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Essays on Sound, Score and Notation

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Chapter Ten

Closing the Gap between Sound and Score in the Performance of Electroacoustic Music

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> Fundamentally, notation is a serviceable device for coping with imponderables. Precision is never the essence in creative work. Subliminal man (the real creative boss) gets along famously with material of such low definition, that any self-respecting computer would have to reject it as unprogrammable. Creative work defines itself. Therefore confront the work.[1] (Roberto Gerhard [quoted in Cage 1969, 240].)

This article discusses the problem of the score in the context of electroacoustic music performance. The question of notation and transmission of performance practices and the role of documentation in the maintenance of this repertoire (Bernardini and Vidolin 2005, IRCAM 2007, Penycook 2008), the dependence on ephemeral electronic devices and software (Burns 2001, Puckette 2001, Wetzel 2007), the representation and the performance of space (Bayle 1992, Wyatt 1999, Tutschku 2001, Vande Gorne 2002), or the high demands posed to the editor (Richard 1993, Brech 2007) are some important considerations in which the emergent field of electroacoustic music performance should be inscribed. Here I want to bring forward the role of the performer, addressing the "imperfect" nature of the electroacoustic music score as a salient feature in the context of historical and contemporary musical practices. Through a number of examples based on my experiences with the performance of works for tape, mixed, and live electronics, I will examine those important considerations by discussing different aspects of the score in electroacoustic music performance: lutherie as a score-reading practice, the performer's scores in the context of new compositions and historical works, the relation between performance and score edition, the score as mediator, the score and the

1 Cage 1969, [240]. The first three sentences are Roberto Gerhard's response to Cage's request for a text about notation; the last two sentences were probably added by Cage himself or by his co-editor, Alison Knowles.

performance of space, and the connections between score, analysis and listening. The interpretation of electroacoustic music will be presented as a skilled, creative, and decision-demanding activity, perhaps akin to the improvisational mannerisms of the Renaissance and Baroque (Kientzy 2003 [2009]). At the same time, wanting to meaningfully engage the dialogue initiated by the score, the performer will seek to read between the lines and to question the coherence of his interpretation.

I.

Playing the tape recorder in the dissociated time

In the 1950s, the direct manipulation of electronically generated sounds appeared to be a compelling answer to the conflict created by Webern's expanded twelve-tone-technique; the limits of the playable had been reached as a consequence of the rationalisation of all musical parameters (Eimert 1954, 43). Composers celebrated the opportunity to aspire to the "objective contemplation of proportions and balance," (Goeyvaerts 1955, 15) free of the "living parasitic sound" (Eimert 1955, 13) inherent in human performance. Instead of writing down the music as a score that had to be translated into sound by instrumental or vocal interpreters, a sound composition could be fashioned exactly in the form that it would reach the listener. However, the resistance posed by the electronic medium suggested a parallelism between the work in the studio and instrumental performance. For instance, the correspondence between Stockhausen and Goeyvaerts (Sabbe 1981, 49–50) reveals that in 1953, while the latter still believed in the exactitude of electronic generators as a means to achieve a pure translation of his compositional ideas, Stockhausen argued that the new medium was at least as conditioned by the instrumental and human circumstances of the electronic realisation as was a traditional performance with conventional instruments. The live act took place in the studio instead of the concert hall, a novelty that accentuated the role of the performing author.[2] (Eimert described "playing the tape recorder in the dissociated time" as "one of the most wonderful acts of musical production."[3]) In the scores of the sine-wave compositions produced at the WDR, conventional notation was replaced by sets of lines and polygons determining the acoustic properties of each of the constituent partials.[4] But in the end, it remained controversial whether the "instructions for the electro-acoustical realisation"[5] had the symbolic value of real musical writing and whether musicians could read those scores.

2 "In the same way the pianist plays the piano, so must the composer play the tape recorder" (Eimert 1955, 8). Author's translation.

3 "Magnetophonspielen in der dissoziierten Zeit ist einer der wunderbarsten musikalischen Produktionsakte" (Eimert 1955, 9). Author's translation.

4 The reader will remember this form of writing with reference to Karheinz Stockhausen's *Studie II* (1954), perhaps one of the most popular examples of a score for electronic music.

5 "Unlike the usual methods of notation, there is no score, but merely working instructions for the electro-acoustical realisation of the composition" (Eimert, Enkel, and Stockhausen 1954, 52).

Aural tradition

A new form of performance—the practice of sound diffusion[6]—emerged with the advent of *musique concrète*. One forward-looking example of notation conceived for the spatial projection of a composition fixed on tape is Pierre Henry's score for the *decoupage spatial* (spatial decoration) of Olivier Messiaen's *Timbres—Dureés* from 1952.[7] The pioneer practitioners of *musique concrète* referred to two techniques for the presentation of spatial music already recognisable in Henry's score: (a) *relief statique* (static relief), the distribution of sounds over different loudspeaker channels,[8] resembling the spatial extension of the orchestra; or (b) *relief cinématique* (kinematic relief), the instantaneous movements of sound around the audience, shaped by the *chef d'orchestre spatial* waving his arms at the *pupitre d'espace* (Moles 1960, 127–129). The word "acousmatic"—used by Pierre Schaeffer to refer to a deliberate choice of pure listening—was later adopted by François Bayle to designate a genre that is first composed in the studio and later diffused in a public performance with an orchestra of loudspeakers.[9] Worthy of attention—in terms of the correspondence between sound and score—is that in acousmatic music the act of listening is at the foreground of all musical activity. The listening experience guides the composer in the creative processes in the studio[10] and also mediates between the fixed work and the sound projection,[11] where the resources[12] and musical interpretation come into play. The "technique of making an awareness that is established simply and solely from facts of both an intuitive and creative perception,"[13] (Bayle 2008, 242) is the point of departure for a practice in which the score is not a necessary condition at any of its stages of production.

II.

The dilemma of obsolescence

Live-electronic music became a major sphere of activity during the 1960s.[14] Composers incorporated into their scores parts for new electronic devices such as filters and ring modulators (two of the most popular early means of sound processing). In *Musik und Graphik* (1959 [1963]), reviewing the different

6 The words "diffusion," "projection," and "spatialisation" are considered equivalent in this text. See Wyatt (1999) for a discussion of the use of these terms.

7 See Messiaen (2004). The first page of this score is reproduced on p. 15 of the INA/GRM CD-booklet.

8 The sounds were separated by means of filtering specified registers or using a multi-track tape (Moles 1960, 126).

9 See, e.g., Emmerson (2007, Chap. 6), for an introduction to different approaches to multi-loudspeaker sound diffusion.

10 "What he makes and his gestures are induced by the effect of aural perception, the spontaneous understanding of his workings by trial-and-error" (Bayle 2008, 242).

11 For Bayle, the idea of projection also plays a critical role in a wider sense. Acousmatic music is a "music that can only be understood in the form of sound images and that can only be experienced arising out their projection" (Bayle 2007, 181).

12 According to Bayle, the performer's resources are: the arrangement of the sound projectors, the pecularities of the concert location (width, depth, height, resonance, colour), characteristics of the projection instrument (sources, channels, controls), the external conditions (atmosphere of the hall, style of performance), etc. (Bayle 1992, 17).

13 This is the meaning of the term *akousma* (Bayle 2008, 242).

14 See Manning (1993, Chapter 8), for a standard introduction to this genre.

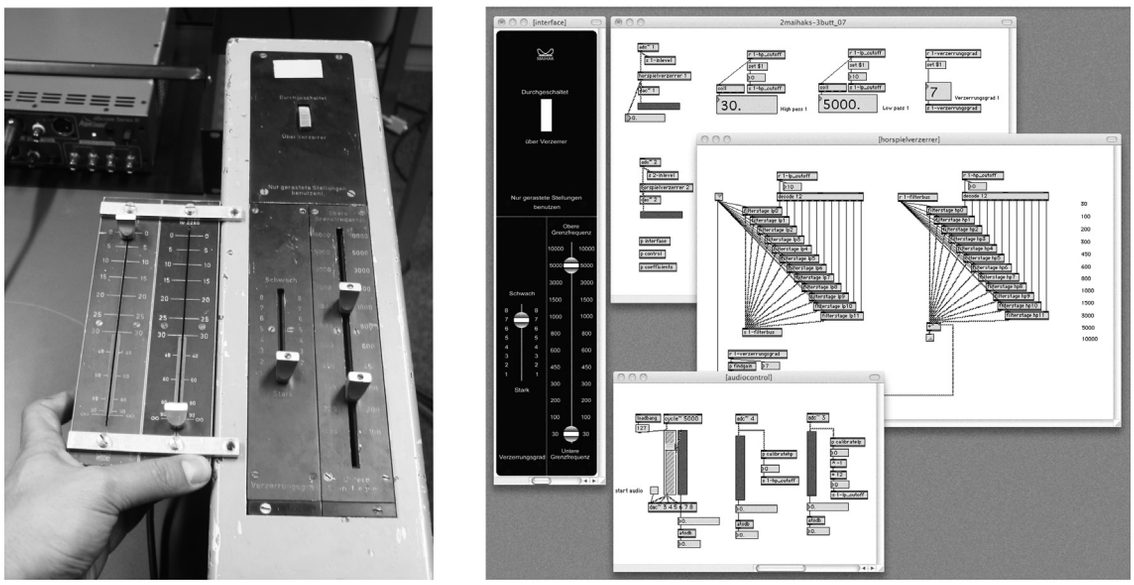

Fig. 1

categories of musical writing,[15] Stockhausen refers to the changes introduced in the notation of electronic music during this period. He writes:

> In the notation of electronic music a connection ultimately appears between numerical data and action notation, i. e., the way the electronic devices should be operated. Not only measurable quantities but also qualitative concepts are conveyed. While in the beginning it was believed that the acoustical properties of every sound could (and should) be exactly described, now we have switched over to characterize the instrument, prescribe the range of actions, and design a schematic illustration according to which the actions should be performed. (Stockhausen 1959 [1963], 181)[16]

Scores like *Mikrophonie I, No. 15* (1964), for six players with tam-tam, two microphones, and two filters with potentiometers, or *Mixtur, No. 16* (1964), for orchestra, four sine-wave generators, and four ring modulators, are examples of this trend. Those scores provide an extended foreword describing the instruments and electronic devices being used and their playing techniques. They also establish an equality between traditional instruments and electronic devices by adding staves that guide the operators' actions during the performance. However, embracing technology also contributed to a subtle reconfiguration of contemporary score-related practices. Analyzing the role of the editor in the maintenance of this repertoire, Marta Brech (2007, 484–5) emphasises that the tendency of composers and engineers to use the latest machinery and develop prototypes and, more recently, the dependence of software on computer architectures and operative systems are problems that often surpass available skills and resources. In practice, the limited accessibility and ephemeral life of the original instruments have encouraged interpreters engaged in the present-day performance of such works to address this question as an integral part of the score-reading process.

15 Schematic and formulaic writing, ideographic notation, action notation, listening scores, scores for imagining, scores for performing, etc. (Stockhausen 1959 [1963]).

16 Translation by the author.

Figure 1. Maihak W49 "Hörspielverzerrer" (left), computer simulation in Max/MSP (*right*).

In connection with the musical examples cited above, I relate two hands-on experiences that explore the dynamics of this interaction:

a. The W49 "Hörspielverzerrer", [Fig. 1] [17] a filter designed by the Maihak company for the Nordwestdeutsche Rundfunk, was first used by Stockhausen in *Mikrophonie I*. Since only a few hundred units were produced in the 1950s, these sought-after filters are hard to get hold of nowadays. However, with the indications provided by the score, a computer-literate musician approaching the performance of this work would today consider devising a "patch" to produce an equivalent effect in a DSP-programming environment[18] such as Pure Data[19] or Max/MSP.[20] Sensitive to historically informed performances, the enterprising performer might even study the possibility of devising an interface that recreates the haptic impression of the original "stepped" faders.[21] But how faithful does the simulation of the original filter need to be? What about the clarification in the score, reading "example of the division in Hz of the 'W49' filter used *so far*" (Stockhausen 1974a, 14; author's italics)—does this not suggest the possibility or even an invitation to experiment with a different set of cut-off frequencies? Many would nowadays consider the use of W49 Maihak filters to be the genuine approach. However, might the implementation of a "click-free filter" (Stockhausen 1974a, 10) have been an improvement to the ears of the composer? Or, rather, are the audible artefacts that occur when sweeping through the frequency grid of a W49 an inherent part of the music? I invite the reader to consider his/her own answers before continuing to the next paragraph.

b. My second example deals with the live-electronic apparatus of *Mixtur 2003, No. 16 2/3* (2003), for five instrumental groups, four sine-wave generator players, four sound mixers with four ring modulators, and sound projectionist. In the score of this composition, the four parts for the sine-wave-generator players are notated as frequency envelopes supplemented with values in Hz as well as pitches approximated to a chromatic scale (Stockhausen 2007a, VII), spanning over a range of thirteen (!) octaves, from C-5 to C8, or 0.5 and 4186 Hz, respectively. For the performances which I am discussing,[22] access to the historical instruments would have been entirely feasible,[23] but the experience gained during the preparatory stages led to questions about the suitability of the original setup. During testing by the author, the tuning possibilities of the available sine-wave generators did not seem to accord with the scale of detail and tuning range asked for in the score. After discussing this with

17 All illustrations are by the author unless otherwise stated.

18 Perhaps using convolution or approximating the coefficients of the digital filter equivalent to the analogue circuit.

19 http://www.puredata.org.

20 http://www.cycling74.com.

21 Those who have had the opportunity to handle a Maihak W49 will have no reservations about the influence that the mechanics of this device have on the form by which the filter gestures can be articulated.

22 Performances with the setup described here took place in Salzburg and Munich: Salzburger Festspiele, 30 August 2006, Lehrbauhof Salzburg (Wolfgang Lischke / Deutsches Symphonie Orchester / André Richard / Experimentalstudio of the SWR); Musica-Viva-Festival, 25 January 2008, Herkulessaal Munich (Lucas Vis / Symphonieorchester des Bayerischen Rundfunks / André Richard / Experimentalstudio of the SWR).

23 The project was under the auspices of the Experimentalstudio of the SWR, an institution that would certainly have been able to provide a set of analogue sine-wave generators and ring-modulators.

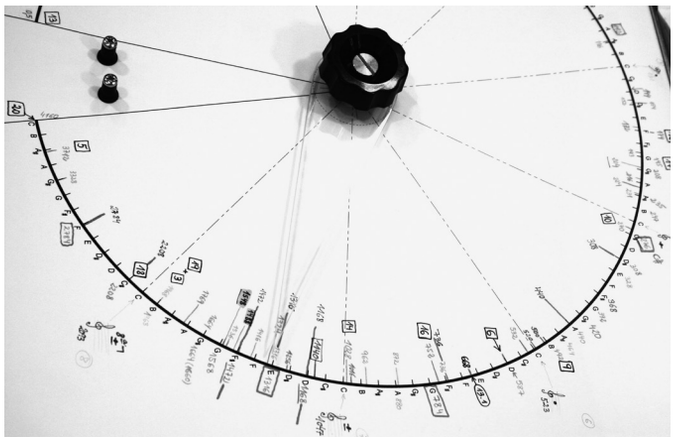

Fig. 2

Stockhausen, a new controller was developed[24] that was optimised for the performance of the intonation curves and that would overcome the imprecision and gestural limitations of the original setup while preserving the expressiveness of the analogue implementation.[25] [Fig. 2]

In proposing two contrasting case studies and formulating such questions I wanted to convey the notion that there may be a range of alternatives deserving consideration. Finding solutions through trying to imagine the sound realisation of the aforementioned scores is also taking musical decisions.

The performer's score

In studying performance itself, the significance of performers' annotations has probably been underestimated. In particular, performances of the music discussed here commonly result in large assortments of notes, sketches, and schematic diagrams that end up incorporated into the performers' scores or into other forms of supplementary documentation. To consider the issue of the performer's writing is to bring to light the details of a musical practice. It is convenient to examine two different poles of this practice: the first staging of a new composition, and the contemporary performance of a classical work.

A new composition is being readied for its premiere—the scenario in which the intention first meets the real. Instrumental sources and electronic transformations, coupled to an array of loudspeakers and microphones, converge for the first time in an acoustic space—an unstable environment sensitive to the smallest changes in the aggregate system. A number of variables in the interaction of instruments and electronics—e. g., playing techniques, the positions of the transducers, or the technological parameters—will need to be adjusted during the rehearsals. As a result of this process, the sound director (*Klangregissseur*)[26]

24 In addition to the author, Joachim Haas, Stefan Huber, and Thomas Hummel were contributors to this project.

25 See also the foreword to *Mixtur 2003, No.16 2/3* (Stockhausen 2007a).

26 *Klangregie* (sound direction) is the usual way to characterise the activity of performing a work with electronics in the German language. Other terms, like "sound projectionist" or *sonista* (Kientzy 2003 [2009]), describe similar roles in other languages. In addition, diverse names are given to the musicianship exercised in the production facilities of the institutional studios, like *Musikinformatiker* (Experimentalstudio of the SWR), and *realisateur en informatique musicale* or "computer music designer" (IRCAM). Depending on the practice at a given studio both functions may be either the responsibility of a single person or undertaken by specialists in each domain.

Figure 2. Detail of the "Zeigerrad," a novel controller developed for the performance of Karlheinz Stockhausen's *Mixtur 2003, No. 16 2/3* (2003). Diameter = 36 cm.

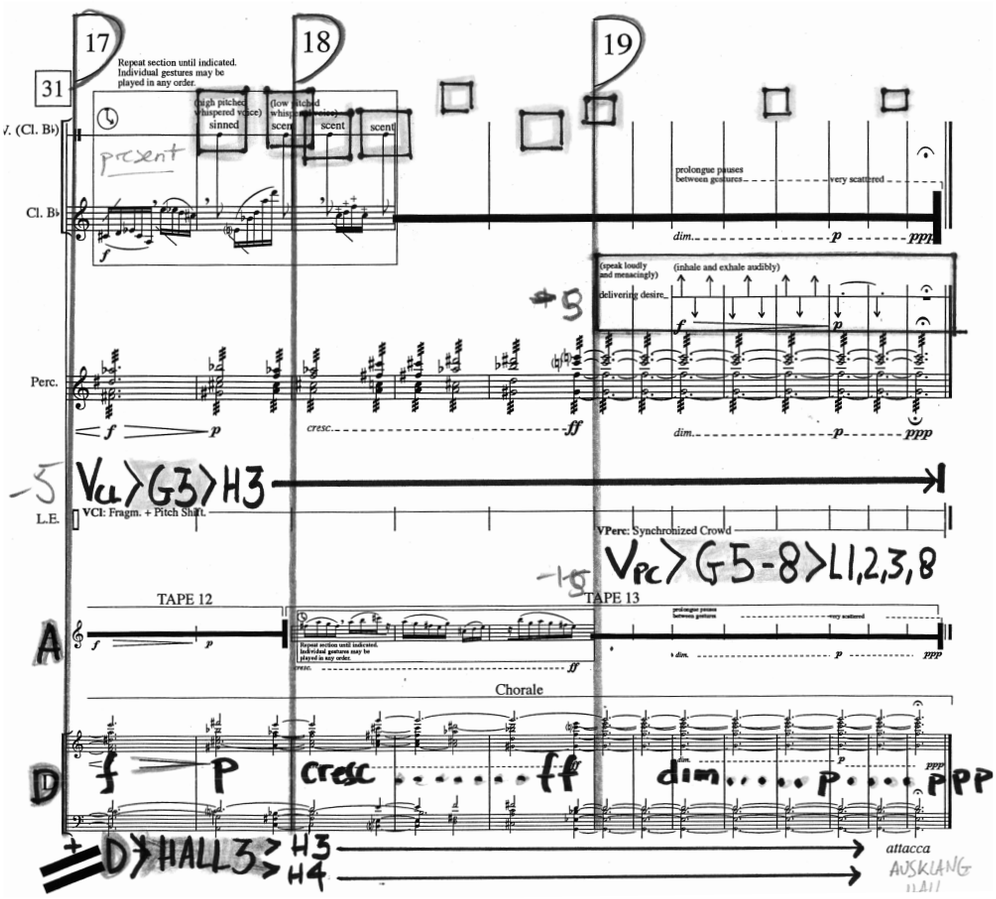

Fig.3

empirically acquires the set of actions that will require attention in the course of the performance. After the concert, his/her score will contain the annotations taken down during the rehearsals, as well as those corresponding to a previous step, the preparation of the score; and together these connect the preexisting notation with the set of actions necessary when playing the piece.[27]

I will take an excerpt from Jimmy Lopez's *Íncubus III* (2009), for clarinet, percussion, and live electronics, as an example.[Fig. 3] In the printed score, the live-electronic part ("L.E.") is indicated by the composer using descriptive keywords (in the illustration we see "VCl: Fragm. + Pitch Shift" and "Vperc: Synchronized Crowd"). Below this part, up to four prerecorded layers are written out on dedicated staves using traditional notation (only layers "A" and "D" are active in this excerpt). The handwritten notes in figure 3, taken down by the sound director, complete the information and provide further understanding of the real-time processes carried out by the computers as well as the spatial behaviour of these processes. In this example, we can see that the voice part of the clarinet player ("VCL") is subject to granular processing ("G3") and the resulting sound particles are subsequently assigned a movement in space ("H3"); simultaneously the voice part of the percussionist is multiplied using a

27 On occasions the composer may decide to ask the sound director to include those annotations in the score, but this is frequently hindered by time constraints if the score is edited before the first performance.

Figure 3. Jimmy Lopez's *Íncubus III* (2009). Filarmonika LLC. A detail of the performer's score with annotations for the live electronics (p. 9).

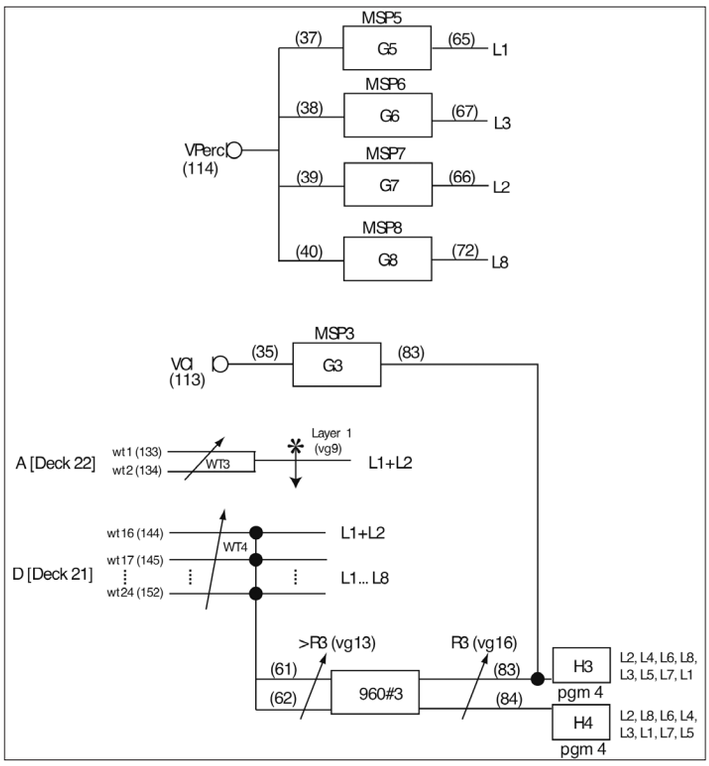

Fig. 4

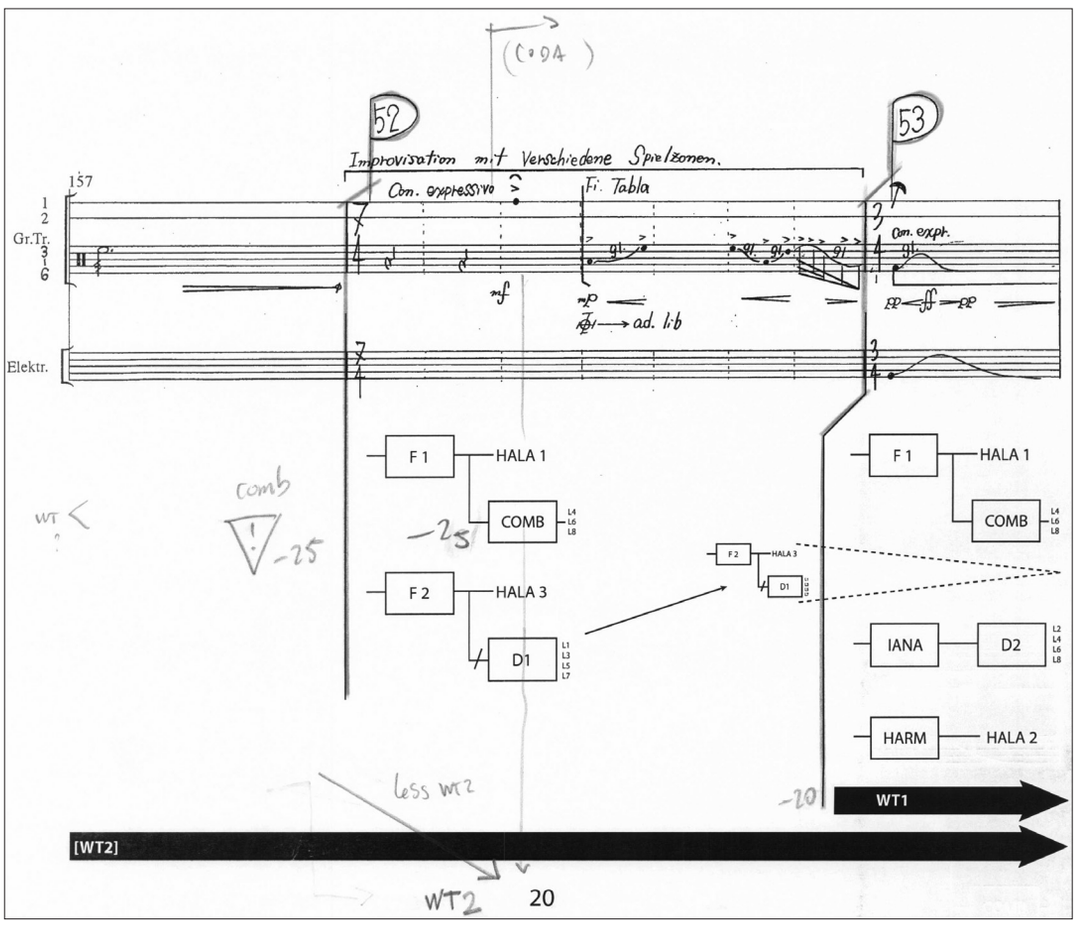

Fig. 5

Figure 4. *Íncubus III*. Sound processing circuit corresponding to cue 19.

Figure 5. Malika Kishino's *Lebensfunke II* (2007/09). Edizioni Suvini Zerboni. A detail of the performer's score assembly (p. 20).

four-voice shuffling algorithm ("G5 – 8") statically assigned to four loudspeakers ("L1, 2, 3, 8"). The sine wave *chorale* ("D")—an eight-channel recording whose dynamic profile is to be shaped live (*f*, *p*, *cresc.*, *ff*, *dim.*, *p*, *ppp*)—is additionally routed to a stereo reverberation ("HALL"), the outputs from which are sent to two independent spatialisation processes ("H3" and "H4"). All the abbreviations cited are simply part of a convention that I established to refer to the faders and knobs that constitute the tactile interface for sound production during the performance. Cues "17", "18" and "19" designate three different sound processing circuits stored in the memory of the computer, of which I kept a detailed record in a separate booklet. [Fig. 4]

In Malika Kishino's *Lebensfunke II* (2007/09), for bass drum and live electronics, we have a variant of the solution presented in the previous example. Initially, the score provided by the composer—based on *Lebensfunke* (2007), a previous version of the work, for bass drum and tape—had two handwritten staves: one notating the part for the bass drum ("Gr[oße] Tr[ommel]"), and a second representing the electronics ("Elektr[onik]"). In realising the new version of the work, which contains a complex live-electronic part,[28] I fabricated a collage combining Kishino's score with a schematic representation of the sound transformation circuits [Fig. 5] to be able to keep track of the thirty-four faders[29] that needed to be controlled during the performance. Unlike *Íncubus III*, where the signal-flow diagrams [Fig. 4] consist of a separate booklet, in *Lebensfunke II* [Fig. 5] I incorporated those diagrams directly on the composer's score in a simplified form that would facilitate more immediate recognition of the mixing structures that are active in each cue.

Moving away from the performance of new works, at the other extreme we have the contemporary performance of a classical work. In order to gain insights into the stylistic and technical aspects of the composition, the interpreter wishing to produce a historically informed performance would seek to compare the edited score with manuscripts and vintage recordings. As suggested by the previous examples, scores that contain annotations by the operator of the antique instruments (as well as connection diagrams, installation plans, and other peripheral documentation corresponding to previous concerts) can be invaluable references. But different sources might also supply competing sets of instructions. For instance, the available materials of Cristóbal Halffter's *Planto por las víctimas de la violencia* (1971), for ensemble and live electronics, reveal that the electronic part has been subject to a number of adjustments in subsequent presentations of the work.[30] The same situation happens with *Variaciones sobre la resonancia de un grito* (1976–77), for eleven instrumentalists,

28 A refined fabric of rapidly changing sound processing modules combined with pre-recorded multichannel files that are projected through eleven loudspeakers installed in two different heights surrounding the audience.

29 The faders correspond to the inputs and outputs of the sound transformation circuits. Not included in this total are the loudspeaker master faders and the three additional faders that are used for the amplification of the bass drum, all of which also need to be adjusted during the performance.

30 For instance, technical documentation corresponding to an undated performance with six loudspeakers—instead of the eight asked for in the score—depicts a quite different organisation of the spatial movements, and the filter bank is omitted (García-Karman 2006, 24).

tape, and live electronics [Fig. 6], a further composition by Halffter in which the published score and the historical realisations of the work diverge in some fundamental aspects, specifically regarding the spatialisation of the instruments.[31] In my experience, such discrepancies—whether following from musical criteria or ascribed to the flexibility or limitations of technology—are common in a broad range of works with live electronics.

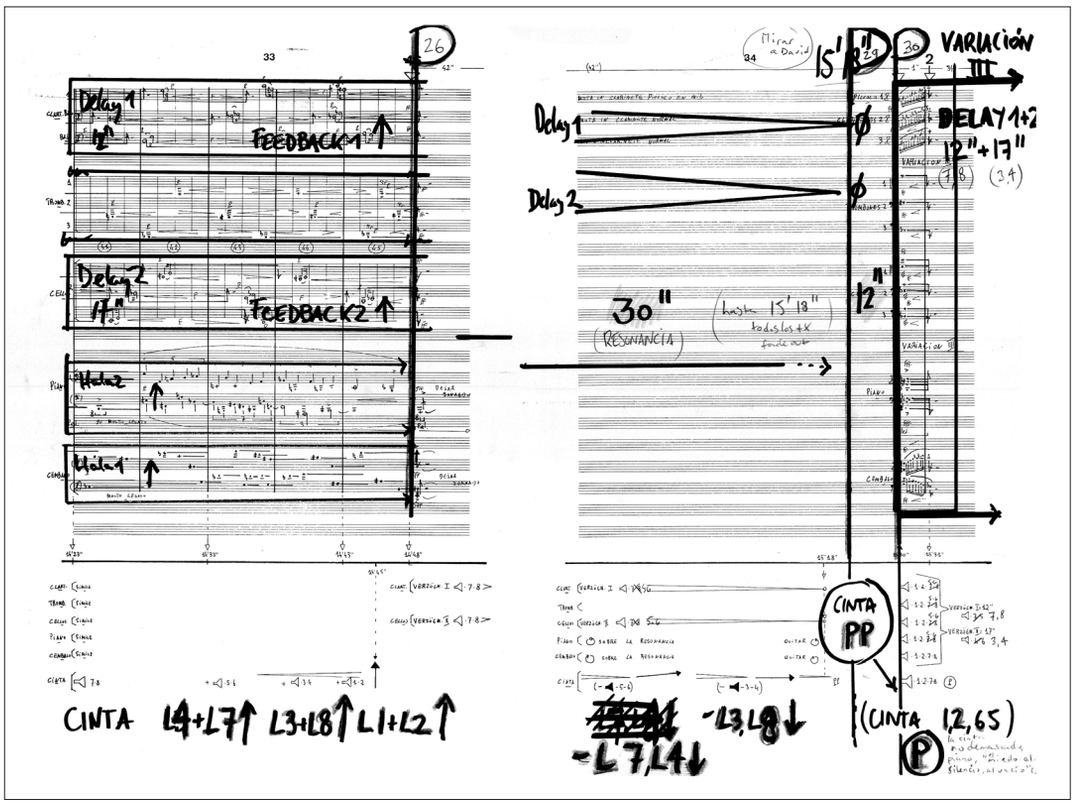

Fig.6

The perfomer as editor

Intricate too is the situation regarding the scores of Luigi Nono. Nono himself treated the tape as an instrument, stressing that his actions at the console "depend on the performance space, depend on the instant" (Riede 1986, 18), and his live-electronic executions have been described as driven by "a certain freedom in altering the planned effects at each performance" (Rizzardi 1999, 52).[32] Moreover, Nono is said to have elaborated the details of

31 In Halffter (1976–77) the amplification of the instruments is extensively subjected to spatial treatment, but the documentation available suggests that this was omitted in the historical performances.

32 Such is the intention reflected in Nono's words, chosen as the foreword to the score of *Post-prae-ludium*, one his last creations. There he says, "the provided notation, the new execution technique as well as the live-electronic part, they all together embody the effect of one of my interpretations" (Nono 1987 [1992], Foreword; author's translation).

Figure 6. Cristóbal Halffter's *Variaciones por la resonancia de un grito für 11 Instrumente, Tonband und Live-Elektronik* (1976/77). A detail of the performer's score with annotations for the live electronics (pp.33–34). © Copyright 1977 by Universal Edition (London) Ltd., London/UE 16663.

his compositions in cooperation with performers chosen for their ability to "become independent of a strict notation and perform the *process* that carried the compositional intention" (Rizzardi 1999, 47), requiring them to get actively involved in the musical decisions. Perhaps we could posit the notion of "oral scores" (55) in which two processes—the composer's proposals and the performer's reactions to these—converge. More precisely, the incomplete formulation of Nono's scores has to be understood as the result of long phases of acoustic research in the studio and of exploration of extended performance techniques with the interpreters. André Richard explains that only after such preparatory work, "Nono—usually in a short time—drafted the score. In this phase he elucidated, only as a reminder, the performance techniques for the interpreters. The new compositions were then rehearsed directly in the place where the premiere took place" (Richard 1993, 100; author's translation). Nono's own manuscripts provide only sparing information regarding the sound processing, but the electronic transformations—programmed during the work at the studio and carefully adjusted during the rehearsals at the performance space—were "a clearly defined situation" (101). Today, it is easy to understand the importance of the work done jointly by Nono's collaborators and the editor in the publication of those scores. Such a venture has to confront the problem of making the transmission of the work possible whilst not providing a formulation that may seem too definitive, contradicting the original intention. Referring to this dilemma, André Richard appeals for good sense in finding the right balance between a precise definition of the text and the necessary allowance of freedom (103).

III.

The score as mediator

I propose now to consider the following five observations, taking the previously discussed instances as points of reference:

i. With the arrival of the recording medium, the traditional differentiation between the conception of the musical work and the act of interpretation was obscured. Sound recording offered a way of fixing and manipulating musical ideas and also a means for listening directly to the result of these manipulations. The score lost its significance as the mediator between composition and performance, two activities that no longer take place in different spaces and times. However, the act of writing, whether enacted on paper, as was traditional, or whether manifested on magnetic tape or computers, continued to take place in the studio. So also did performance and improvisation (regardless of who was sitting at the controls of the electronic devices, be it the composer himself or another person). The German musicologist Volker Straebel suggests that overlooking the realisation and performance of electroacoustic music may have been strengthened by the idealistic attitude of the German tradition, in contrast with other schools like American experimental music where craftsmanship remained central (Straebel 2009).

ii. The common view that electroacoustic notation is something imperfect can be interpreted as the formulation of an implicit answer to a primordial question: whether the score is to be considered as a "text" or as "mere instructions" (Dalhaus 1965). Looking at the score as a set of instructions implies the recognition of ambiguity in the potential variability of its realisations. Inherent in this interpretation is the idea that such ambiguity is a defect. A text, on the other hand, can be incomplete if that which is not notated is self-evident. Like other forms of writing, a score for electroacoustic music is not a neutral means of representation but the expression of a system of relations; you have to understand the language to be able to read the text. But the notation of electroacoustic music is not based on a widely accepted system of signs; there are a number of dialects. Moreover, as we have seen with Nono's scores, the idea that the notated is essential and persistent—and the non-notated, variable and peripheral—is sometimes misleading.

iii. In all musical traditions, a given musical practice—which extends beyond the score—is necessary for the "correct" performance of a work. Acousmatic music is a good example of a tradition where listening and orality have taken the place of musical writing. In a certain sense, when Bayle talked about the three moments of the listening experience he was writing a "score" for the performance of acousmatic music: (1) perception—which is related to the sensual experience, the position of the sources in the binaural space and the exploration of musical strategies; (2) identification—concerned with the appearance of causal forms and designs, the consciousness of the objects' contours and limits, the comparison of experiences, the acquisition of perspective; and (3) interpretation—a return to the first intuition in which the space of figures is projected onto a system of correspondences that connect the act of listening with meaning and emotion, activating the setting to music (Bayle 1992). Scores themselves are constructs of traditions.

iv. With the so-called "emancipation of notation"—which opened the door to a variety of graphical representations of sound—it becomes interesting to consider to whom the score is being directed. We have the composer's writing for the performer (e. g., symbolic or action notation), the composer's and the performer's private writing (e. g., sketches), and writing addressed to the listener (e. g., listening scores). The multiplicity of writings found in the scores of electroacoustic music, ruled by personal criteria "to the point of making scores appear indecipherable" (Eco 1964 [1982], 305), needs to be put in the context of such lines of communication. The electronic studio not only offered the composer new instruments and musical materials but also provided a space where new communication processes between composers and performers could take place.

v. We may think of composition and performance as musical activities that improvise on an existing practice (Benson 2003). From a phenomenological perspective, musical works of all periods are subject to two parallel processes: (1) the tendency toward the crystallisation of a work, and (2) the work in flow. It is in the nature of technology to resist the first behaviour. (The increasing pace of development and the lack of perspective

possibly make this phenomenon more obvious). Performance traditions are themselves changing. Tradition also entails the possibility that contact with the original intention will be lost. Musical writing is the intention of sound; sound is the expression of musical intentions.

IV.

On playing space

Since we also think of space in terms of imponderables and not only as a parametrical construct, finding symbolic notation for the spatial experience is an elusive problem. Referring to the role of scores in the practice of sound diffusion Scott Wyatt writes: "we feel that the existence of a projection score assists the performer and reduces the amount of large scale improvisation. While the performer does not have to follow each notated moment within the score, it does serve as a basic road map reflecting salient aspects of the projectionist's performance design" (Wyatt 1999). François Bayle's articles are occasionally accompanied with sketches (1992, 15–16, 19; 2007, 10–11, 44–46) that show different sorts of cue sheets and notes for the sound projection and the layout of the loudspeaker orchestra, but at the same time the composer considers it premature to discuss a "projection score that continues to be in its early stages" (Bayle 1992, 20). We could ask if intuition-driven, site-specific scores, in which the projectionist notates the actions to be taken during the performance, are not destined, by their very essence, to be always in a permanent state of rudimentary being. This might also be the reason behind the tendency to codify space in the form of performance practices (better transmitted by listening attentively in the proximity of the mixing console).

Different schools of sound projectionists have considered the question of the "collision" of a composition realised in the studio with the reality of the space where it is presented. Bayle speaks of the "internal space," formed within the work itself, and the "external space," where the work is heard (Bayle 2008, 243). Denis Smalley uses the concept of "spatial consonance" and "spatial dissonance" to refer to the tensions between the composed space and the listening space (Smalley 1991, 121). Hans Peter Haller and Luigi Nono perceived this imbalance as an incentive to new creative possibilities (Haller 1991, 37). For them, space was a formal aspect of composition, but the space designed was an illusion and the sound processes needed to be adjusted for each performance, opening an on-going dialogue regarding the interpretation of the "soundspace" (*Klangraum*).[33]

Spatial fidelity and the synthesis of sound fields are among the interests of the "new spatial objectivity" (Emmerson 2007, 163). Here discussion focuses on techniques such as Higher Order Ambisonics (HOA) or Wave Field Synthesis (WFS), which benefit from environments with carefully controlled conditions in terms of loudspeaker geometries and architectural acoustics. Some time ago, I attended two concerts, under the motto "Von Mono zum Wellenfeld," which

33 For instance, Haller—discussing the spatial conception in *Prometeo* (1981/84)—explained that the soundspace "was newly developed, tried out, listened" for each performance (1991, 43).

offered a unique opportunity to listen to a number of musical compositions with different spatialisation techniques through a variety of diffusion systems. For me the most successful spatial experience (in terms of musicality) was John Chowning's four-channel composition *Turenas* (1972).[34] Perhaps the different approaches to the multi-channel presentation of electroacoustic music spark controversy among practitioners and theorists of spatial music (Harrison and Wilson 2010), but I am not taking sides when I examine the weak links of both the realistic and idealistic traditions of spatialisation. On the contrary, I believe that it is beyond doubt that the quest to control spatiality—a fertile subject for prospective exploration and speculative thinking represented by techniques like HOA and WFS—will contribute to a new level of perceptual awareness and bring unforeseen possibilities for music yet to come, even if composition and performance of spatiality remains a problem in the artistic domain.

This digression on space finishes with two arguments that support the potential benefit of bringing together live electronics and the performance of space:

1. There is first the flexibility of the sound structures. In live-electronic music, because synthesis and processing take place at the time of sound production, it is possible to interfere with and alter the parameters of a real-time process in order to obtain a certain quality. One such example is the trivial operation of adjusting a spatial movement to which an instrumental source (e. g., a violin playing on stage) is subjected in a certain section of a musical work. It suffices to have an efficient method for changing and memorising the new variables in the computer.[35] This may put us in mind of Eimert's performance in dissociated time, except that here the dissociated performance takes place "inside the associated space" of the concert hall in the course of simulations or rehearsals. All of the parameters of the real-time processes have potential significance as a means of expression, conspiring with the room in which the work develops.
2. The electroacoustic installation for a performance with live electronics is a resonating network of electroacoustic transducers, computer programs, and spatial architecture. By the very definition of "live electronics," assuming the most common situation, in which microphones and loudspeakers share the same space, the output of the electroacoustic chain finds a way back to its input.[36] Using appropriate equations, the acoustician is able to predict the behaviour of this recursive coupling, based on the geometry and technical data of loudspeakers and microphones and the properties of the enclosing room. The sound technician obtains the same knowledge by exploring the thresholds of an installation during a sound-check (eventually smoothing out the resonances

34 "Von Mono zum Wellenfeld II." Concert performance, TU Berlin WFS-Hörsaal H 0104, August 2, 2008 (20:30).

35 The reader will sense the importance that the experienced performer of live-electronic music gives to designing algorithms that yield the required flexibility during the preparation stages.

36 The conditions that make the acoustic circuit unstable are given by the so-called Barkhausen stability criterion, causing acoustic feedback. For a summary, see Wikipedia."Barkhausen satbility criterion." http://en.wikipedia.org/wiki/Barkhausen_stability_criterion (accessed March 1, 2011).

with a parametric filter). The musician will learn to find these resonances through acoustic experimentation and attentive listening,[37] and can take advantage of them musically.[38] It is also possible to "tune" the performance system by adjusting the position of the microphones and loudspeakers, or changing the parameters of the transformations. Inhabiting this resonating suprastructure with musical intuition and creative perception is playing an expressive instrument.

V.

Analysing and listening

Those concerned with the analysis of electroacoustic music have to confront the fact that most compositions for tape do not provide a score.[39] Analysts usually resort to the available tools for the representation of sound or develop new ones,[40] seeking to establish models that may help to understand the details and the large-scale form of the composition. Methods that rely on listening have also been proposed, like Nattiez's *Analyse du Niveau Neutre* (Roy 2003, chapter 6) that aims—based on the perception of musical gesture—to segment a work in morphological units with the goal of making a transcription.

"Hörverstehen heißt: Laute erkennen, Wissen aktivieren, Bekanntes mit Unbekanntem verknüpfen, das Gehörte interpretieren"[41] (Solmecke 1992, 9). In a sense, listening comprehension (in which a student of languages engages) is analogous to the experience of musical listening, which, in close agreement with the previous quote, is described by music cognition in terms of selection, interpretation and storage. Listening scores like György Ligeti's *Artikulation* (1958) or Luciano Berio's *Thema—Omaggio a Joyce* (1958) aim to provide the listener with a bridge to other areas of cognition. Similarly, musicians have exercised the ability of relating what they listen to with their own musical experience. Listening is a way to create "inwardness": interiorising a musical composition is a process in which listening and memory play an important role.[42] Performers also rely on listening as a means to compare their expectation (internal listening) to the sound produced, adjusting the playing technique accordingly and continuously. Furthermore, like the analyst, the performer is interested in the internal level of the music, understanding the score (perhaps using tools provided by the theoretician) and mediating this understanding to the listener through performance. Performers can also benefit from observing the analysts' use of writing in order to bridge the gap left by the score in electroacoustic music. Analysing

37 Hence the importance of having rehearsals in the concert venue.

38 Not necessarily bringing the system into oscillation! But many artists, from The Who to Alvin Lucier, have resorted to this principle.

39 "Most compositions for tape do not come with a score. The lack of a written document creates great difficulties for the musicologist" (Risset 2002, XV).

40 E.g., Bayle's *acousmographe*, or the Musical Analysis and Representation System (MARS), http://dbis.rwth-aachen.de/cms/projects/MARS (accesed March 1, 2011).

41 Listening comprehension means: recognising sounds, activating knowledge, linking what is familiar with the unkown, interpreting what has been heard. Author's translation.

42 For instance, Hans Tutschku has underlined the necessity of learning compositions by heart for the sound projection of acousmatic music (Tutschku 2001).

and listening are means of reflecting and developing interpretative criteria. Devising performance scores is a way to keep track of those ideas and organise their implementation during the performance.

A final attempt on two performance scores

For the performance of Luigi Nono's *La fabbrica illuminata* (1964)[43] for soprano and four-channel tape[44] I have put together a score-assembly combining screenshots of the amplitude against time representation of the four channels of the tape, side by side with the part for the soprano. [Fig. 7]

The waveform view is especially convenient in *La fabbrica illuminata* because each of the four channels of the tape—based on recordings of three different sound sources (environmental recordings made at the Italsider ironworks in Genova, the voice of soprano Carla Henius, and the choir of the RAI)—consists of a sequence of tape cut-ups, rather than a mixture of different layers of sound.[45] In my score, these three sources are respectively identified using the following conventions: environmental noises are framed in coloured boxes, the utterances and words of the soprano are transcribed as text, and the choir parts are filled out with cut-outs of the composer's sketches[46] used for the recordings of the choral parts (the latter not seen in figure 7). I regard putting together this "waveform-score" as part of the exercise of memorising the tape and understanding the way sound materials are deployed,[47] leading to the definition of criteria and development of performance strategies. Foreground guidelines for the performance could be the consideration of the relationship between the tape and the voice, the overall fader strategies in accordance with the temperaments of each section, or the working out of the textual relations—both within the different channels of the tape and between tape and singer (e.g., recorded voices that may act as echoes of the live part in the soprano).

Figure 8 is an example that reveals my particular interest in the elaboration of the very soft *canti intimi* of the tape solo in "Giro del letto", circumscribed by timer indications that help to guide the fader movements through the narrow signal-to-noise ratio of this part. The numerals in pencil [Fig. 8] correspond to dynamic values for the calibration of the faders. In general, those numbers represent tendencies around which fader activity should gravitate in a certain passage, but they may also serve as an aid in shaping more detailed dynamic contours. Such annotations are subject to continuous revision during rehearsals, and although they provide a relative indication of level, etc., they have to be reconsidered for each performance.

43 For the circumstances surrounding the conception of this work see Henius 1999, 9–24, and Nono 1967 [1975], 105–106.

44 The tape was created in the "Studio di Fonologia di Milano della RAI" under the supervision of Marino Zuccheri (Henius 1999, 21).

45 Carla Henius provides interesting details of the production of the tape in her notes (Henius 1999).

46 Borrowed from different sources like Spangemacher (1981, 31, 33, and 37).

47 Connecting the score-assembly with some of the existing analysis of this work (Riede 1986, 30–47; Spangemacher 1981, 27–44) provides a valuable support for understanding Nono's use of the three sound sources as structural and metaphorical devices (e.g., the protesting crowds in the beginning giving way in the second chorale to factory noises that progressively develop until completely dominating the human voices at the end of the first part).

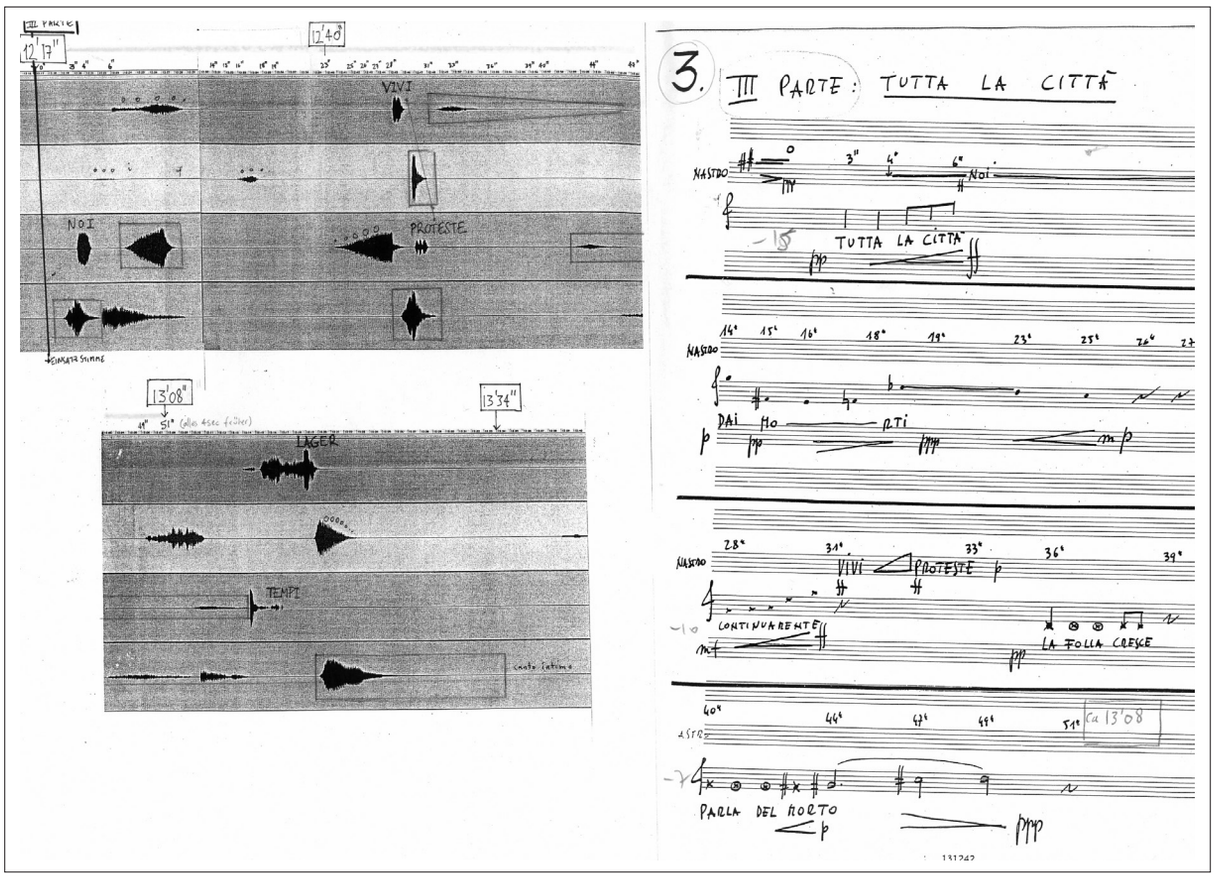

Fig.7

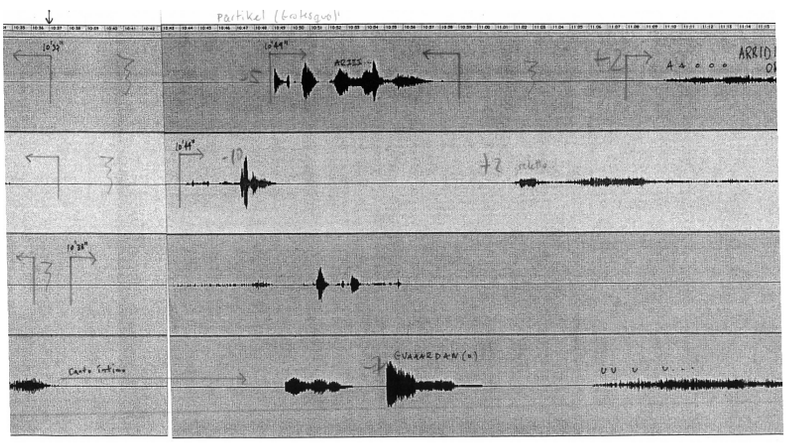

Fig.8

Figure 7. A detail of the performer's score-assembly for the sound projection of Luigi Nono's *La fabbrica illuminata* (1964). Ricordi.

Figure 8. *La fabbrica illuminata*. A detail of the performer's score with annotations.

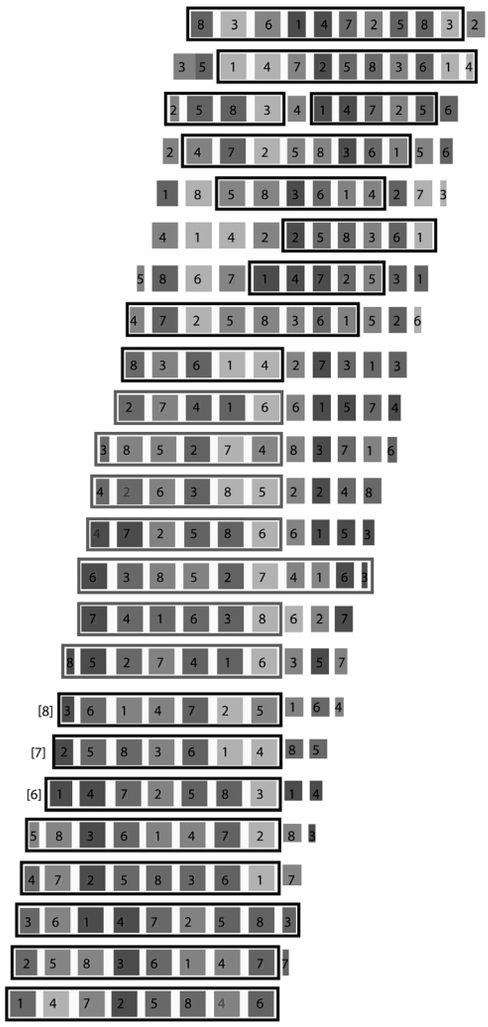

Fig.9

Fig.11

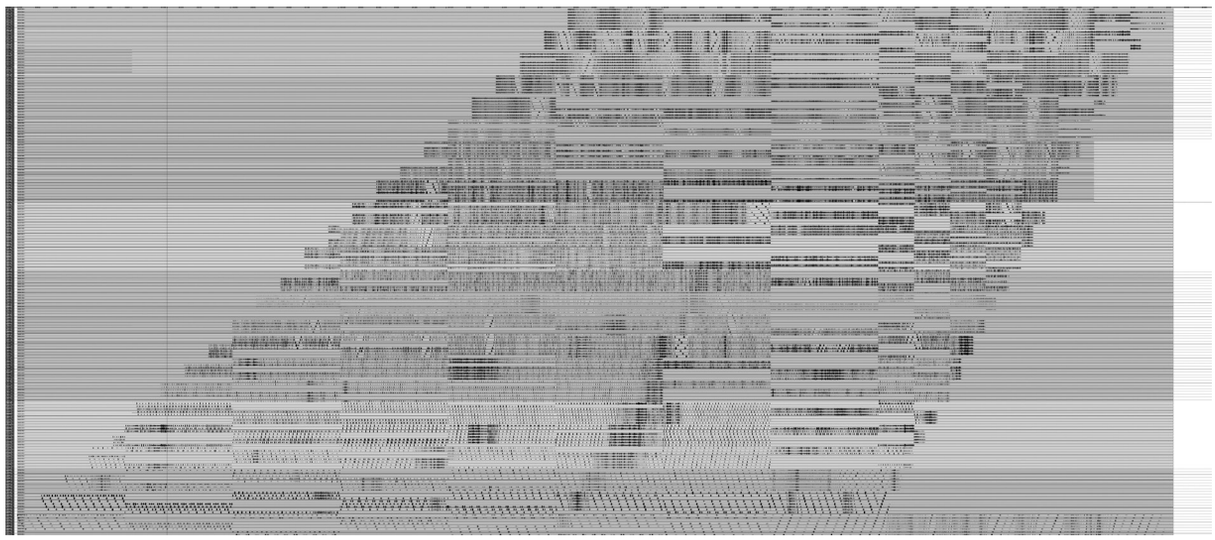

Fig.10

Figure 9. Schematic diagram of the spatial movements in Karlheinz Stockhausen's *Cosmic Pulses* (2007), from an unpublished analysis by the author.

Figure 10. The performer's worksheet with the melodic layers expanded as 24*8 = 192 tracks.

Figure 11. The performer, during an open rehearsal of *Cosmic Pulses*. (Photograph courtesy of Rita Torres.)

In the case of Stockhausen's electronic work *Cosmic Pulses* (2007), for eight-channel tape, a comparable approach is out of question due to the phenomenally dense superposition of melodic layers.[48] In this work I refer to the composer's form scheme[49] and my own analyses of the spatial movements [Fig. 9] for planning the performance. Without going into detail, I find it practical to organise the work into three major blocks: the opening section, with the presentation and successive layering of the 24 loops (until 00:15:20); the middle section (from 00:15:20 to 00:24:00), prioritising the interaction with the projection space and balancing the three groups of eight layers; and finally, the simplification of this texture (from 00:24:00 to the end), concentrating in the resolution of tension and indulging in the spatial *accelerandi* that finish up each of the melodic loops. The score devised for this purpose is a large format printout of the 24 melodic layers. [Fig. 10] This template then serves as a worksheet for highlighting salient features, time code cues and other markings taken down during the rehearsals. [Fig. 11]

48 Twenty-four melodic loops are successively layered on top of each other, rotating according to 241 trajectories at different tempi (Stockhausen 2007b).

49 See pp. 7–8 of the CD-booklet (Stockhausen 2007b).

REFERENCES

Bayle, François. 1992. "Die Raumodyssee." *Sonderton '92. Elektroakustik und Raum*, edited by Karlheinz Essl, Norbert Schweizer, and Klaus Hollinetz, 12–21. Linz: Offenes Kulturhaus. Originally published as "L'Odyssée de l'espace," *L'Espace du Son*, 1988.

Bayle, François. 2007. *Komposition und Musikwisssenschaft im Dialog IV (2000–2003)* edited by Cristoph von Blumröder. Berlin: Lit Verlag.

Bayle, François. 2008. "Space, and more." *Organised Sound* 13(1): 241–249.

Benson, Bruce E. 2003. *The Improvisation of Musical Dialogue. A Phenomenology of Music*. Cambridge: Cambridge University Press.

Bernardini, Nicola, and Alvise Vidolin. 2005. "Sustainable Live Electro-Acoustic Music." Available at http://www.aimi-musica.org/files/Bernardini-Vidolin-SMC05-0.8-FINAL.pdf (accessed August 1, 2011).

Brech, Martha. 2007. "Braucht man Editionen elektroakustischer Musik?" In *Musikalische Analyse und Editionsphilologie*, edited by Friederike Wißman, Thomas Ahrend and Heinz von Loesch, 483–488. Wiesbaden: Breitkopf & Härtel.

Burns, Christopher. 2001. "Realizing Lucier and Stockhausen: case studies in the performance practice of electroacoustic music." In *Proceedings of the International Computer Music Conference* 2001, 40–43. Ann Arbor, MI: MPublishing, University of Michigan Library.

Cage, John, ed. 1969. *Notations*. New York: Something Else Press. Also available at http://ubu.wfmu.org/text (accessed January 23, 2012).

Dahlhaus, Carl. 1965. "Notenschrift heute." *Darmstädter Beiträge zur Neuen Musik*, vol. 9, 9–34. Paris: Schott.

Eco, Umberto. 1964 [1982]. *Apocalicciti e integrati*. 3rd ed. Milan: Bompiani.

Eimert, Herbert. 1954. "Zur Musikalischen Situation." *Technische Hausmitteilungn des Nordwestdeutschen Rundfunks* vol. 6(1/2): 42–46.

Eimert, Herbert. 1955. "Die sieben Stücke." *Die Reihe* 1: 8–13.

Eimert, Herbert, Fritz Enkel and Karlheinz Stockhausen. 1954. "Fragen der Notation elektronischer Musik." *Technische Hausmitteilungn des Nordwestdeutschen Rundfunks*, vol. 6(1/2): 52–54.

Emmerson, Simon. 2007. *Living Electronic Music*. Hampshire: Ashgate.

García Karman, Gregorio. 2006. "Una propuesta para la restauración electrónica de *Planto por las víctimas de la violencia*." Paper presented at *I Congreso Internacional de Música y Nuevas Tecnologías Contemporáneas*, University of Sevilla.

Goeyvaerts, Karel. 1955. "Das elektronische Klangmaterial." *Die Reihe* 1: 14–16.

Haller, Hans Peter. 1991. "Klang- und Zeitraum in der Musik Nonos." *Die Musik Luigi Nonos*, 35–49. Edited by Otto Kolleritsch. Vienna: Universal Edition.

Halffter, Cristóbal. 1971. *Planto por las víctimas de la violencia*. Vienna: Universal Edition.

Halffter, Cristóbal. 1976–77. *Variaciones sobre la resonancia de un grito*. Vienna: Universal Edition.

Harrison, Johty and Wilson, Scott, editors. 2010. "Sound—Space: New approaches to multichannel music and audio." *Organised Sound* 15(3).

Henius, Carla. 1999. "Tagebuchnotitzen zur Entstehung von Luigi Nonos *La fabbrica Iluminatta*." In *Luigi Nono. Aufbruch in Grenzebereiche*, edited by Thomas Schäfer, 9–24. Saarbrücken: PFAU.

INA/GRM. 2004. *Archives GRM.* 5 CDs. Institut National de l'Audiovisuel.

IRCAM. 2007. *Journées professionnelles sur le métier de réalisateur en informatique musicale*. Professional meeting. Paris: IRCAM, Salle Igor-Stravinsky, 22–23 June.

Kagel, Mauricio. 1965. "Komposition—Notation—Interpretation." *Darmstädter Beiträge zur Neuen Musik*, vol. 9, 55–63. Paris: Schott.

Kassel, Matthias. 1994. "Der Klangregisseur als Musiker. Aspekte musikalischer Interpretation durch Echtzeitsteuerung in der Aufführung live-elektronischer Werke." Magisterarbeit, Albert-Lüdwigs-Universität zu Freiburg I. Br.

Kientzy, Daniel. 2003 [2009]. "La interpretación órgano-acusmática, una metacameralidad. La nueva música de cámara." Translated by Reina Portuondo. *Arte, ciencia y tecnología* 4: 4–6. Available at <http://www.fundestellos.org/ACT4.pdf> Originally appeared in *Les cahiers de l'ACME* 213.

Kishino, Malika. 2009. *Lebensfunke II*. Milan: Edizioni Suvini Zerboni.
Lombardi, Daniele. 1980. *Scrittura e suono. La notazzione nella musica contemporeanea*. Rome: Edipan.
López, Jimmy. 2009. *Íncubus III*. Texas: Filarmonika LCC.
Manning, Peter. 1993. *Electronic and Computer Music*. Oxford: Clarendon Press.
Messiaen, Olivier. 2004. Timbres—*Dureés*. (1952). In INA/GRM. CD 1 (12). *Archives GRM*. Institut National de l'Audiovisuel, 5 CDs.
Moles, Abraham. 1960. *Les musiques expérimentales*. Paris: Éditions du Cercle d'Art Contemporain.
Nelson, Peter and Stephen Montague, editors. 1991. "Live Electronics". *Contemporary Music Review* 6(1).
Nono, Luigi. [1967] 1975. "Der Musiker in der Fabrik." In *Luigi Nono: Texte: Studien zu seiner Musik*, edited by Jürg Stenzl, 104–106. Zürich: Atlantis.
Nono, Luigi. 1964 [2008]. *La fabbrica illuminata*. Milan: Ricordi.
Nono, Luigi. 1987 [1992]. *Post-prae-ludium*. Milan: Ricordi.
Penycook, Bruce. 2008. "Who will turn the knobs when I die?" *Organised Sound* 13(3): 199–208.
Puckette, Miller. 2001. "New Public-Domain Realizations of Standard Pieces for Instruments and Live Electronics." In *Proceedings of the International Computer Music Conference 2001*, 377–380. Ann Arbor, MI: MPublishing, University of Michigan Library.
Richard, André. 1993. "Musica fuori dalle convenzioni e notazione grafica tradizionale: limiti della transmissione della musica di Luigi Nono." In *Con Luigi Nono* (Catalogue of the 1992 Venice Biennale), 97–103. Milan: Ricordi.
Risset, Jean Claude. 2002. Foreword to *Electroacoustic Music: Analytical Perspectives*, edited by Thomas Licata. Westport, CT: Greenwood Press.
Rizzardi, Veniero. 1999. "Notation, oral tradition and performance practice in the works with tape and live electronics by Luigi Nono." *Contemporary Music Review* 18(1): 47–56.
Riede, Bernd. 1986. *Luigi Nonos Kompositionen mit Tonband*. Munich: Musikverlag Emil Katzblicher.
Roy, Stéphane. 2003. *L'analyse des musiques électroacoustiques: Modèles et propositions*. Paris: L'Harmattan.
Sabbe, Herman. 1981. "Herr Furtwängler von Morgen." In *Musik-Konzepte 19: Karlheinz Stockhausen*, edited by Heinz-Klaus Metzger and Rainer Riehn, 49–52. Munich: edition text + kritik.
Smalley, Denis. 2007. "Space-form and the acousmatic image." *Organised Sound* 12(1): 35–38.
Smalley, Denis. 1991. "Spatial Experience in Electro-acoustic Music." *LIEN Revue d'Esthethique Musicale: L'Espace du Son* 2: 123–126.
Solmecke, Gert, editor. 1992. "Hörverstehen." *Fremdsprache Deutsch* 7. Munich: Klett Edition Deutsch. Available at http://www.uni-kassel.de/fb2/daf/docs/Artikel_hoeren.pdf (accessed August 12, 2011).
Spangemacher, Friederich. 1981. "Fabbrica illumiata oder Fabbrica illustrata?" In *Musik-Konzepte 20: Luigi Nono*, edited by Heinz-Klaus Metzger and Rainer Riehn, 27–44. Munich: edition text + kritik.
Spangemacher, Friederich. 2006. "Dialektischer Kontrapunkt. Die elektronischen Kompositionen Lugi Nonos zwischen 1964 und 1971." Saarbrücken: PFAU-Verlag. First published 1983 by Bosse-Verlag.
Stockhausen, Karlheinz. 1954 [1956]. *Studie II*. London: Universal Edition.
Stockhausen, Karlheinz. 1959 [1963]. "Musik und Graphik." In *Texte zur elektronischen und instrumentalen Musik*, vol. 1, edited by Dieter Schnebel, 176–188. Cologne: DuMont. Originally published in *Darmstädter Beiträge zur Neuen Musik*, vol. 3. Mainz: Schott, 1960.
Stockhausen, Karlheinz. 1964a [1974a]. *Mikrophonie I, No. 15*. London: Universal Edition.
Stockhausen, Karlheinz. 1964b [1974b]. *Mixtur, No. 16*. London: Universal Edition.
Stockhausen, Karlheinz. 2003 [2007a]. *Mixtur 2003, No. 16 2/3*. Kürten: Stockhausen-Verlag.
Stockhausen, Karlheinz. 2007b. *Cosmic Pulses: Thirteenth hour from KLANG*. Kürten: Stockhausen-Verlag, CD 91, compact disc.
Straebel, Volker. 2009. "The Project for Magnetic Tape (1952/53): Challenging the Idea of a Critical Edition of Historic

Music for Recording Media." Unpublished paper read at *Music: Notation and Sound*, joint conference of the International Association of Music Libraries and the International Musicological Society. Amsterdam, 10 July.

Tutschku, Hans. 2001. "On the Interpretation of multi-channel Electroacoustic Works on Loudspeaker-Orchestras: some thoughts on the GRM-Acousmonium and Beast." Translated by George Goodman. Available at http://www.tutschku.com/content/interpretation.en.php (accessed April 1, 2011).

Vande Gorne, Annette. 2002. "L'interprétation spatiale. Essai de formalisation méthodologique." *Revue Déméter*, 2002. Available at http://demeter.revue.univ-lille3.fr/interpretation/vandegorne.pdf (accessed October 3, 2011).

Wetzel, David. 2007. "A model for the conservation of interactive electroacoustic repertoire: analysis, reconstruction, and performance in the face of technological obsolescence." *Organised Sound* 11(3): 273–284.