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**Spatial concepts and performance practice. On the impact of evolving sound diffusion standards on electroacoustic music**

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**Abstract**

This study examines the musical impact of loudspeaker setups for different electroacoustic compositions that were modified in the course of their performance history or at some point during the composition process. The specific cases of Stockhausen's *Gesang der Jünglinge* and *Kontakte*, Ligeti's *Artikulation* and Harvey's *Mortuos Plango, Vivos Voco* are discussed in view of possible consequences for their performance practice.

**Introduction**

The history of electroacoustic music has seen the emergence of a series of sound recording and production formats that have in the course of time become standards, generally implying a specific speaker disposition: mono, stereo, quadraphonic, octophonic, ambisonics dome, 5.1, wavefield synthesis arrays. However, such standardized dispositions do not always fit the original conceptions of compositions. In some cases, pieces were initially conceived for other dispositions, and it was only in the course of the composition process or at some point in their performance history that they were adapted to standardized setups.

For today's performer, who can more easily accommodate different performance setups even in one and the same concert, this issue raises questions on a conceptual and aesthetic, as well as on a practical level.

- Did changes in the prescribed setup of pieces affect fundamental aspects of the pieces, perhaps leading to a loss of specific aesthetic qualities that are perceived?
- Should we today try to recreate original setups in concert, even if we thereby contradict the last documented state of the composer's intentions and/or own practice?

While experimenting with different listening conditions and looking for site-specific solutions is of course a fundamental aspect of any serious electroacoustic performance practice, we wanted to specifically explore and understand the margin for action within a historically informed electroacoustic performance practice facing real spatial conditions, using current technology and taking into account contemporary listening modes and attitudes.

The pieces discussed were studied within two research projects on the performance practice of electroacoustic music realized at ICST (Institute for Computer Music and Sound Technology of the Zurich University of the Arts) since 2012, the first of which was dedicated to the study of pieces produced at the Milan *Studio di Fonologia*, while the second project, which was funded by the Swiss National Science Foundation, was dedicated to the study of pieces held at the Paul Sacher Stiftung, Basle.

The contribution this paper seeks to make is to assess the impact of different loudspeaker setups by comparing them in practice, looking for the relations between musical structure and spatial disposition and taking into account our own performance experience gained in previous projects and in different performance spaces. Drawing on source material and existing studies, we are indebted to all researchers previously devoted to the subject, and particularly to Pascal Decroupet and his work on related issues in Stockhausen's works.

## ***Gesang der Jünglinge* (1955-56) by Karlheinz Stockhausen, WDR Studio Köln**

A staple of the historic repertoire, *Gesang der Jünglinge* is Stockhausen's first mature electronic piece. It is well known that the piece was not realized as it had first been projected and presented in the article "Aktuelles"<sup>1</sup>. Instead, Stockhausen restarted the project after having finished the first 28 seconds. The last "G" part exists only in the sketches.

The second manuscript of the realization score<sup>2</sup> shows clearly that the first part A was conceived for only 4 channels, while parts B to F were to consist of five channels. The distribution of channels and loudspeakers in space is addressed in some sketches on pages 23 and 31-32 (general sketches). For a detailed discussion of the position of the loudspeakers see also Decroupet 2018.

For the first performance of the piece, a 4-track tape machine was used, and the 5th channel was played from an additional tape machine. Both machines had to be synchronized manually. For practical reasons, Stockhausen then decided to merge tracks 4 and 5 into one track, in order to accommodate the 4-track format<sup>3</sup> that was to become widely used in concerts from the beginning of the nineteen sixties. Today, the piece distributed by the Stockhausen-Verlag, is this 4-channel version. The composer specifies a setup with two loudspeakers for each channel in the corners of the space with channels 1 to 4 disposed clockwise starting rear-left.

The most important issue when playing the currently rented quadraphonic version is how it affects the composed spatialization in parts B-F. This can be seen exemplarily in part C, a key section of the work (2'45"-3'43").

It starts with a dense, loud and fast moving texture following a circular clockwise trajectory, the spectrum consisting of short pitched particles distributed over a wide register (150-3.450 Hz). During the first 2 1/2 cycles, the movement slows down and the spectrum gradually transforms into a quiet filtered noise band (300-700 Hz) at 2'54", leaving space to the voice entering in the foreground ("Preist den Herrn Sonne und Mond") and creating one of the most quiet and transparent moments in the piece where every movement is clearly perceivable. The first sequence with almost 5 cycles is contrasted with a counter clockwise movement of eight sounds without voice. This leads to a short last closing phrase consisting

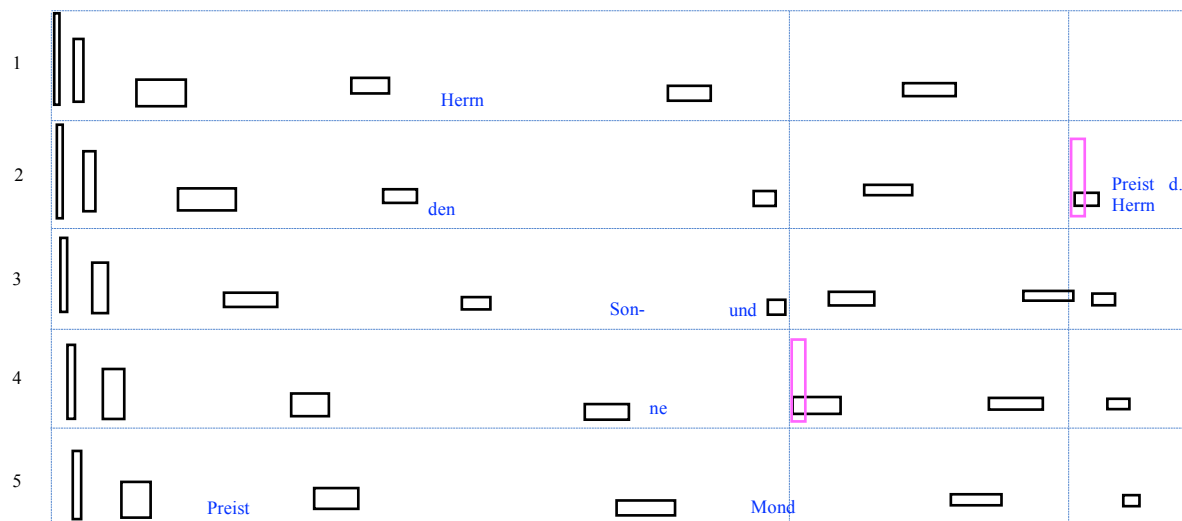
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<sup>1</sup> Pascal Decroupet, Elena Ungeheuer and Jerome Kohl, "Through the sensory looking-glass: The aesthetic and serial foundations of *Gesang der Jünglinge*", *Perspectives Of New Music*, 36(1), 1998, p. 100 ; Pascal Decroupet, "A question of 'versions'!? Three case studies about 'performing' tape compositions of the 1950s (taken from the European repertoire)", *The Performance Practice of Electroacoustic Music. The Studio di Fonologia years*, Germán Toro Pérez and Lucas Bennett (eds), Bern, Peter Lang, 2018 [in preparation].

<sup>2</sup> Karlheinz Stockhausen, *Gesang der Jünglinge*, score, Faksimile-Edition, Kürten, Stockhausen-Verlag, 2001.

<sup>3</sup> Pascal Decroupet, "A question of 'versions'!? Three case studies about 'performing' tape compositions of the 1950s (taken from the European repertoire)", *op. cit.*

of four sounds again changing direction and the text “Preist den Herrn”. It is obvious that by mixing the 4th and 5th channels, the time structure of the spatial figure gets altered: on the one hand, the radial speed increases and on the other hand, the movement “pauses” on channel four.



**Figure 1:** *Gesang der Jünglinge*, part C, 2’45-3’41”

We can also observe an alteration of the serially derived succession of vocal elements in the audio channels in this section: the layer superimposed onto the first phrase (Preist | den | Herrn | Son- | ne | und | Mond), in the original distribution 5-2-1-3-4-3-5, becomes 4-2-1-3-4-3-4, resulting in repetitions that alter the serial statistical distribution between positions in space.

Since the five original tracks are no longer available, the only way to recover the original mix is to separate both channels, using as reference the realization score. This was undertaken by Pascal Decroupet in the late nineteen-nineties<sup>4</sup>. We used his audio files for our analysis in the studio, which allowed to clearly perceive the differences compared to the 4-track performance material.

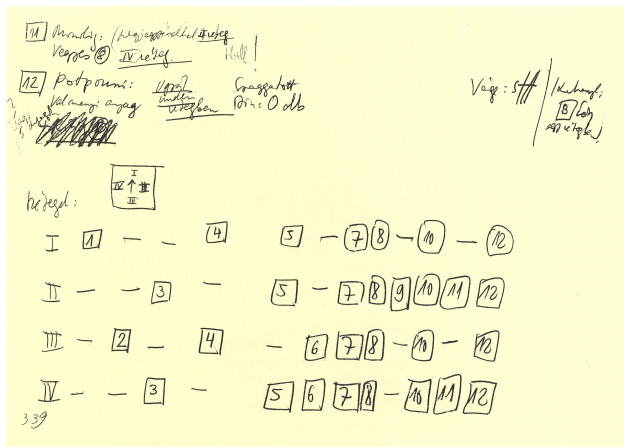
Reconstructing and playing a five-channel version that approximates the original tape as closely as possible is certainly an option that should be considered by today’s performers, since this would allow to experience the piece’s original spatial and structural conception. Obviously, such an undertaking would have to be approved by the editor.

### ***Artikulation* (1958) by György Ligeti, WDR Studio Köln**

The official performance material for Ligeti’s *Artikulation*, which we rented in 2014, does not include any information on speaker setup and sound projection. It is therefore not surprising that more recent performances have in our experience often used the nowadays standard rectangular disposition. However, sketch material by Ligeti and the so-called “Listening score” (Hörpartitur) by Rainer Wehinger published by Schott in 1970 suggest that the originally intended disposition would be to place the speakers at the cardinal points of the

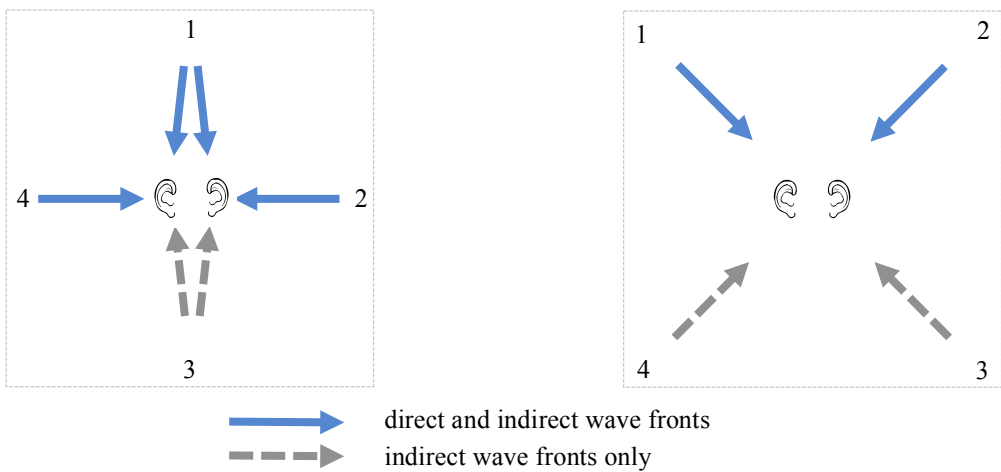
<sup>4</sup> *Ibid.*

listening space (“cross disposition”)<sup>5</sup>. The sketch (figure 2) shows a spatial distribution of sound events on channels 1-4 and adds a corresponding speaker disposition.



**Figure 2:** Artikulation, sketch, p. 30  
(©Schott Music GmbH & Co. KG)

Let us now look at the difference between both setups, taking into consideration the relation between direct signals and reflections (figure 3). The cross disposition on the left generates three different listening situations: one direct wave front for each ear (1), one for either left or right ear (4, 2), and none (2). This results in a heterogeneous sound field, with a large difference of color between front and rear loudspeakers. The square disposition reduces these differences by producing two less unequal situations, front (1, 2) and rear (3, 4) and thus a more homogeneous sound field.



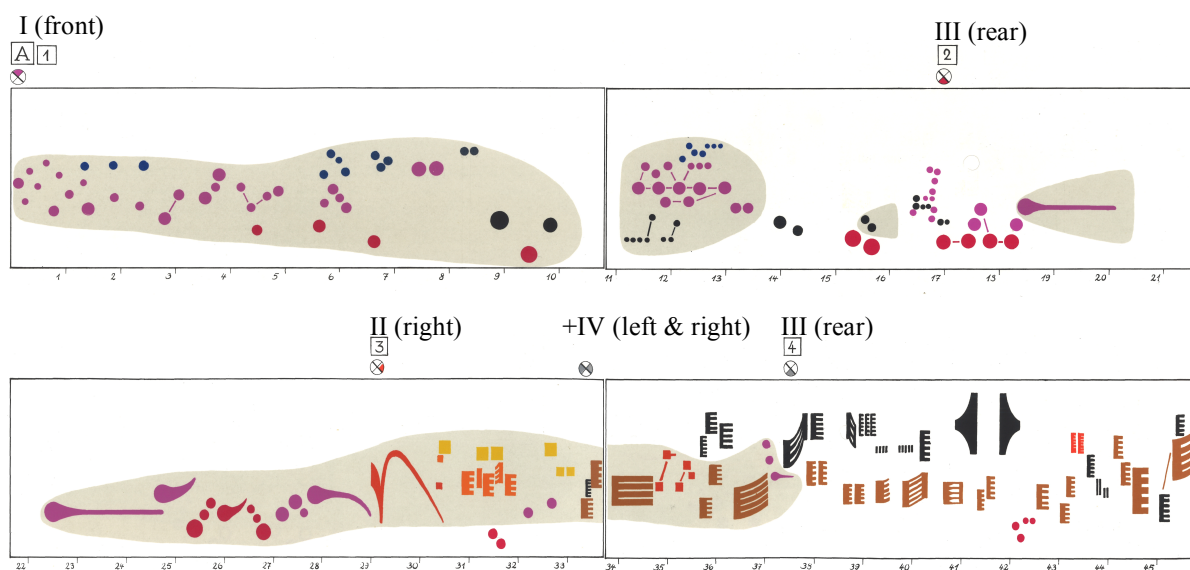
**Figure 3:** Cross and square disposition of four loudspeakers

Ligeti seems to consciously make use of the difference between direct and reflected sound in the cross disposition at the beginning: 17 seconds of noisy spectra in the front are immediately contrasted with 12 seconds of low, muffled sounds in the back for 12 seconds. The sound then opens up to both sides, first to the right and after 4 seconds to the left, finishing after 4 seconds in the back (see figure 4). This opening section appears more plausible spatially in the cross disposition; comparing it to the square disposition proved

<sup>5</sup> György Ligeti, *Artikulation: electronic music, an aural score by Rainer Wehinger*, score, Mainz, Schott, 1970, p. 27, sketch on p. 30.



immediately convincing. It would also seem a likely compositional strategy to us to begin the piece at front center, bearing in mind that listeners at that time would likely have been used to listening to monophonic recordings emitted from a sound source in front of them.



**Figure 4:** *Artikulation*, score by R. Wehinger (0'-46'')

The circles divided in four segments above the system represent the spatial direction  
(©Schott Music GmbH & Co. KG)

It is not without a certain irony that in the 5.1 SACD release of the piece produced at ICST, we finally decided to mix the four channels in the “wrong” square disposition, since because of the lack of a discrete back channel, a mix with virtual positions using panning proved far less convincing than the channel-separated version shifted by 45°. Thus, accommodating a specific distribution format, in this case a CD in 5.1 and stereo, made it seem necessary to divert from the original disposition, which reminds us of the performance history of the piece during which at some point, the standard rectangular setup presumably became more or less the norm in concerts.

### ***Kontakte* (1959-60) by Karlheinz Stockhausen, WDR Studio, Köln**

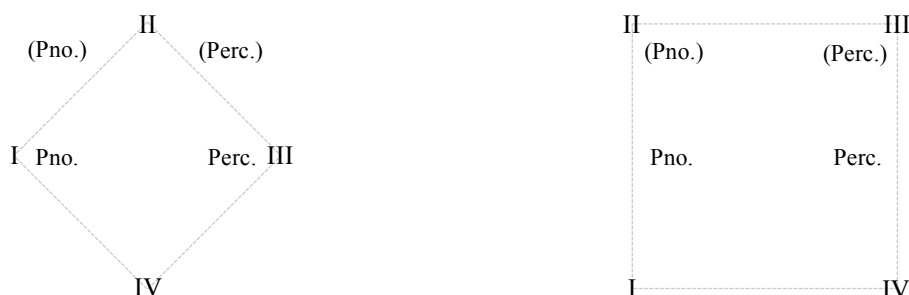
The first edition of the performance score for *Kontakte* (UE 1966) specifies that the 4-channel tape be played back over four loudspeaker groups left, front, right, back. Photos of a performance in Stockholm in November of 1960 with David Tudor and Christoph Caskel show a corresponding setup with the stage in the center of the space, dividing the audience in two opposite halves<sup>6</sup>. The later edition of the performance score published by Stockhausen Verlag in 1995 and the documentation of the audio material on the other hand call for a rectangular, clockwise distribution of the loudspeakers starting at the left rear (see figure 5), resulting in a 45-degree shift of the sound trajectories<sup>7</sup>. While Stockhausen apparently never explicitly commented on this changed prescription, Simon Emmerson in his book *Living*

<sup>6</sup> Pascal Decroupet, “Karlheinz Stockhausen: *Kontakte*”, *Electroacoustic Performance Practice Database*, Germán Toro Pérez (ed), Zurich, Institute for Computer Music and Sound Technology, 2016-17, <http://ppeam.zhdk.ch> (last accessed 02/18).

<sup>7</sup> *Ibid.*

*Electronic Music*<sup>8</sup> points out that Stockhausen may have wished to create a more homogenous sound field in the space by using two crossed loudspeakers in each corner of the space.

The following graphic shows a comparison of the two loudspeaker setups taking into account two different variants for the position of the instruments:

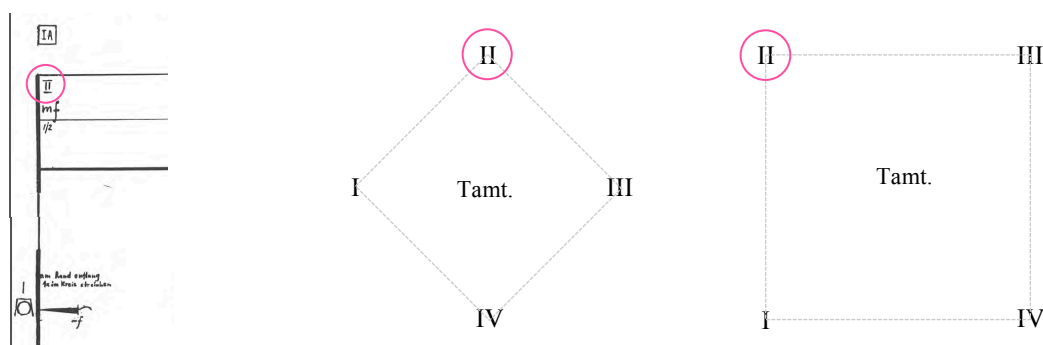


**Figure 5:** *Kontakte*, disposition of sound sources:  
left, UE score 1960, right, current performance material

Let us see how these setups affect the overall spatial relations within the quadraphonic tape itself and between the layer of the instrumental parts and the tape.

There are different types of spatial movements and relations between electronic and instrumental layers in the piece. Circular, statistical (serial structured) and random movements are shifted by 45°, but not significantly altered. However, exposed, accentuated events on single positions, linear movements as well as movements and correspondences or contrasts between pairs of tracks in relation to the instruments, which figure very prominently in the piece, are perceptibly affected. The following examples illustrate those cases.

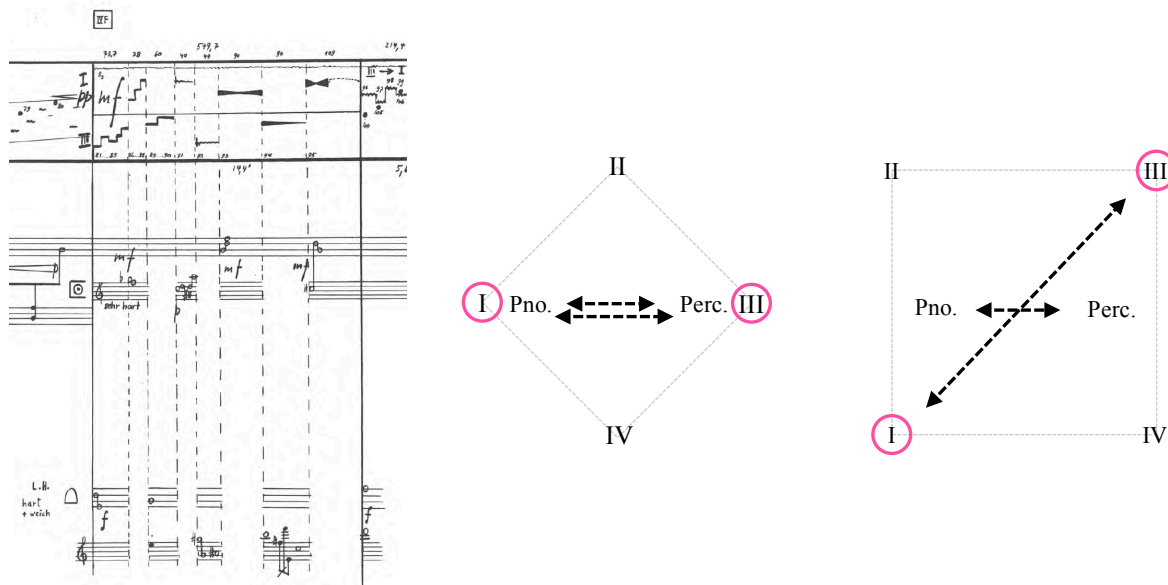
The opening gesture of Moment I A consists in the electronic part of a filtered noise followed by a reverberant impulse and a crescendo on the tam-tam, which is played along the rim, the instrument being positioned in the center. In the square disposition the electronic sound comes from the left front corner. In the cross disposition both sources are located in the center, which in both instrumental setups sounds natural and well-balanced.



**Figure 6:** *Kontakte*, Moment I A  
(©Stockhausen-Stiftung für Musik, Kürten,  
www.karlheinzstockhausen.org, www.stockhausen-verlag.com)

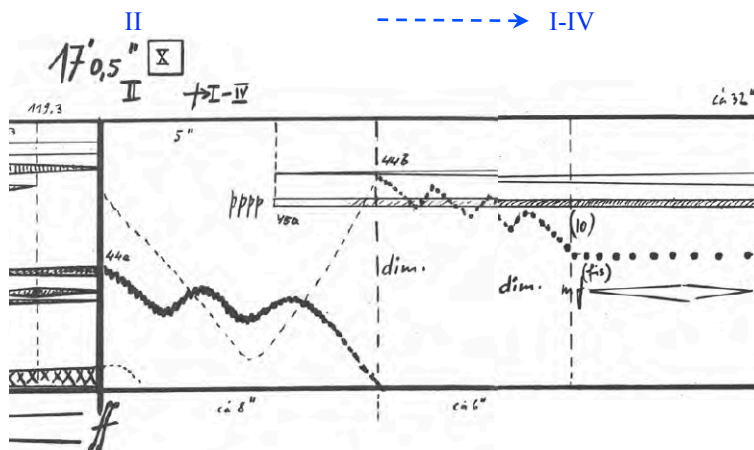
<sup>8</sup> Simon Emmerson, *Living Electronic Music*, Aldershot (UK), Ashgate Publishing Ltd, 2007, p. 156.

In Moment IV F a, the electronic sounds in channels I and III are perfectly synchronized with the instrumental sounds. In the cross disposition both planes are in correspondence, resulting in synchronized pairs on opposite positions: cowbells and piano (left)/channel III (right), crotales and cowbells (right)/channel I (left). In the square disposition the spatial “contact” between the instrumental and electronic sources gets lost due to the 45° shift of the tape.



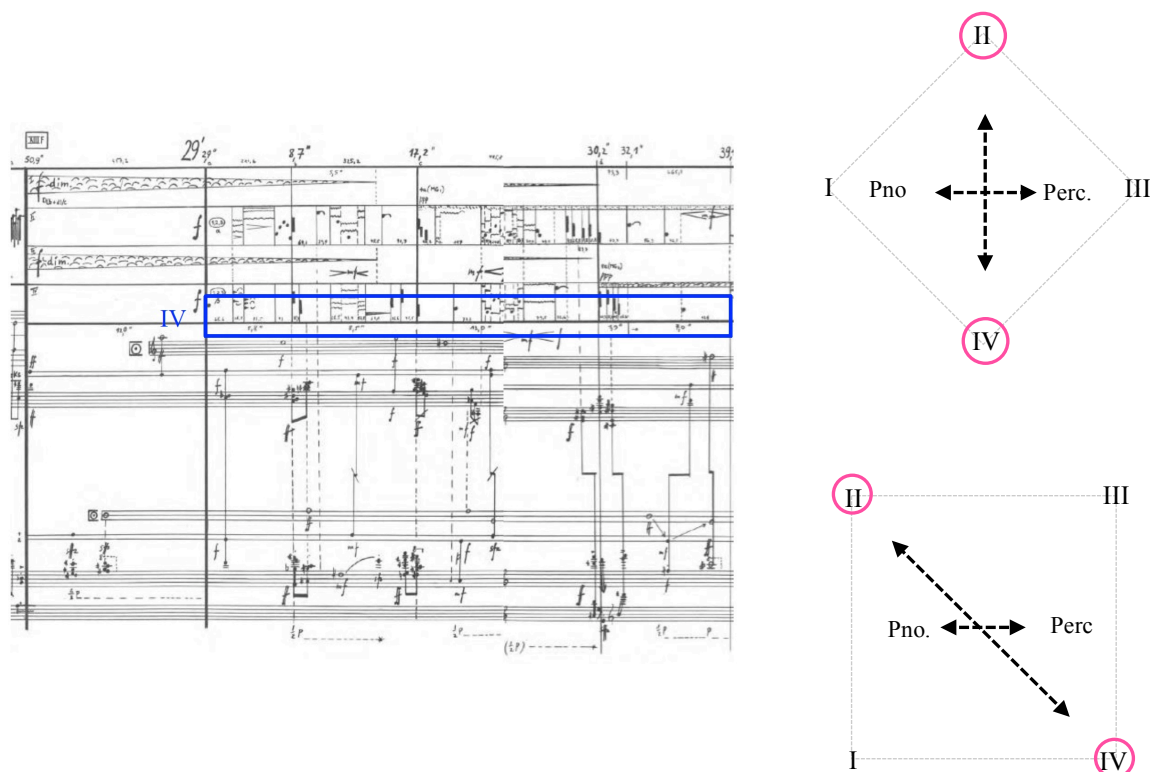
**Figure 7:** *Kontakte*, Moment IV F a  
 (©Stockhausen-Stiftung für Musik, Kürten,  
 www.karlheinzstockhausen.org, www.stockhausen-verlag.com)

In the solo section of the tape in Moment X, one of the most exposed parts of the piece, a glissando line remains alone on track 2 continued after 5” by a second glissando line in the same channel and transforming into a sequence of dry impulses on f# (“fis”) evenly distributed on the four speakers before reverb is increased. In the cross disposition, this section would start in the front, which in comparison to the rectangular disposition (front left) sounds more consistent and in clear correspondence to its spatial transformation.



**Figure 8:** *Kontakte*, Moment X  
 (©Stockhausen-Stiftung für Musik, Kürten,  
 www.karlheinzstockhausen.org, www.stockhausen-verlag.com)

In the long sequence from Moment XIII F until Moment XV A three pairs of sound sources (pno./perc., channels I/III and II/IV) remain in relation to each other. At 29'29" instrumental impulses corresponding in timber and dynamics to the instrumental sounds (left-right) appear on channels II and IV over front and rear speakers in the cross disposition, while the sounds in the other two channels fade out. In comparison to the square disposition, where channels II and IV would sound over a diagonal axis, the whole sound image again seems naturally balanced.



**Figure 9:** *Kontakte*, Moment XIII F  
 (©Stockhausen-Stiftung für Musik, Kürten,  
 www.karlheinzstockhausen.org, www.stockhausen-verlag.com)

In sum, the perceptibility of the symmetry inherent to the piece is clearly affected by the 45° shift. Nevertheless, this cannot be fully conveyed through graphic and verbal explanations. Only in the studio or in the concert hall it is possible to fully perceive and assess the difference.

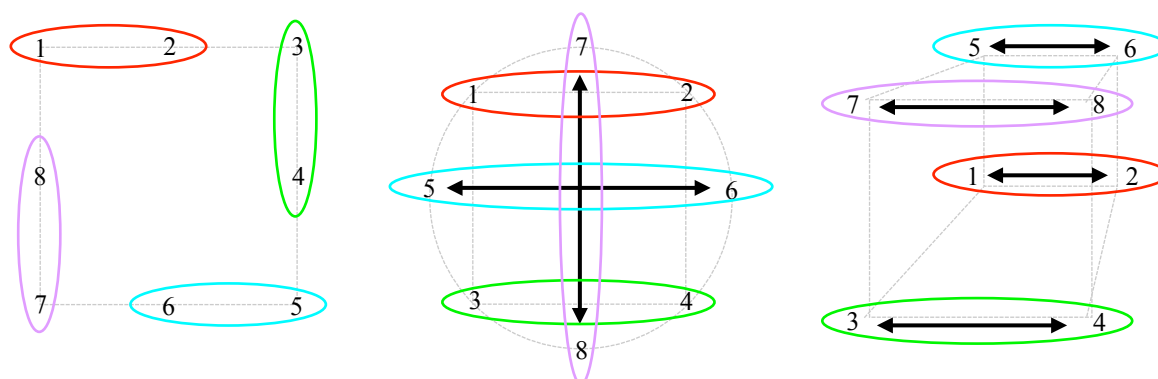
Following Simon Emmerson's interpretation cited above, Stockhausen seems to have developed his own multichannel standard based on acoustic considerations, which he applied to all his pieces, even if this meant forfeiting some work-specific spatial relations in his early works. Today's performer thus faces a dilemma: is it more important to provide an ideal setup for a balanced sound diffusion, or to make audible the original spatial concept and thus fundamental structural features of the work that have been obscured by later practice? We believe that performers should confront this issue and decide on a concert setup based on a comparison carried out in listening to both variants. We would also argue that it is legitimate to present the original spatialization in concert, even if this contradicts Stockhausen's later prescription and practice, as doing so can render important features of the piece perceivable.

## ***Mortuos Plango, Vivos Voco* (1980) by Jonathan Harvey, IRCAM**

The official performance material for *Mortuos Plango, Vivos Voco*, which was rented to us in 2014, contains a rectangular routing diagram for the sound projection that is at odds with the distribution described by Bruno Bossis as the one intended by the composer<sup>9</sup>. We will call the latter “square/cross”. Yet another disposition is depicted in sketches for the piece<sup>10</sup>, suggesting that Harvey was, at least at some stage of the composition process, thinking about a cube setup<sup>11</sup>. The following three examples, from the introduction of the bell (0’00”) and the voices (0’14”) in the beginning, and from the bell sound re-synthesized by the voices towards the end (6’33”) reveal interesting spatial relations between both sonic layers.

### **1<sup>st</sup> example: bell divided in ascending frequency layers**

In the disposition cited by Bossis, a clear symmetry in the first part is perceivable: at the beginning, bell sounds are heard on all 8 channels, divided into spectral layers, with strong pairwise correspondences between channels 1/2, 3/4, 5/6, 7/8, in ascending order (red, green blue and violet), with channels 1 and 2 containing the fundamental. In the cube disposition, the higher registers are located in the upper loudspeakers. While in the rectangular disposition suggested in the performance material the layers appear separated and the strong fundamental pair unnaturally located at mid-front and front-left, both square-cross and cube dispositions allow for a well-balanced layer pairing (see figure 10).



**Figure 10:** *Mortuos Plango, Vivos Voco*, loudspeaker dispositions, left, performance material, center, square-cross, right, cube from early sketches

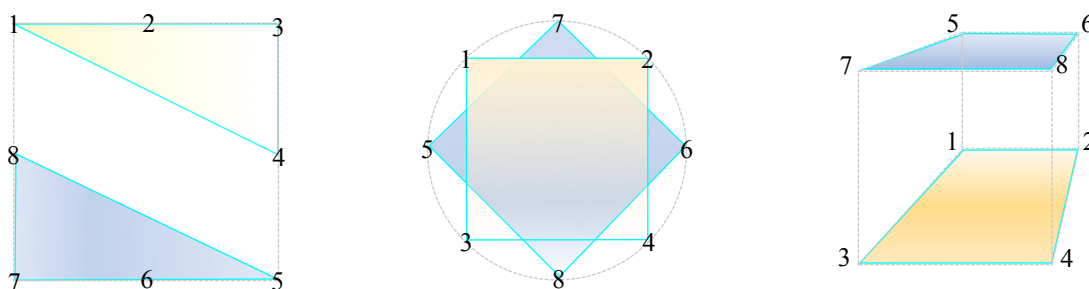
### **2<sup>nd</sup> example: voices enter in the upper side**

After 14 seconds the bells sound only over channels 1-4, and the voices appear in channels 5-8, lasting together until 0’27”. In the square/cross disposition, those channels correspond to the cardinal points. In the rectangular disposition, they would be in the back and left side of the space. In the cube disposition, however, the voices would start sounding on the upper plane in opposition to the bells sounding at the bottom (see figure 11).

<sup>9</sup> Bruno Bossis, “*Mortuos Plango, Vivos Voco* de Jonathan Harvey ou le miroir de la spiritualité”, *Musurgia*, 11(1-2), 2004, p. 129-130.

<sup>10</sup> Jonathan Harvey Collection, Paul Sacher Foundation, Basle.

<sup>11</sup> On the dispositions, see also Jonathan Harvey, “*Mortuos Plango, Vivos Voco*, Performance”, in *Performance Practice of Electroacoustic Music database* [on line], <http://ppeam.zhdk.ch/song/mortuos-plango-vivos-voco/> (last accessed 02/18).

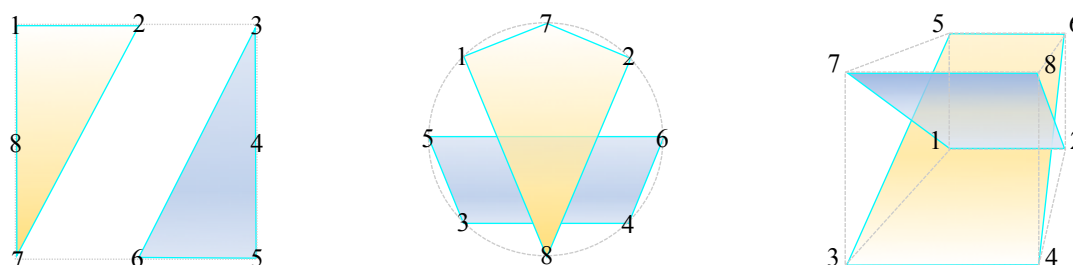


**Figure 11:** *Mortuos Plango, Vivos Voco*, spatial relation between bells (yellow) and voices (blue) at 0'14''

### 3<sup>rd</sup> example: recapitulation, bells re-synthesized with voices in crossed planes

In the last section (6'33''), the full bell stroke resynthesized with the voices appears again as the main element in channels 1 and 2, the decay being echoed in channels 7 and 8. The remaining four channels contain instances of the lower spectrum of the bell (see figure 12).

- In the square/cross disposition the attack (front-left and front-right) and the decay (front-center and back-center) occur in a T disposition. The bell-sounds are mirrored in the middle and back part of the space.
- In the rectangular disposition the voices are located in the front-left part of the room, the secondary layer in the right-rear part, again obviously sounding out of balance.
- In the cube setup, however, the re-synthesized bell would appear front-low and its resonance rear-high on a diagonal plane, and the lower bell in the complementary 90° shifted plane.



**Figure 12:** *Mortuos Plango, Vivos Voco*, spatial relation between bells and voices at 6'33''

In *Mortuos Plango, Vivos Voco*, the processual interchange of sonic properties between two different sound layers (the bells symbolizing dead, the voice symbolizing life), exemplarily illustrated through cross synthesis techniques, can be considered a main conceptual and structural aspect of the piece. The cube disposition, which was apparently first envisioned by the composer, clearly articulates this spectral process in the spatial domain: at the beginning, both layers are introduced separately, voices above and bells below, at the end, when they achieve the utmost degree of interrelation, they are presented in crossing planes.

It seems clear that Harvey abandoned the cube disposition in favor of a disposition of eight loudspeakers on a plane surrounding the audience. At this point, we can only speculate about the reasons for this decision. Was it based on practical considerations, perhaps the difficulty to realize the cube setup in different venues? Was it made for acoustic reasons, the composer



aiming to achieve a more compact sound image in view of the specific perceptual limitations of sound sources located above the listener?

Further studies on the genesis of the piece might possibly shed more light on the reasons for Harvey's abandoning the idea of a cube setup. The question if we should in this case try to recreate the preliminary concept in concert will again have to be at least considered by performers aiming to uncover and present structural and symbolic layers inherent to the piece.

## 5. Conclusion

These examples put into evidence the tension between original spatial concepts and their practical realization. The prevalence of standardized sound diffusion modes can in some cases lead to the neglect of original, non- or pre-standard individual concepts. Performers should therefore maintain a critical attitude in dealing with performance materials, "standard" setups and even auctorial prescriptions, and consider making audible aspects of compositions that have been hidden due to practical reasons or due to technical standardization, thus allowing for a broader insight into underlying compositional features.

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