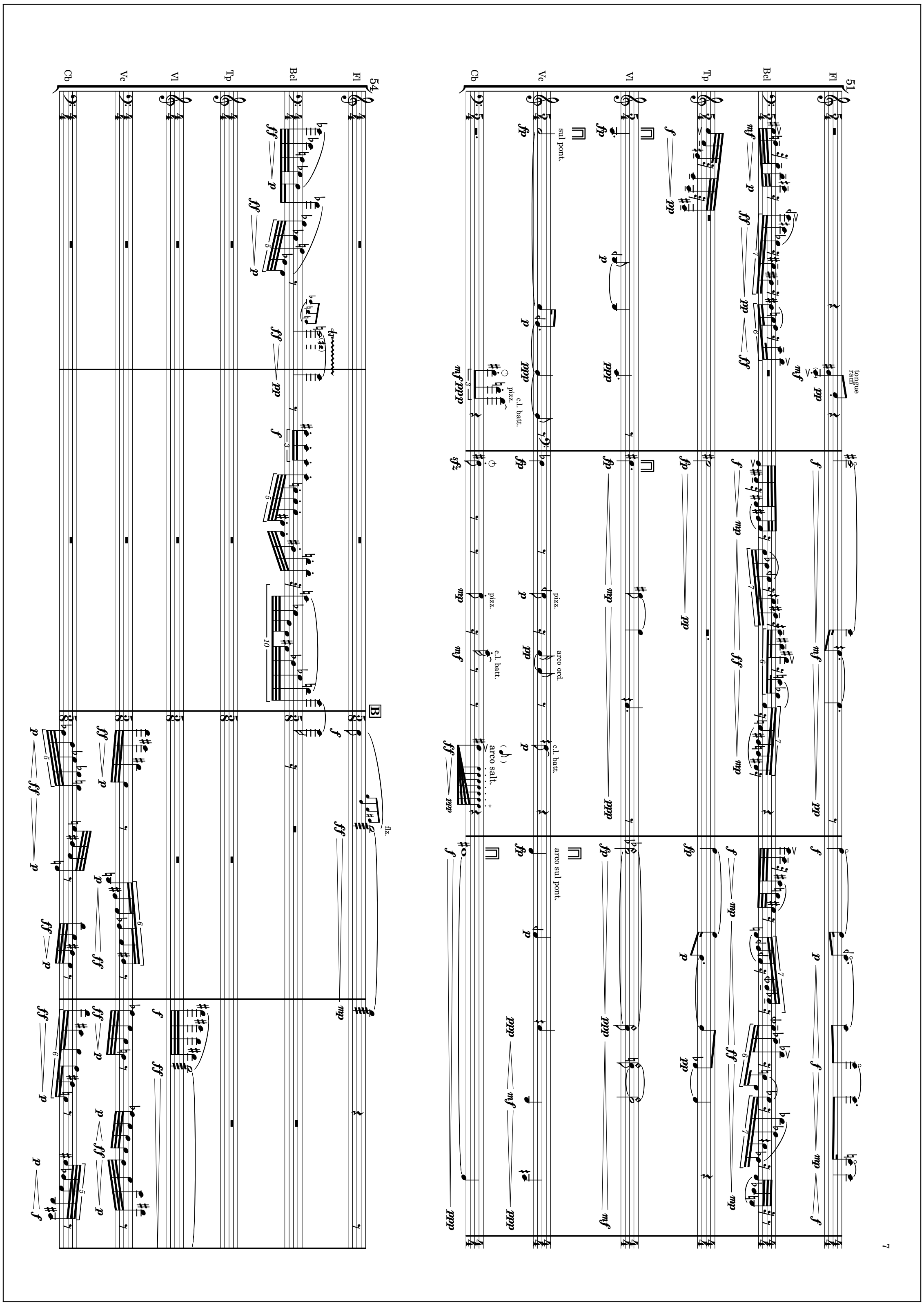

2
Fl
Bcl
Tp
Vl
Vc
Cb
ord.
arco
with air
pizz.
arco salt.
* exact amount ad lib.
sul pont.
pizz
slap
arco sul tasto

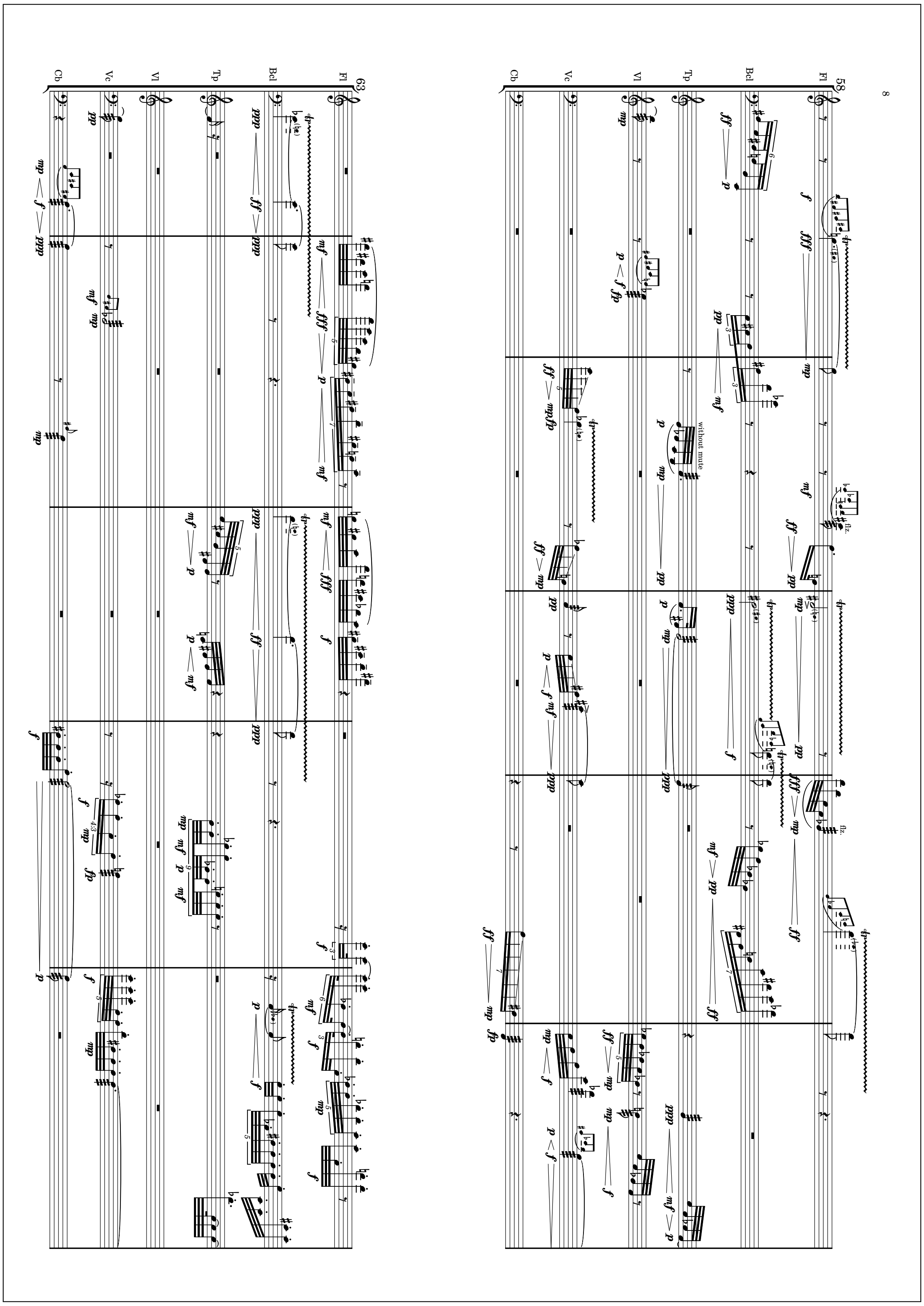

17
Fl
Bcl
Tp
Vl
Vc
Cb
arco ord.
sul tasto
ord.
pizz.
flz.
arco
sul pont.
tongue ram
sul pont.
3
20
Fl
Bcl
Tp
Vl
Vc
Cb
ord.
sul pont.
sul tasto
pizz.
ord.
8va
arco ord.
slap
slap
sul pont.
pizz.

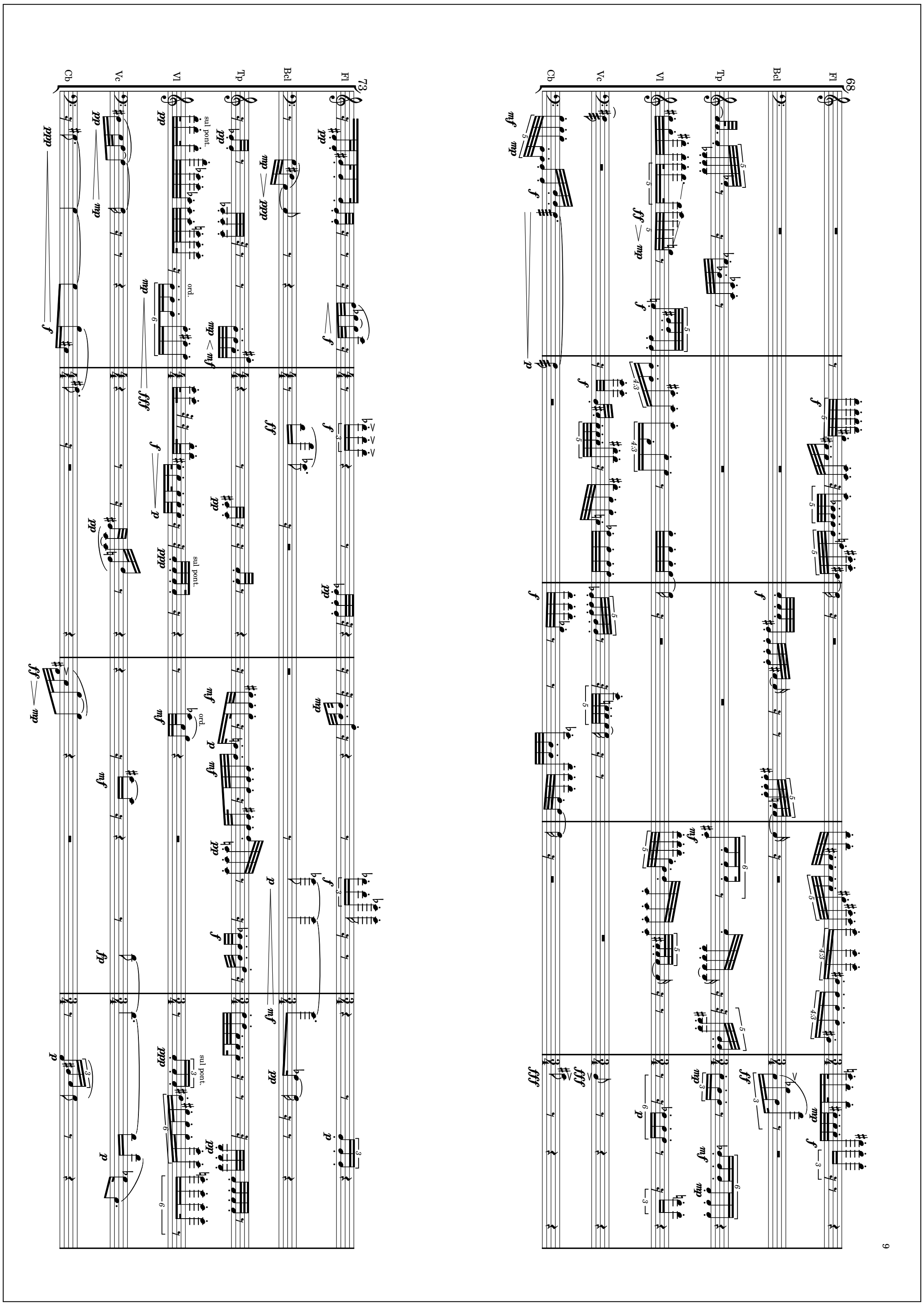

4
24
Fl
Bcl
Tp
Vl
Vc
Cb
27
flz.
slap
tongue ram
sul pont.
sul tasto
ord.
arco
pizz.
c.l. batt.

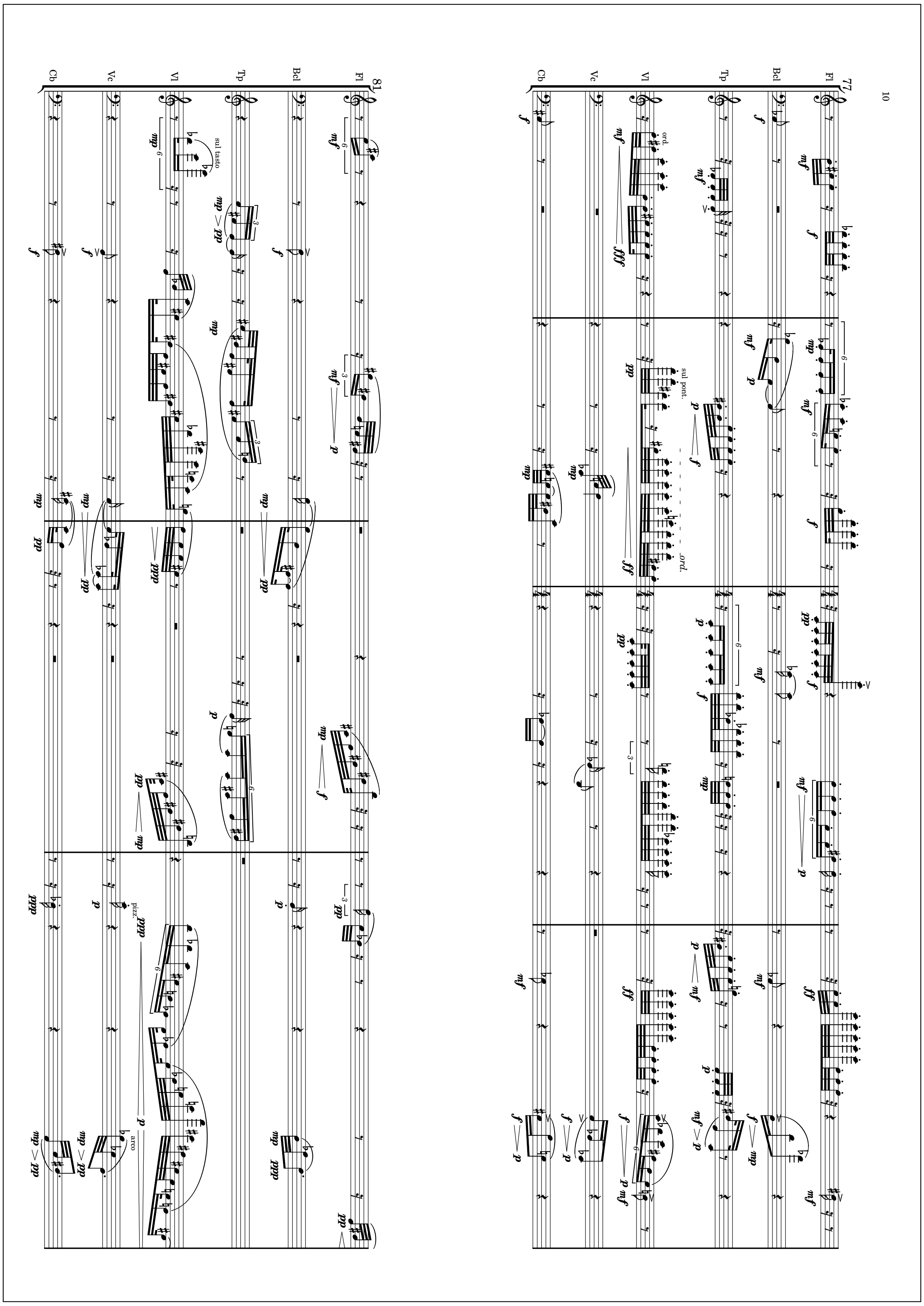

Fl
Bcl
Tp
Vl
Vc
Cb
A
with straight mute
arco ord.
sul pont.
pizz.
arco
c.l. batt.
arco salt.
slap
tongue ram
* exact amount ad lib.

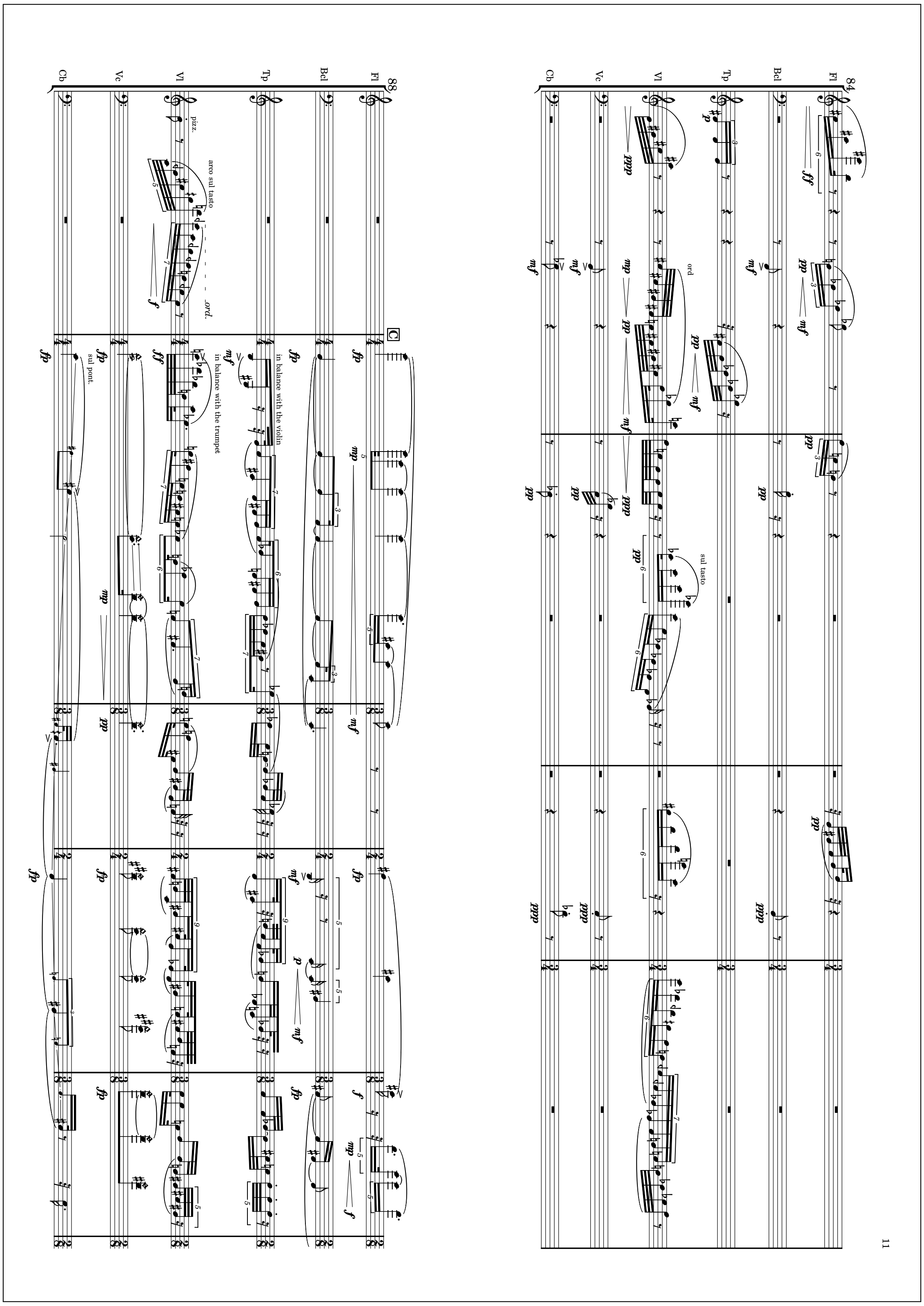

6
42
Fl
Bcl
Tp
Vl
Vc
Cb
47
Fl
Bcl
Tp
Vl
Vc
Cb
slap
pizz.
arco salt.
sul pont.
ord.
cl. batt.
arco ord.
tongue ram
arco sul pont.

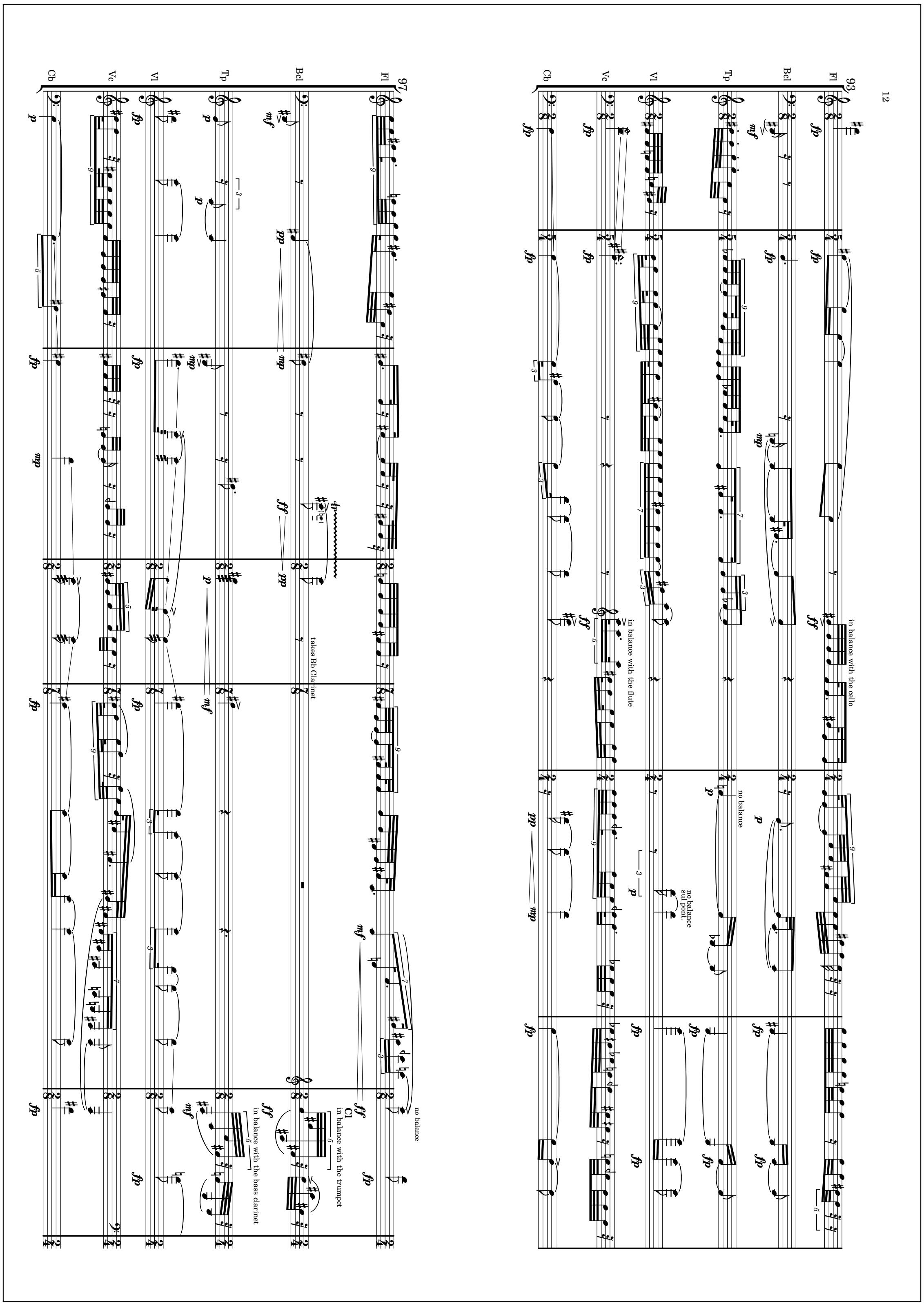

7
51
Fl
Bcl
Tp
Vl
Vc
Cb
tongue ram
sul pont.
pizz.
c.l. batt.
arco ord.
arco salt.
arco sul pont.
54
B
flz.

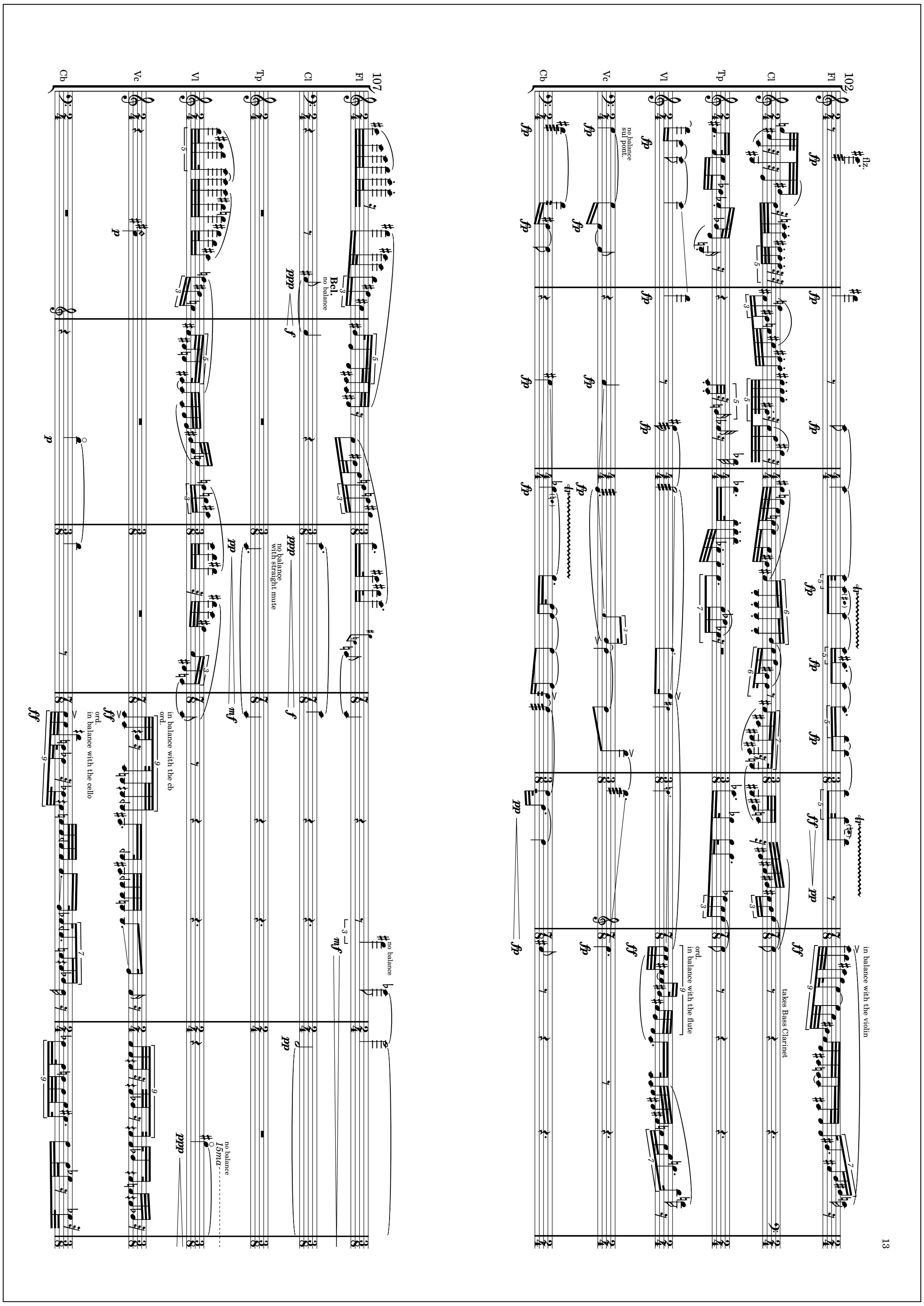

8
58
Fl
Bcl
Tp
Vl
Vc
Cb
without mute
flz.
63

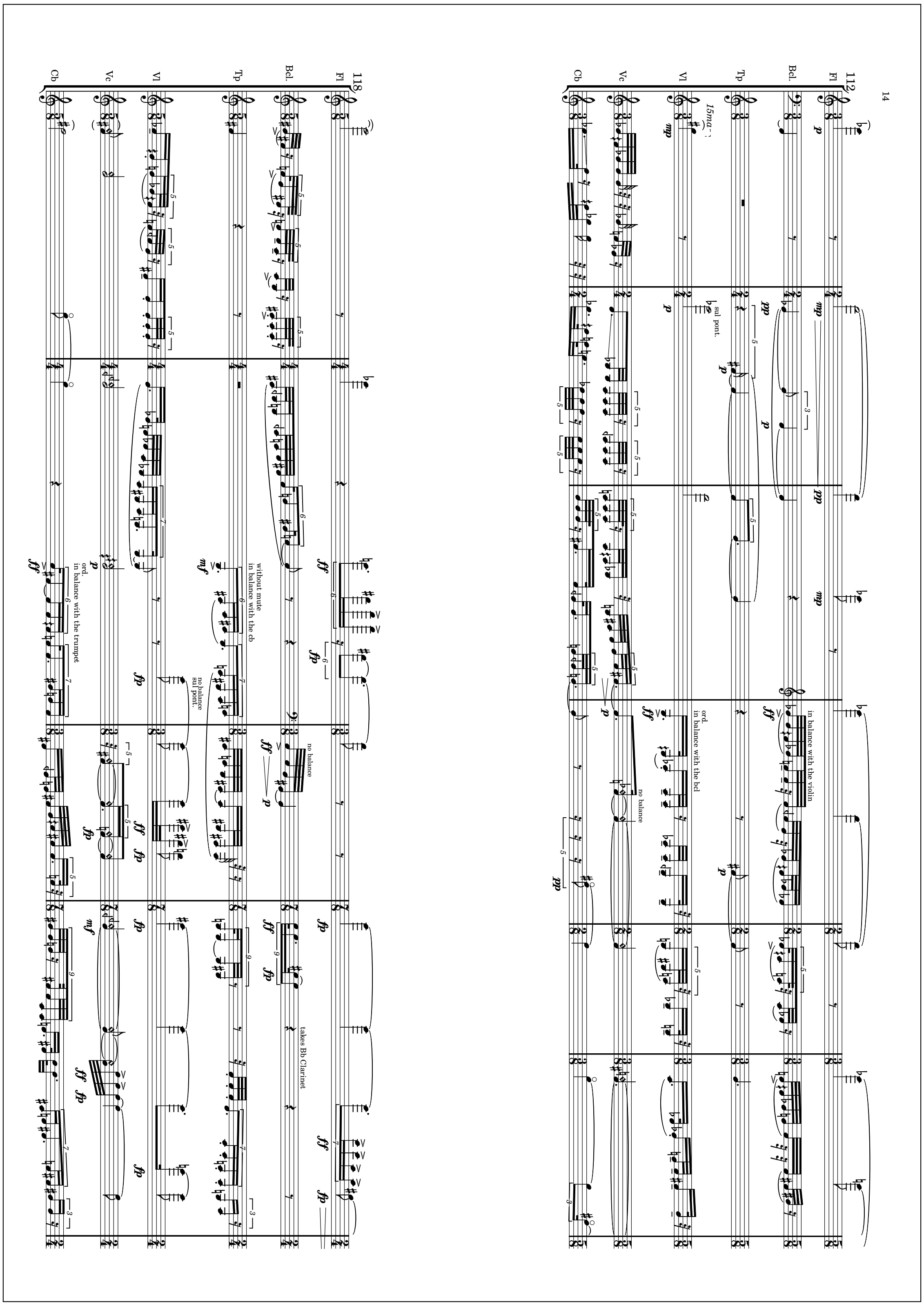

68
Fl
Bcl
Tp
Vl
Vc
Cb
73
Fl
Bcl
Tp
Vl
Vc
Cb
sul pont.
ord.
9

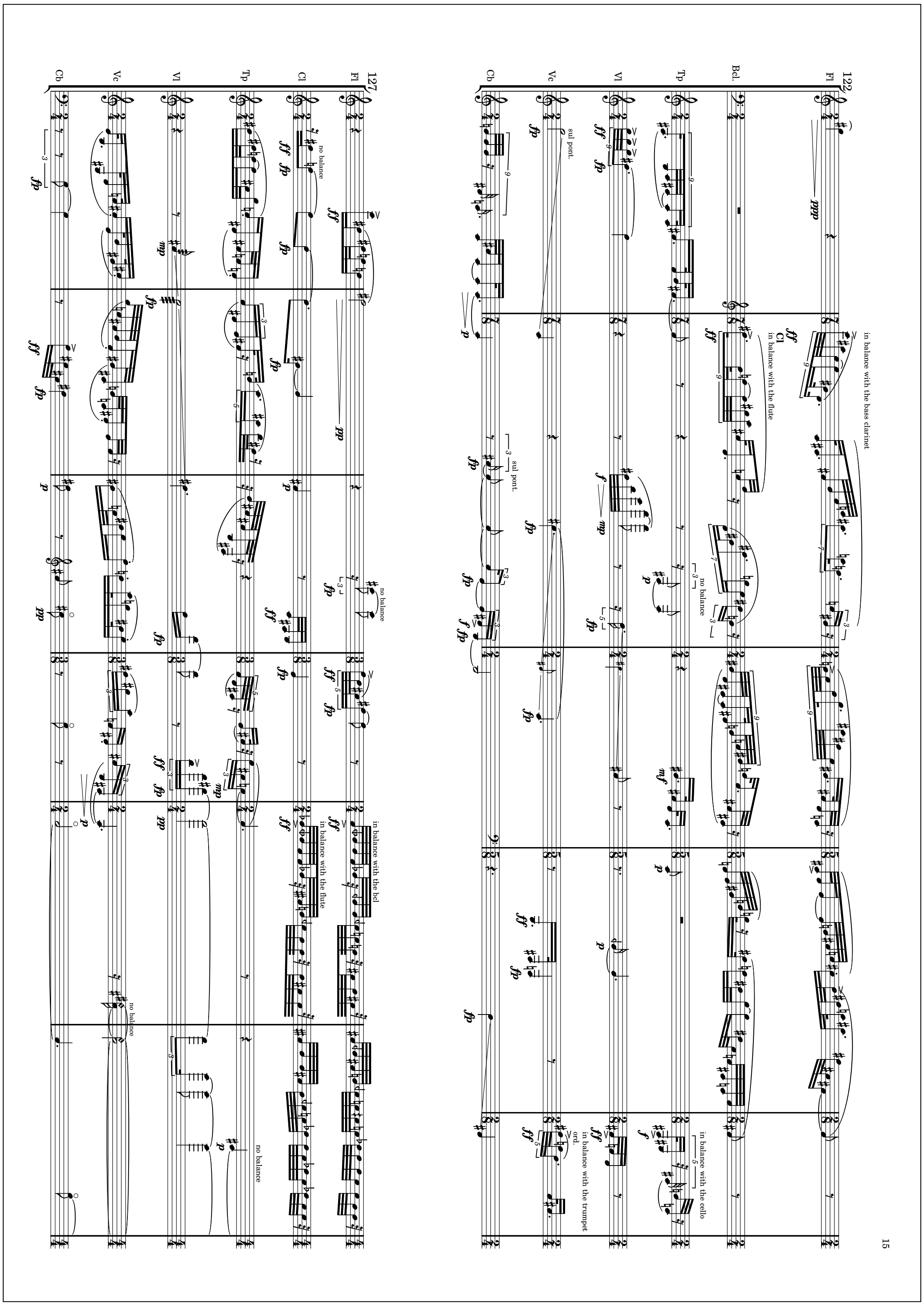

10
77
Fl
Bcl
Tp
Vl
Vc
Cb
ord.
sul pont.
81
sul tasto
pizz.
arco

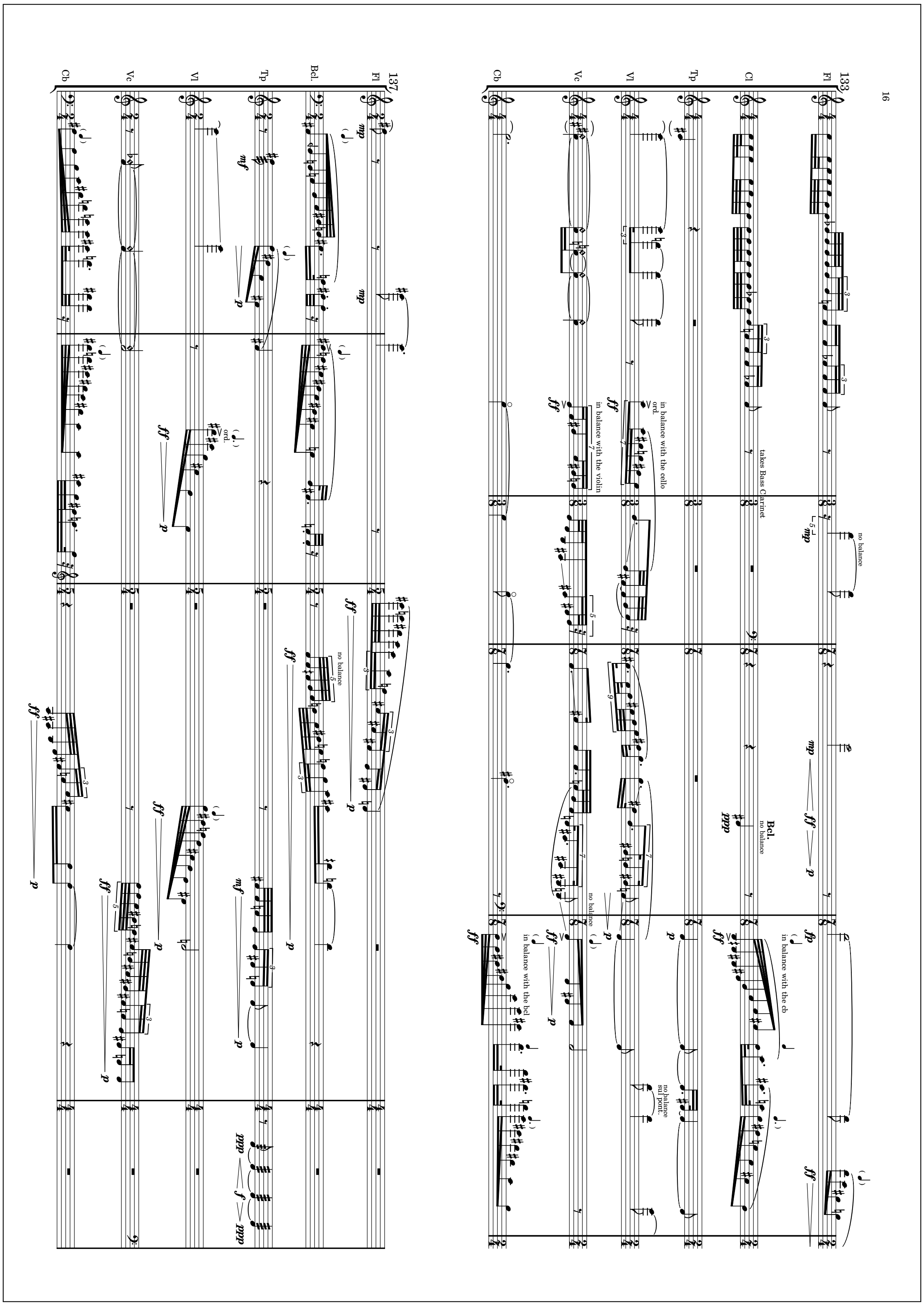

84
Fl
Bcl
Tp
Vl
Vc
Cb
ord
sul tasto
88
pizz.
arco sul tasto
ord.
C
in balance with the violin
in balance with the trumpet
sul pont.
11

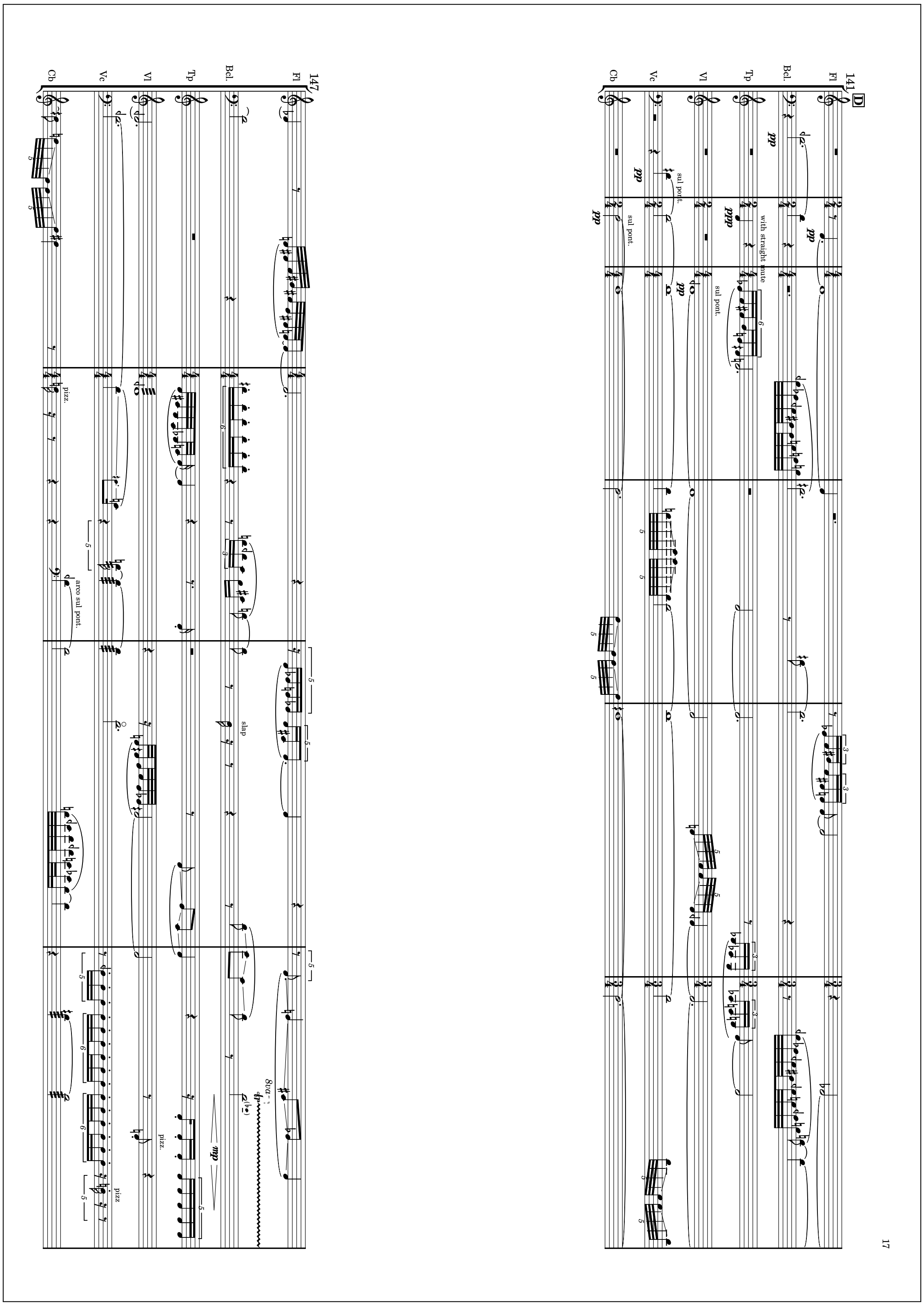

12
93
Fl
Bcl
Tp
Vl
Vc
Cb
in balance with the cello
in balance with the flute
no balance
no balance
sul pont.
97
takes Bb Clarinet
Cl
in balance with the trumpet
in balance with the bass clarinet
no balance

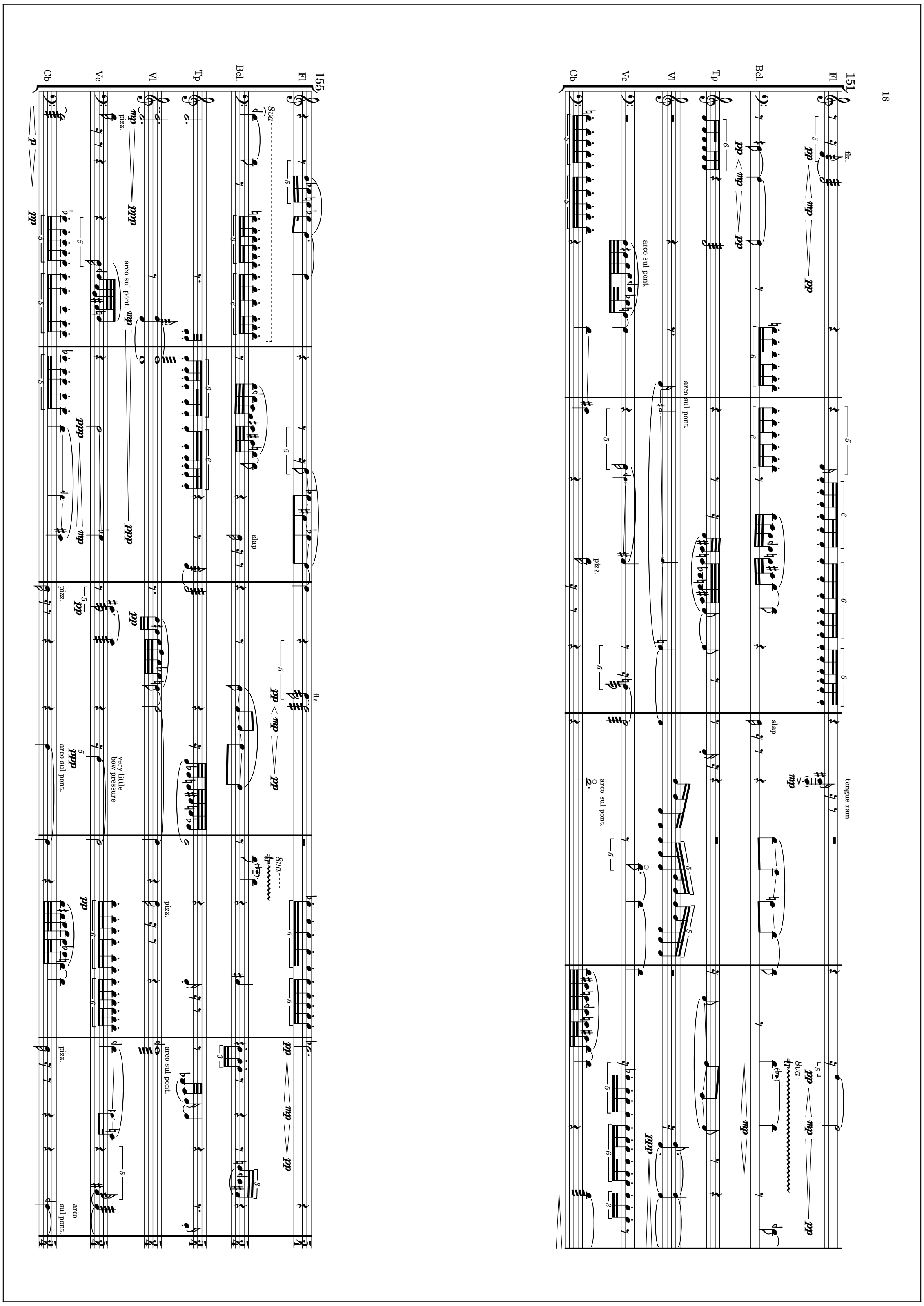

13
102
Fl
Cl
Tp
Vl
Vc
Cb
flz.
no balance
sul pont.
in balance with the violin
takes Bass Clarinet
ord.
in balance with the flute
107
Bcl.
no balance
no balance
with straight mute
in balance with the cb
ord.
ord.
in balance with the cello
no balance
no balance
15ma

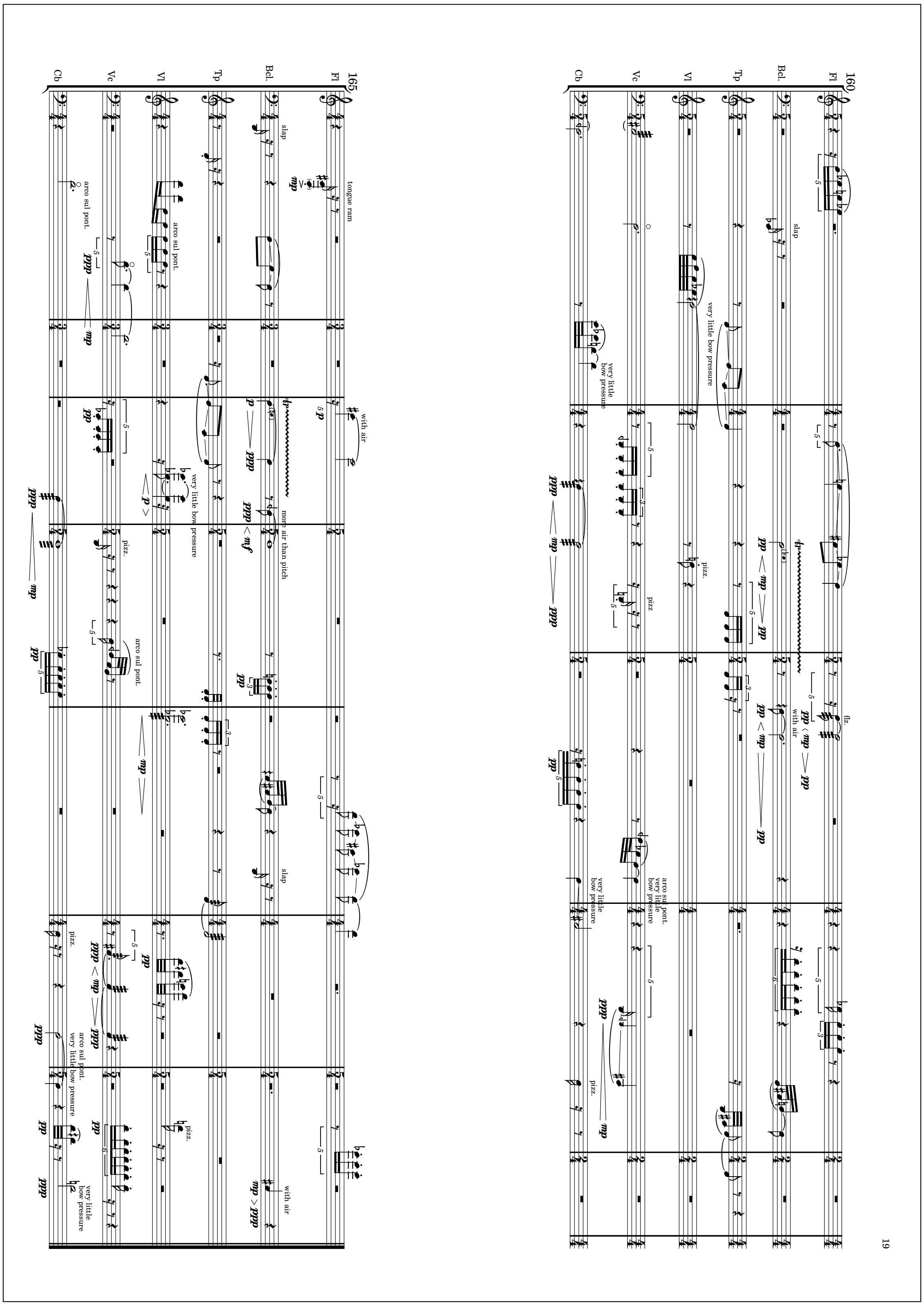

14
112
Fl
Bcl.
Tp
Vl
Vc
Cb
15ma
sul pont.
in balance with the violin
ord.
in balance with the bcl
no balance
118
without mute
in balance with the cb
no balance
sul pont.
in balance with the trumpet
takes B♭ Clarinet


122
Fl
Bcl.
Tp
Vl
Vc
Cb
in balance with the bass clarinet
Cl
in balance with the flute
sul pont.
no balance
in balance with the cello
ord.
in balance with the trumpet
15
127
Fl
Cl
Tp
Vl
Vc
Cb
no balance
in balance with the bcl
in balance with the flute


16
133
Fl
Cl
Tp
Vl
Vc
Cb
in balance with the cello
ord.
in balance with the violin
takes Bass Clarinet
no balance
Bcl.
in balance with the cb
no balance
sul pont.
137
Bcl.
ord.


141
D
Fl
Bcl.
Tp
Vl
Vc
Cb
sul pont.
with straight mute
147
pizz.
arco sul pont.
slap
8va
17


18
151
155
Fl
Bcl.
Tp
Vl
Vc
Cb
flz.
slap
tongue ram
arco sul pont.
pizz.
very little
bow pressure
arco
sul pont.
8va


160
Fl
Bcl.
Tp
Vl
Vc
Cb
slap
very little bow pressure
pizz.
with air
flz.
arco sul pont.
19
165
tongue ram
more air than pitch

C. Ten Questions for G. M. Koenig

The questions and answers reproduced below (in the German original and in my English translation) stem from an email correspondence with G.M. Koenig. Apart from several general questions, I was mainly interested in Koenig's view on some of the main topics covered in this thesis. Several of his answers have been discussed in passages of this text.

Meine erste Frage betrifft deine Sicht auf Technologie und Ihre Rolle in musikalischer Komposition. Du hast mal davon gesprochen, dass der Komponist dem Computer lehrt zu verstehen und zu sprechen, "was der Computer sagt, zeigt dem Komponisten, was er selber verstanden hat und aussprechen konnte". Könnte man den Computer also als Erkenntniswerkzeug verstehen?

Ob man den Computer als Erkenntniswerkzeug verstehen könnte? Ganz sicher, was natürlich nicht heißt, dass man die gemeinten Erkenntnisse nicht auch ohne Computer erwerben könnte. Der Computer jedoch zwingt den Komponisten, über Fragen nicht nur nachzudenken und nicht nur Antworten zu finden, sondern diese auch noch algorithmisch abzufassen und damit zu generalisieren.

My first question concerns your view of technology and its role in musical composition. You once said that the composer teaches the computer to understand and speak, "what the computer says show the composer what he himself has understood and could express." Could the computer thus be understood as an Erkenntniswerkzeug*?*

If one could understand the computer has an *Erkenntniswerkzeug*? Certainly, but of course that doesn't mean, that the referred to insights could not also be gained without the computer. However, the computer forces the composer to not only think about questions and find answers, but also to formulate them algorithmically and thereby to generalize. By the way, 'understanding' and 'expressing' are not always necessary, since the composer applies his 'knowledge', which is partly conscious and unconscious to him, Übrigens sind „Verständnis" und „Aussprechen" nicht stets notwendig, denn der Komponist wendet sein „Wissen", das ihm teils bewusst, teils unbewusst ist, laufend an, ohne über es zu reflektieren. Ich wollte nicht den Eindruck erwecken, dass dem Komponisten ohne Computer gewisse Erkenntnisse verborgen geblieben wären; mir fiel nur auf, dass man beim Abfassen eines komponierenden Algorithmus überhaupt in unerwartete Fragestellungen gerät, die leicht über die vorliegende Aufgabe hinausreichen und damit den eigenen Horizont ganz allgemein erweitern.

Der Serialismus wird ja oft dem „Hoch-Modernismus" zugeordnet. Ein typischer Vorwurf der ihm auch gemacht wird ist, dass er nach „Reinheit" strebt und hermetische geschlossene Systeme hervorbringt, die mehr Wert auf einen autonomen Herstellungsprozess als auf das klangliche Resultat legen. Ich denke jedoch, dass die formale Strenge von PR2 und SSP, nicht als Streben nach „Reinheit" zu verstehen sind, sondern eher dazu dienen einen inneren Zusammenhalt dort zu gewährleisten, wo bekannte Regeln und Zusammenhänge nicht mehr unbedingt gelten. Wie siehst Du diesen „Reinheitsvorwurf"?

Über die Frage des geschlossenen Systems bzw. des autonomen Herstellungsprozesses habe ich oft nachgedacht und denke manchmal, er betrifft eher Vermutungen als sorgfältige Analysen.

permanently without deliberating it. I didn't want to create the impression that some insights would remain concealed without the computer, I have only noticed that the formulation of a composing algorithm brings about unexpected questions, which can easily exceed the present task and thereby expand one's horizon quite generally.

Serialism is often associated with 'high modernism'. It is typically accused of striving for 'purity' and creating hermetically closed systems, which attach more importance to an autonomous production process than to the sound result. However, I think that the formal strictness of PR2 and SSP is not to be understood as a striving for 'purity', but rather serves to guarantee inner cohesion where known rules and relationships are not necessarily applicable. How do you see this 'purity accusation'?

I have often thought about the question of closed systems and of autonomous production processes and sometimes I think it rather concerns speculations than thorough analyses. Theoreticians who, for example, analyze works by Stockhausen often encounter deviations from seeming rules, which they expect (hope?) to find applied mechanically. I think – based on many conversations with composers, especially while collaborating with them in the electronic studio – that the work with rows and with 'parameters' and their forms of organization in general, Theoretiker, die etwa die Werke Stockhausens analysieren, stoßen häufig auf Abweichungen von scheinbaren Regeln, die sie maschinenartig angewandt zu finden erwarten (erhoffen?). Ich denke - auf Grund von vielen Gesprächen mit Komponisten, vor allem während der Zusammenarbeit im elektronischen Studio - dass die Arbeit mit Reihen und überhaupt mit ,,Parametern" und ihren Organisationsformen eher als geistige Disziplin verstanden werden sollte denn als Hermetik oder Reinheit. Ehe der Komponist Beziehungen zwischen klanglichen Ereignissen herstellt, muss er sich über ihre Eigenschaften, ihre Variabilität im Klaren sein. Vorgegebene Ordnungen wie tonale Harmonik oder einen Formenkanon gab es zur Zeit der Serialisten nicht mehr, jedenfalls wurden sie nicht mehr als zeitgemäß erfahren. Der Serialismus erlaubt, ein Beziehungsnetz zu entwerfen, in dem der Komponist - je nach erfinderischer Virtuosität - sich mehr oder weniger frei bewegen kann.

Eine damit zusammenhängende Frage betrifft die Beschreibung, bzw. die Antizipation des Ergebnisses. Das Bild vom guten Komponisten, der sich einen Klang vorstellen kann und ihn dann erfolgreich umzusetzen weiß ist nach wie vor gängig. In deiner Arbeit scheint das Ergebnis dem Prozess nicht vorauszugehen, somit werden die Mittel auch nicht nur zweckmäßig eingesetzt. Wie siehst Du dieses Verhältnis von Ergebnis und Herstellungsprozess?

should rather be understood as an intellectual discipline than as something hermetic or purity. Before the composer creates relations between sound events, he has to be aware of their properties and variability. Given systems such as tonal harmony or the canon of forms didn't exist anymore during the time of the serialists, at least they were not experienced as contemporary. Serialism allows creating a network of relations within which the composer – depending on his inventive virtuosity – can move more or less freely.

A connected question concerns the description or the anticipation of the result. The image of the good composer as one who can imagine a sound and know how to realize it successfully is still very common. In your work, the result does not seem to precede the process, in this way the means are not only used for utilitarian reasons. How do you see this relationship of result and process of production?

The relationship of result and production process is ambiguous. As well as one can deduce the production process from the result, it is conceivable to start from the process (which as such starts from the experience of 'results', i.e. the performance of one's own or other people's works) and to accept the result as a logical consequence of a logical process. In my own work, I don't distinguish between the two. If I envisage a result, I invent a process and if a process is fascinating me it only does so because it promises certain results.

Das Verhältnis von Ergebnis zu Herstellungsprozess ist zwieschlächtig. Ebenso, wie man vom Ergebnis den Herstellungsprozess ableiten kann, ist es denkbar, vom Prozess auszugehen (der ja als solcher wohl von der Erfahrung von ,,Ergebnissen" – also der Aufführung eigener oder fremder Werke – ausgeht) und das Ergebnis als logische Folge eines logischen Prozesses hinzunehmen. In meiner eigenen Arbeit mache ich zwischen beiden keinen Unterschied. Wenn mir ein Ergebnis vor Augen steht, erfinde ich einen Prozess, und wenn mich ein Prozess fasziniert, tut er das nur deshalb, weil er bestimmte Ergebnisse verspricht. Allerdings kann ich den Fall nicht ausschließen, dass man sich derartig in einen Prozess vertieft, dass das Ergebnis - obwohl man es während der Ausarbeitung des Prozesses ja ständig im Auge hat - an Bedeutung einbüßt. Schließlich ist der Komponist ein Erfinder (nicht nur ein Hersteller) und somit Experimentator.

Ich denke es gibt zwei Tendenzen, die heutzutage in der algorithmischen Komposition vorherrschend sind, zum einen die Berechnung von Stilkopien und zum anderen die Übertragung von Daten oder Prozessen aus den Naturwissenschaften. Dein Ansatz scheint mit keinem der beiden Tendenzen viel gemeinsam zu haben. Könnte man sagen, dass Du weder in bestehender Musik verbleibst (Stilkopien), noch ,,von außen" die Musik zu erweitern suchst (z.B. von den Naturwissenschaften aus),

However, I cannot exclude the case that one delves into a process to an extend which lets the result lose some importance, although one is constantly concerned with it during the elaboration. After all the composer is an invented (not only a producer) and thus an experimenter.

I think there are two predominant tendencies in algorithmic composition today. On the one hand there is the calculation of style replications and on the other there is the transference of data or processes from the natural sciences. Your approach doesn't seem to have much in common with either of them. Is it possible to say that you are neither remaining within existing music (style replications), nor seeking to expand music 'from outside' (e.g. starting from the natural sciences), but seeking to leave or expand music from within?

The observation of two contemporary tendencies (style replications and reference to the natural sciences) is very right. My starting point was music, as I came upon it after the war with Webern and Varèse as the most important role models. Through Schönberg/Stockhausen I came in contact with the serial theory. It gave me the possibility of a definable construction of coherent relations that could be planned. I would not call it 'leaving' but rather 'expanding'. although I could not say in which way it was expanded. Maybe it was rather a 'building on' and a 'pushing further' of how it once was.

sondern sozusagen die Musik von innen zu verlassen oder zu erweitern suchst?

Die Beobachtung zu zwei heutigen Tendenzen (Stilkopie und Anlehnung an Naturwissenschaften) ist sehr richtig. Mein Ansatzpunkt war die Musik, wie ich sie nach dem Kriege vorfand, mit Webern und Varèse als den wichtigsten Vorbildern. Über Schönberg/Stockhausen kam ich mit der seriellen Theorie in Berührung. Sie hat mir die Möglichkeit einer planbaren und definierbaren Zusammenhangsbildung geboten. Ein ,,Verlassen" würde ich das nicht nennen, eher ein ,,Erweitern", obwohl ich nicht angeben könnte, was auf welche Weise erweitert wurde. Vielleicht war es eher ein ,,Anknüpfen an" und ,,Weitertreiben von" Musik, wie sie einmal war.
Vielleicht war es eher ein ,,Anknüpfen an" und ,,Weitertreiben von" Musik, wie sie einmal war.

Du hast mal davon gesprochen, dass ein Kompositionsprogramm immer auch ein Kompositionsmodell ist. Könnte man sagen das ein Kompositionsprogramm hilft dem Komponisten das Modell, also die Begrenzungen, in dem er sich befindet bewusst zu machen und aktiv zu gestalten? Findet Komposition immer innerhalb von Modellen statt?

Deine Frage, ob ein Kompositionsprogramm dem Komponisten hilft, dessen Begrenzungen aktiv zu gestalten, ist sehr berechtigt.

You once said that a composition program is always also a model of composition. Is it possible to say that a composition program helps the composer to render conscious the model – the limits in which he is situated – and then to actively design them? Is composition always taking place within models?

Your question, whether a composition program helps composers to actively design its limits, is very valid. Otto Laske, who worked a lot with the program [Project 1], especially emphasized that quality. I would affirm the question whether composition always takes place within models only with hesitation. Nevertheless, I think that music always deals with music and that it thus becomes its own model or example. Then again, musical progress is caused especially by crossing borders, the model is being expanded, distorted, or even negated.
I myself have never experienced Project 1 as a model, except during its design, but rather as a generator with which a canvas and at the same time a material is being created, with which one can, so to say, 'embroider' it.

I would be interested in the role that generality plays for you, generality in two different meanings. On the one hand I ask myself how general PR2 has been for you, not only with respect to PR1 and your previous compositional praxis, but as a generalization of (serial) music itself. The second question on the other hand concerns the 'generality' of the output.

Otto Laske, der viel mit dem Programm gearbeitet hat, hat gerade diese Eigenschaft besonders hervorgehoben. Die Frage, ob Komposition immer innerhalb von Modellen stattfände, würde ich nur mit Zögern bejahen. Ich denke allerdings, dass Musik immer von Musik handelt und damit zu ihrem eigenen Modell oder Vorbild wird. Andererseits wird musikalischer Fortschritt gerade durch Grenzüberschreitung bewirkt, das Modell also erweitert, verzerrt oder gar negiert.
Selber habe ich Projekt 1 – außer bei seinem Entwurf – aber nie als Modell erfahren, eher als Generator, mit dem ein Stramin und zugleich ein Material erzeugt wird, mit dem man diesen sozusagen ,,besticken" kann.

Mich würde interessieren welche Rolle Allgemeinheit für dich spielt, Allgemeinheit in zwei verschiedenen Bedeutungen. Zum einen frage ich mich wie allgemein PR2 für dich war, nicht nur im Bezug auf PR1 und deine vorherige kompositorische Praxis, sondern als Verallgemeinerung (serieller) Musik an sich. Die zweite Frage betrifft die ,,Allgemeinheit" des Outputs. Es scheint mir so, als ob der hohe Grad an Abstraktion manchmal einen sehr allgemeinen Output zur Folge hat. Ich denke da z.B. an ,,Übung für Klavier", obwohl das Stück aus einer Vielzahl von Situationen besteht, scheinen mir diese dennoch sehr ,,generell" in ihrer Erscheinung.

Erstens: Programme wie Projekt 1 und Projekt 2 stellen natürlich Verallgemeinerungen von Kompositionsprinzipen (oder -regeln)

It seems to me as though the high degree of abstraction sometimes entails a very general output. I am thinking, for example, about Übung für Klavier*, although the piece consists of a variety of situations, they seem to me rather 'general' in their appearance.*

Firstly: Programs such as Project 1 and Project 2 of course represent generalizations of compositional principles (or rules), but are supposed to grant the composer the freedom for individual design. PR2 was not even intended to be a generalization of PR1 (and it isn't one), but as a generator of different PR1-systems (which it ultimately didn't become). I see PR2 rather as an extension of PR1 than as its generalization. The cause of the design of PR1 was the question what a composer 'knows' about music and whether/how he uses his knowledge while working. What remains open is whether he is conscious of the program as a given model or whether he creates his own models with the help of the program.
Secondly: the output is the goal of programming and thus necessarily as general as the program. For more individual (less general) purposes the program has to be controlled through the choice of corresponding input material or choice of a mode of interpretation, during the elaboration of the score, which conforms to the goal. While working with PR1 and PR2, I have always pursued the goal to test the programs (thus also to put their degree of generality to the test).

dar, sollen aber dem Komponisten die Freiheit zur individuellen Gestaltung einräumen. PR2 war nicht einmal als Verallgemeinerung von PR1 gedacht (was es ja auch nicht ist), sondern als Generator für unterschiedliche PR1-Systeme (was es schließlich nicht geworden ist). Ich sehe in PR2 eher eine Erweiterung von PR1 als dessen Verallgemeinerung. Anlass zum Entwurf von PR1 war die Frage, was ein Komponist über Musik "weiß" und ob/wie er sein Wissen bei der Arbeit planend einsetzt. Dabei bleibt offen, ob er sich des Programms als eines gegebenen Modells bewusst ist oder mit Hilfe des Programms eigene Modelle schafft.
Zweitens: der Output ist das Ziel des Programms und daher notwendigerweise so allgemein wie das Programm. Für individuellere (weniger allgemeine) Zwecke muss man das Programm durch Wahl des Eingabematerials entsprechend steuern bzw. bei der Ausarbeitung der Partitur einen dem Ziel entsprechenden Interpretationsmodus wählen. Ich habe bei der Arbeit mit PR1 und PR2 immer das Ziel verfolgt, die Programme zu testen (also auch ihren Allgemeinheitsgrad auf die Probe zu stellen). Das galt vor allem bei den ersten Versuchen, z.B. den Partituren zu ,,Projekt 1 - Version 1" und ,,Projekt 1 - Version 3". Ebenso galt es für den PR2-Erstling "Übung für Klavier". Bei späteren Kompositionen (etwa der Segmente-Reihe, dem zweiten Streichquartett oder dem Streichtrio) habe ich eher versucht, innerhalb und mit Hilfe

That applied specifically to the first experiments, for example the scores of *Projekt 1 - Version 1* and *Project 1 - Version 3*. It applies likewise to the PR2-firstling *Übung für Klavier*. With the later compositions (for example the *Segmente* series, the second string quartet or the string trio), I have rather tried to realize individual compositional concepts within and with the help of the program's generality.

In your writing and in your whole approach one can often find references to Adorno. I assume the title of your collected writings Ästhetische Praxis *refers to Adorno's* Ästhetische Theorie. *I would be interested in your relation to Adorno, how and in which way he has influenced you?*

It is true that the title *Ästhetische Praxis* refers to Adorno's *Ästhetische Theorie*. I've read his *Philosophie der Neuen Musik* and *Dialektik der Aufklärung* shortly after their publication and have since then read pretty much all he wrote. Later, I got to know him personally, corresponded with him and visited him in his office in Frankfurt. Once he offered to help me find a job. He influenced me philosophically, I inherited my philosophical interest from my father, who was a Schopenhauerian. I read Schopenhauer's collected writings on my train rides between Detmold, where I studied music, and Brunswick, where my parents lived.

der Allgemeinheit des Programms individuelle kompositorische Konzepte zu realisieren.

Es finden sich in deinen Schriften und in deinem ganzen Ansatz oft Bezüge zu Adorno. Ich nehme an der Titel deiner gesammelten Schriften ,,Ästhetische Praxis" bezieht sich auf Adornos ,,Ästhetische Theorie". Mich würde dein Verhältnis zu Adorno interessieren, wie und auf welche Weise hat er dich beeinflusst?

Es stimmt, dass der Titel ,,Ästhetische Praxis" sich auf Adornos ,,Ästhetische Theorie" bezieht. Seine ,,Philosophie der Neuen Musik" und ,,Dialektik der Aufklärung" habe ich kurz nach Erscheinen gekauft und gelesen und seitdem so ziemlich alles, was es von ihm gab. Später habe ich ihn persönlich kennen gelernt, mit ihm korrespondiert und ihn in seinem Frankfurter Büro besucht. Einmal hat er mir bei der Suche nach einem Job seine Hilfe angeboten. Er hat mich philosophisch beeinflusst; das philosophische Interesse hatte ich von meinem Vater geeerbt, der ein Schopenhauerianer war. Schopenhauers Gesamtwerk habe ich auf Eisenbahnfahrten zwischen Detmold, wo ich Musik studierte, und Braunschweig, wo meine Eltern wohnten, gelesen. Es gab für mich aber nicht nur Adorno, gelesen habe ich auch Horkheimer, Benjamin, Bloch, Kracauer und andere. Auch etwas Kant und etwas mehr Hegel. Aber: was meine musikalischen Ideen anbelangt, bin ich von Adorno weniger beeinflusst, weder von seinen

But I was not only interested in Adorno, I read Horkheimer, Benjamin, Bloch, Kracauer and others. Also some Kant and somewhat more Hegel. But concerning my musical ideas, I was less influenced by Adorno, neither by his works nor by his critique (of serial and electronic music), which is owed to a conservative understanding of music.

A topic which receives relatively little attention in your writings is the listening of music. How do see the relationship of the composition and the listening of music? And can one say that serial music was also a project to transform listening with the help of a certain distance to it?

It had to come: the listening of music. I can say little about that, since I assume that everybody listens differently. Although I listen to music, reading scores is practically equivalent to me. (I wished the listeners could read scores.) Obviously, I have listened to myself during the production of my electronic works, since there is a lot to hear. With instrumental music that is less evident, since it requires interpretative performance, which is often bungled.
The question whether serial music was supposed to (or could) transform listening sounds very much like Stockhausen, who would have liked to shape his listeners according to his music. There are listeners, who have no use for modern music (especially atonal, non-thematic music), while there are others, who do not care if there is only something sounding.

eigenen Werken noch von seiner Kritik (an serieller und elektronischer Musik), die sich wohl eher einem konservativen Musikverständnis verdankt.

Ein Thema, das in deinen Schriften relativ wenig Beachtung findet ist das Hören von Musik. Wie siehst Du das Verhältnis von Komposition und dem Hören von Musik? Und in wie fern kann man sagen, dass die serielle Musik auch ein Projekt ist mit Hilfe einer gewissen Distanz zum Hören das Hören selbst zu transformieren?

Es musste ja kommen: das Hören von Musik. Darüber kann ich wenig sagen, denn ich gehe davon aus, dass jedermann anders hört. Ich höre zwar Musik, aber das Partiturlesen ist mir praktisch äquivalent. (Ich wünschte, die Musikhörer könnten Noten lesen.) Offensichtlich habe ich aber mir selber bei der Produktion meiner elektronischen Werke zugehört, denn da gibt es eine Menge zu hören. Das ist bei instrumentaler weniger evident, weil sie der interpretierenden Aufführung bedarf, die gern danebengeht.
Die Frage, ob serielle Musik das Hören transformieren sollte (oder könnte), klingt sehr nach Stockhausen, der sich am liebsten seine Hörer (wie Karl Kraus seine Gegner nach seinem Pfeil zurecht geschnitzt) nach seiner Musik zurecht gestutzt hätte. Es gibt Hörer, die mit moderner Musik (atonaler, nichtthematischer vor allem) wenig oder nichts anfangen können, während es auch solche gibt, denen es ganz egal ist, Hauptsache es tönt.

Listeners also tend to let themselves get carried away by the enthusiasm with which the musicians handle their instruments. Music is ephemeral, it does not invite to linger. I am thinking about the visitors of museums, who are taking about the pictures. The audience is not talking about the music in the intermissions, about what they heard (or did not hear?). Sometimes I think, it would be easier for music if it had no listeners, especially in a time without listening conventions (like for example still in the time of Bach or Mozart).
I myself rather think about the musicians than about the listeners while composing (instrumental music). I compose for myself, composing is fun!

A central reference point for your music seems to me to be a historical line of tradition, which reaches from Beethoven over Mahler, Schönberg until Stockhausen. How do you see the continuation of this line, did it dissolve, change its form?

I do not quite agree with this line of tradition I would rather oppose the line Beethoven/Brahms/Schönberg with line Haydn/Schubert/Mahler. The early Stockhausen was committed to Webern (according to his own state of awareness) the late Wagner (even if he might not have realized that). But whichever lines of development one might think up, currently, they all seem to end in a state of perplexity.

Hörer lassen sich auch gern vom Enthusiasmus mitreißen, mit dem die Spieler ihre Instrumente bearbeiten. Musik ist flüchtig, lädt nicht zum Verweilen ein. Ich denke ans Museumspublikum, das über die Bilder redet. Das Publikum in Konzertpausen spricht nicht über Musik, über was sie gehört (oder nicht gehört?) haben. Manchmal denke ich, die Musik hätte es leichter ohne Hörer, vor allem in einer Zeit, die keine Hörkonventionen (wie etwa zur Zeit Bachs oder Mozarts noch) mehr kennt.
Selber denke ich beim Komponieren (von Instrumentalmusik) eher an die Spieler als an die Hörer. Ich komponiere um meiner selbst willen; Komponieren macht Spaß!

Zentraler Bezugspunkt in deiner Musik scheint mir eine historische Traditionslinie zu sein, die von Beethoven über Mahler, dann Schönberg bis zu Stockhausen reicht. Wo siehst Du die Weiterführung dieser Linie, hat sich diese aufgelöst, ihre Form geändert?

Der Traditionslinie stimme ich nicht ganz zu, eher würde ich Beethoven/Brahms/Schönberg einer Linie über Haydn/Schubert/Mahler gegenüberstellen. Der frühe Stockhausen war Webern (seiner eigenen Bewusstseinslage nach) verpflichtet, der später Wagner (auch wenn er das selbst nicht gemerkt haben sollte). Aber welche Entwicklungslinien man sich auch ausdenken mag: sie scheinen gegenwärtig im Zustand der Ratlosigkeit zu enden. Hat man früher gewitzelt,

One used to joke about serious music degenerating into serial music, today one can refer to electronic music becoming superficial sound art. Or another image: one used to listen to music in a tail-coat, now one downloads it.
But I do not want to be only pessimistic. Music is made by composers, only they decide how it will continue.

My last question concerns the idea of sound synthesis, especially non-standard sound synthesis. If non-standard sound synthesis is not based on the simulation or analysis of existing sounds, is it possible to say that compositional principles, as in SSP or SAWDUST, become principles of sound production? Moreover, it is interesting to note that the term is actual only referring to digital sound synthesis. It seems almost as if analog sound synthesis had anyhow been 'non-standard'. Is it possible to say that what emerges with digital sound synthesis is not 'non-standard', but 'standard' (since the realistic simulation of 'real' sounds was not possible in the analog studio)?

Instead of responding to the different subquestions, I want to say the following. If I am well-informed the term 'standard' refers to the reproduction of spectra of acoustic instruments and 'non-standard' refers to everything which does not have this goal, but is rather interested in processes which manifest themselves in form of sound.

die seriöse Musik wäre zur seriellen verkommen, könnte man heute auf die Verflachung der elektronischen Musik zur Klangkunst verweisen. Oder ein anderes Bild: Musik besuchte man früher im Frack, heute wird sie heruntergeladen.
Aber ich will nicht nur pessimistisch sein. Musik wird von Komponisten gemacht, nur sie werden entscheiden, wie es weitergeht.

Meine letze Frage betrifft die Idee der Klangsynthese, insbesondere die Non-Standard Klangsynthese. Wenn diese nicht auf der Simulation oder Analyse existierender Klänge basiert, können wir damit sagen, dass hier kompositorische Prinzipien, wie bei SSP oder SAWDUST, zu Klangherstellungsprinzipien werden? Darüber hinaus ist es interessant zu bemerken, dass der Begriff sich ja eigentlich nur auf digitale Klangsynthese bezieht. Es scheint fast so als wäre analoge Klangsynthese sowieso ,,non-standard" gewesen. Könnte man also sagen, dass was mit der digitalen Klangsynthese also erscheint ist nicht ,,non-standard", sondern ,,standard" (denn realistische Simulation von ,,realen" Klängen war ja im analogen Studio sowie nicht möglich)?

Statt auf die verschiedenen Subfragen einzugehen, möchte ich folgendes sagen. Wenn ich recht beraten bin, nennt man (im Computerbereich) ,,standard" die Nachbildung von Spektren der akustischen Spielinstrumente und ,,non-standard" alles, was diese nicht zum Ziel hat sondern sich vielmehr für Prozesse interessiert,

At the time of the *elektronische Musik* these terms did not exist, because there was no sound production using computers, by its nature was 'non-standard' – except for those cases in which instrumental sounds were supposed to be imitated in the electronic studio (Stockhausen, *Kontakte*, e.g.). With SSP, I wanted to try to apply compositional principles to sound synthesis with the intent to undertake an empirical mapping of algorithms and sound categories. Paul Berg – to mention another example – used to the so-called accumulator like a musical instrument in his ASP-program, by having all program instructions refer to it in oder to change its content: shift, ring-shift, add, multiply, complement and so on. Then there are borrowings from mathematics (fractals, genetic processes, thermodynamics etc). What matters in the end are not the processes, but their possibilities of relating the results to each other in the sense of musical form components. I do not regard processes of non-musical provenance as compositional principles, which "here become principles of sound production" (although they might be suited for sound production), but I find it more sensible to directly start from musical form principles. I hardly see any approaches like that. What is produced today with composers as electronic or electroacoustic music is (more or less) the digital imitation of analog sound models, I have hardly ever heard a computer sound which could not in principle have been produced in the analog studio die sich in Form von Klängen äußern. Zur Zeit der elektronischen Musik gab es diese Begriffe nicht, weil es keine Klangproduktion mit Computern gab; ihrer Natur nach war sie ,,non-standard" – abgesehen natürlich von Fällen, wo im analogen elektronischen Studio auch instrumentale Klänge imitiert werden sollten (Stockhausen, Kontakte, z.B.). Mit SSP wollte ich versuchen, kompositorische Prinzipien auf die Klangsynthese anzuwenden mit der Absicht, ein empirisches ,,mapping" von Algorithmen und Klangkategorien zu unternehmen. Paul Berg – um ein anderes Beispiel zu nennen – hat in seinem ASP-Programm den sog. accumulator wie ein Musikinstrument benutzt, indem sich alle Programmbefehle auf diesen bezogen, um seinen Inhalt zu verändern: shift, ring-shift, add, multiply, complement usw. Dann gibt es die mathematischen Anleihen (fractals, genetische Prozesse, Thermodynamik usw.). Worauf es letzten Endes ankommt, sind nicht die Prozesse sondern die Möglichkeit, ihre Resultate im Sinn musikalischer Formkomponenten aufeinander zu beziehen. Prozesse nicht-musikalischer Provenienz betrachte ich nicht als kompositorische Prinzipien, die "hier zu Klangherstellungsprinzipien werden" (obwohl sie sich zur Klangherstellung eignen mögen), sondern finde es sinnvoller, direkt an musikalische Formprinzipien anzuknüpfen. Dazu sehe ich jedoch kaum Ansätze. Was gegenwärtig mit Computern als elektronische oder elektroakustische Musik produziert wird,

(apart from sound movements in space or wave field synthesis, but these methods do not have to do with the production of sound, but with its reproduction over acoustic radiators).

ist (mehr oder weniger) die digitale Nachahmung analoger Klangvorbilder; ich habe kaum je einen Computerklang hört, der sich im Prinzip nicht auch im analogen Studio hätte herstellen lassen (von Klangbewegungen im Raum oder der Wellenfeldsynthese einmal abgesehen, aber bei diesen Verfahren geht es ja nicht um die Klangproduktion sondern deren Reproduktion über Schallabstrahler).

D. Contents of the CD

The accompanying data CD contains the described program PR2 and its source code, the source code of the SuperCollider unit generators, the scores of *K2* and *Description Without Place*, and this text as a pdf file.

Directory	**Content**
/pr2/bin	Contains the PR2 binary application for Mac OS X (Intel) and Microsoft Windows
/pr2/sources	Contains the source code of PR2
/sc-ugens	Contains the source code of the SuperCollider unit generators *PV_Stoch* and *Gepin*
/scores	Contains the scores of *K2* and *Description Without Place*
/thesis	Contains this document as a pdf file

Table .4: Contents of the CD