SPATIAL MUSIC

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1. The Compositional Use of Space and Movement

Existing parameters are weighted differently in compositional practice, but also in interpretation.

To date, at the forefront of the majority of instrumental compositions there are parameters of tonal pitch, as well as timbre, rhythm and articulation complemented by volume. In other words, while a number of composers introduced the parameter of space in the form of location or sound position (e.g. Stockhausen in "carré" or "groups"), in instrumental music space was yet to remain attached to practicability, albeit this was augmented by means of acrobatic actions or dance music (again, Stockhausen in "Michaels Reise", "LICHT-BILDER" etc.) With the introduction of the loudspeaker as a universal carrier, sound could be positioned at will. Since the use of complex space-sound environments, the parameters of spatial position and movement as well as gesture have experienced a Renaissance. However, problems are presently coming to light, which hitherto remained unprocessed due to the limited movement of the instruments: the compositional use of space and movement. In this sphere, with "Kontakte" (Contacts) Stockhausen had already evolved a strictly compositional approach in which he integrated space in a serial form in the canon of other parameters. He retained this approach right up until his last works. Luigi Nono, by contrast, examined the theme of space rather with respect to the effects and substance of sound – namely a somewhat subjective approach in which space served the elaboration of specific effects.

Although multi-channel works have meanwhile become widespread, space has tended rather to be used more interpretatively than compositionally. Also subsumed under interpretative usage is the perceptually-oriented distribution of the material. The sounds, for instance, were distributed in such a way that they were acoustically transparent and no compression of sounds occurred, in much the same way a sound engineer achieves in his work at the mixing desk. This approach has more to do with a perceptual necessity than with a compositional, conceptual activity. Here, deficits in the treatment of spatial acoustics become clearly evident. Ultimately it has to do with unifying acoustic perceptual necessities with compositional strategies – something which additionally impedes this undertaking, but which is nevertheless demanded of composers. Essentially, they encounter this combination of problems during the use of other parameters such as pitch, rhythm, polyphony etc., and must constantly bring aspects of the concept into agreement with the necessity of perception or psychoacoustics. The contrapuntal technique represents just such an approach.

Different strategies are to be found in the purely compositional use of space: a number of these more or less conceptually applicable strategies are outlined in the following.

1.1. Space as a Structuring Method

a) Like timbre, articulation or tone pitches, structures or rhythms may be articulated with the aid of space. This becomes clearly evident by way of simple sound material, such as tonal repetition. The single tones of this repetition may be distributed over two loudspeakers, for example, and thus generate a rhythm or a grouping of tones comparable to a grouping through legato or separation of tones through staccato. What is remarkable here is that spatial positioning is to be structured in a similar fashion to phrasing or instrumentation material.

b) Similarly, existing structural types, such as a trill can be decomposed with the help of space, and transformed into other, far more complex structural types. The example in Figure 1 elucidates the possibilities with the aid of spatial positioning to achieve interaction between the structure of the sound material and the second structure, as introduced by way of spatial positioning.



Fig. 1 Two steps of spatial connotation to a trill

Should one augment the complexity of this arrangement with additional structures such as timbre, then the result, in spite of a simple arrangement, would be a complex one. By extending the parameters usedby additional accents in pitch and volume, for instance, the material can be further enriched, meanwhile remaining interpretively comprehensive.



Fig. 2 A fractaled spatial and timbre structure superimposed to a trill

1.2. Space for the Abstract Serial Use of Position

Serial structuring technique is based on a continual renewal of material through recombinability. Behind this is an ideal of a unique tonal form as had already articulated by Webern. Whereas, for the most part, Webern still used small tonal groups, the later Darmstadt School continued to articulate this ideal. This ideal has two consequences which depend on the perspectives on the material: on the one hand, the view onto the detail which detects the singularity in the combination of the various parameters, while on the other it is triggered by a greater viewing distance, and the multiplicity and continuous renewal of the material.

In order to form the material in this way, parameters are required which function in their differentiation, that are clearly distinguishable, rapidly perceptible or which can even be reproducible from memory.

The integration of the various parameters in the serial system has been practiced by composers since the 1950s. However, they had to abandon the original thesis of the equal treatment of all parameters since it was not possible to implement for neither ear nor tonal generation. As a result, the diversity of parameters was reduced. Instead of twelve levels of volume, one composed with eight which brought with it continued substantial difficulties, above all for interpreters. With the emergent development of electronic technology came the hope of obtaining the desired differentiation of all parameters, though, in this connection other phenomena other phenomena connected with the ability of the brain's ability to deal with complexity were to become important.

If there is an element, such as a tone, each minute differentiation or deviation from this tone, for instance, of the voice, from the predecessor or from the context is easily recognizable. In this case, the smallest changes to the tone would be easy to perceive. However, if there are many different tones, the same differentiation will cease to be perceptible since the reference is missing. Furthermore, in the context of complexity, the speed with which the information is provided plays a role. If it increases, perceptual differentiation is reduced. Accordingly, perception changes according to the quantity of information. The tonal material is better compared to a fractal. Depending on viewing distance, the complexity is the same! What alters in perception in the case of a shift in distance is the differentiation of a specific level of information.

What happens in the case of surplus information? The brain alters the differentiation of the perception of single elements, collects these together in smaller, then larger groups, ceases to perceive the tonal objects as such, but only their reciprocal relationship. In other words, it carries out data reduction. In the case of further compressions of information, tonal groups are collected into larger unities exclusively determined by approximate qualities. Fast, slow, frequency, distribution, the type of extreme points, does the whole move, etc. Xenakis used this form of perception in his work. One might characterize this as a static description or perception of the material.

What this means for the composer is that he must ensure the clarity of the materials he uses. The parameters used must neither be too simple nor too complex – unless he intends to create explicitly simple music. In this connection one may refer to the work of Stockhausen and Xenakis. As several examples in their work show, both wrestled for the right use of parameters, once again departed from the original positions with good reason while continuing with what functions.

With respect to space, this results in serial technique using the clear perceptibility of parameters as an ideal. This was certainly one reason for the Darmstadt School's hostility towards Xenakis, since he worked with a static perception. If the parameters of spatial position should now be used in a serial manner, then it should be possible to reproduce a certain number of positions in perception or memory so as to guarantee clear perceptibility.

With his arrangement in "Oktophonie", Stockhausen experimented with at least six defined surfaces – much like canvasses on which he positioned certain material types. With separately controlled loudspeakers many more positions can be determined in space. However, one would use only selected positions and thereby sacrifice the continuity of the space, namely movement. This problem was quickly recognized with the result that in "Kontakte" Stockhausen used both elements: fixed position and moving sounds.

With the help of the Sound Dome, which unfolds above the public, at least nine clearly reproducible positions can be used: front left, center, right. Left to the rear, center, right and finally center space to the left, above, right. These nine places more or less agree with that which is applied to dynamic differentiation: ppp, pp, p, mp, middle level, mf, f, fff.

With the aid of such systems composers are able to develop complex serial structures with clearly perceptible spatial positions, and may reproduce these at any time. Depending on the size of the system, these positions can be extended, for example to twelve or more. The link to other perceptual levels would also render perceptible far greater complexity. With certain visual stimulants, such as LEDs, positioned on loudspeakers, the composer would be able to combine this information with a sound and thus to a position concept containing considerably more reproducible positions.

1.3. Space for the Distribution of Multiple Complex Sound Events

For the most part, composers sound out the limits of the possible. This is especially the case in electro-acoustic music, since such limits may be extended with the aid of technical means. One such limit has to do with the complexity of the sound material used. By a multi-layered construction of sound events, or through processing methods such as granular synthesis, sound situations begin to emerge which go beyond that which the ear or brain is capable of processing. The reasons for this are multifaceted. On the one hand, masking effects begin to emerge as soon as several sounds are layered over one another. On the other hand, hearing seeks to compress information when it goes beyond a certain complexity. Thus, complexity itself is something relative, since what overstrains one listener may well demand too little of another. Complexity may be subdivided into a physical complexity and a complexity of processing information. The physical complexity of the sound can even be measured and has an effect on every listener. Subjective complexity, by contrast, is differently distributed. Thus, many listeners are better trained in the perception of complex events and are easily able to classify, recall, describe and even differentiate. Both forms of complexity can be substantially improvised by the acoustic conditions in the perceptual process.

As evidence of this one may cite the historically developed orchestral arrangement. Here, the instrumental groups are compiled and positioned separately from one another. In the German arrangement the first violin is situated to the left, the second violin further to the right; then the violas, the celli at front right and the contrabass to the right at the rear behind the celli. The instruments are positioned in an approximately ten-meter area, or sometimes more. This is not only advantageous for the players, but also for the listeners who are thus able to perceive the single voices. Imagine all instruments were randomly positioned: the result of such spatial mix up would be that many informational details in the voices would vanish. The impression of sound would be more diffuse and less transparent. It is for this reason that sound engineers seek to retain this spatial division, or even augment it during recording.

When further pursuing this line of thought, an unambiguous insight begins to reveal itself. If one were to record each group of instruments one by one, and play them back through separate loudspeakers, the perceptual differentiation would then increase. And further, if one were to record each single instrument and play it back through a loudspeaker, this would then result in the most enhanced form of differentiation and clarity of information.

The next aspect involves the distance of listener to object. The greater the distance of listener to orchestra is, the greater the superiority of the acoustic overview, albeit it at the expense of the differential possibilities of perception. In short, the closer the listener is to the sound object, the more differentiated his perception will be.

Hence, at least in classical music one may assume that there exists an ideal of harmony which permits all voices to appear in equilibrium. This certainly does not apply for contemporary music to the same extent, especially for electronic music. And practice also shows that this so-called sweetspot is not a reality, since in the

concert halls and opera houses provide seats to the left or right of the center, or even behind the orchestra, which are located far beyond the sweetspots. One might even go as far as to maintain that only the conductor is positioned in the sweetspot.

A sound scenario may be evolved as a consequence of such facts – something that leads to an incredible enhancement of perception, and does not at all work with the concept of ideal equilibrium between the voices. Accordingly, the optimum would be that the listener would move through the orchestra and still retain a short distance to the instruments. He would thus have to move above or below the orchestra. However, there would be decisive disadvantages if he would move above the sounds were the sounds located below. In such a case, his own body would shade many of the higher partial tones. This process would intensify considerably among a public of higher listeners. However, were sounds were to be located above the listeners an optimal transmission to the ear would be guaranteed.

In this case there it would be possible to furnish the entire available space with sound sources. The stage surface would thus be enormously enlarged. In order to keep this procedure practical, the surface above the listeners is provided with a network of loudspeakers. By means of a simple process (Vector Based Panning, or VBaP) the distribution of sounds is also facilitated between the loudspeakers.

1.4. Space as an Immersive Sound Environment

The conventional auditory scenario in concerts favors the frontal sonic irradiation of the public. At first glance, this is significant for the optimization of auditory devices on the perception of frontally derived sound events. However, it is the eyes that are exclusively directed frontally; the question thus arises as to whether the true cause for the frontal alignment is based rather on the attributes of visual perception. The fact is that hearing indeed is in a position to perceive and locate the sounds around us. Accordingly, one perceptual process occurs in the following manner: the ear perceives a noise and determines its direction. The head then turns towards the source of sound so as to produce a visual contact with the source of the sound. This perceptual process admits of unambiguous conclusions of acoustic perception. Hearing is not frontally oriented but is omnidirectional. In other words, frontal orientation in the concert halls is based exclusively on visual contact with the musicians.

The natural kind of hearing encompasses 360 degrees in both horizontal and vertical levels. It is for this reason that coughing and various other noises made by the public are disturbing during a concert.

This ability of all-round hearing in the perception of spatial acoustics is used continually. The reflection of frontal sound derives from all four walls of the concert hall. Why, in spite of this, is priority awarded to frontal perception when it is only founded on visual facts? Many composers have asked themselves this question in the past. Zarlino broke open this paradigm with his eight-choir compositions. Furthermore, the spatial acoustics of churches, with their hard reflecting surfaces, which generated a strong echo and semi-formation, dispelled the priority of the frontal. Many church organs are even positioned behind the nave and the tonal level is detached from visual events.

From these facts, a scenery of perception may be developed clearly distinguishing itself from practice. The immersive environment represents a far more perfect kind of perception of music than is the convention in concert halls. The audience no longer views the tonal object with the corresponding location: the sound is at this point and I am located at this point. It is rather located within a universe of sounds in which any given sound is possible. The sound becomes the environment that surrounds the audience. Thus music is no longer perceived as a consistently clearly outlined object, but rather as the potential of a range of perceptions comprising many levels but also many possibilities of perception. In so far as it does not yet possess this already completed object character, an immersive environment invites investigative perception. This music possesses a manifold visual-(auditory-) angle with a plurality of objects which the listener must actively compose into more complex combinations. That which the conductor produces in his interpretation, his ideas of the equilibrium of voices, namely, a specific perspective on the various tonal objects, can also be produced in an immersive environment by the listeners themselves. The listener does not listen to the orchestra, but by focusing and altering the direction of listening, or even by way of his own movement through the orchestra, he is capable of perceiving the elements of the work in a far more differentiated manner than is the case in a conventional auditory situation. This results in an active or creative listening. The ability to interact with the tonal level is considerably more active and the sensual impression of the sounds surrounding the

listeners is stronger and more pronounced.

One ought to add that the acoustic reality of a younger public is clearly oriented towards immersive environments. Headphones and the multichannel system of the cinema tend to make reception lean towards immersive perception.

1.5. Space for the Articulation of Movement and Gesture

Finally, the available space also facilitates the use of movement and gesture. The potential of an interpretation of tonal material by way of a movement had already been demonstrated by Stockhausen with the rotating sounds in "Kontakte". Here, a good spatial sound system is far more feasible with a practical control. To be sure, in his movement patterns Stockhausen focused on very simple forms mainly for practical considerations. He later used movement in an interpretive manner, by means of a mixing desk controlled by a joystick or touch panel. By contrast, in Turenas, John Chowning demonstrated the use of complex movement structures. It is especially the combination of geometric form and alterations in speed that create a complex microcosm of gestural possibilities. The alteration in speed of a straight movement is in a position to develop completely different impressions of a single form of movement. To be sure the perception of complex movements cannot simultaneously be perceived in any number. Simultaneous perception of several voices is limited much in the same way. However, a skillful combination of static and moving sounds can generate rich phrases that use the dimension of space in a new way.

1.6. Space as a Medium of Perspectival Perception

Auditory Focusing: The Cocktail Party Effect

One of the brain's unique attributes when dealing with acoustic stimulation may be seen in the cocktail party effect. If sources of sound are distributed in space, the brain has the possibility to focus on a source of sound, and to attenuate this source of sound by up to a volume of 9dB. As a result certain sound sources are highlighted – much like the eye is able to focus on a specific point or object in a spatial environment. This is only possible if the sound object is distributed in space and is not too far from the listener, since the portion of the indirect sound such as reflection and echo of various sounds mix with one another.

Depth Layering

By way of positioning sounds in a setting, sound develops perspectival attributes. Close-range, middle-range and background emerge much as they do in a painting. It is through this that the perceived tonal material alters. The canon in Ligeti's orchestral work "Atmospheres" serves as a good example. This is composed of a many-voiced canon played by the string section. Through the diverse voices, this section sounds like a cluster which, though static, moves within itself. However, were the listener to approach the string section or walk through it, the levels of foreground, middle-ground and background would result in their own structures. In the foreground one hears a single melody of the canon with all tonal aspects of the instrument; in the middle-ground a contrapuntal, many-voiced texture is to be heard in which the harmonic quality of many voices were perceptible together. The background would also reflect what the listener perceives in the concert – the cluster moving within itself.

However, by virtue of the listener's immersive situation, he is able to switch between these levels. The differentiation of perception and the richness of detail is considerably higher than that of conventional hearing. And nevertheless, through the possibility of alternating between foreground, middle-ground and background, all conceivable qualitative attributes are offered simultaneously. In addition, the perspective which brings other sections into focus may be adjusted by turning the head.

Finally, an active or interactive listening also exists here.

1.7. An Array of Loudspeakers for the Simulation of Variable Acoustics

A further possibility for the use of spatial music-environments is to be found in the simulation of real reflection patterns. Reverberators accumulate the emergent reflections on two or five channels. Here, the information responsible for the direction of realistic perception is lost. Should realistic patterns of reflection now be developed, this may occur with an environment, which allows for the distribution of possible sources of sound within the space. Interestingly enough, such systems are already available in opera houses. They are also used for spatial simulation: only, however, for amplifying the singer or the orchestra. Thus, on the initiative of the Stuttgart opera house, it was possible to erect a sound-dome installation within a very short space of time, and to adjust it almost without deploying loudspeakers. However, the perception of space transforms itself enormously when thematized through spatial composition.

2. An implementation of a spatial diffusion system

2.1. The Sound Dome (Klangdom) project and its background

For as long as sound-producing instruments and acoustic spaces have been used, music has been directly confronted with technological issues. Acoustics, style, and aesthetics have evolved in parallel to the history of instrument development, changing interactively with advancements of the technological resources employed. The influence of electronic technology on music in the 20th century propelled significant changes both in the physical properties of the instruments and in the way music was received on the whole. By breaking the paradigm of binding the instrument to the physical necessities of sound generation, the sound itself was liberated to the point of complete dematerialization, becoming pure vibrations in air. The implementation of newly developed interfaces and new forms of interaction with the sound only became possible through this change.

Of the new possibilities for presenting sound, space is currently being emancipated as a separate parameter, significantly changing the way we think about sound. Concert spaces with «loudspeaker cathedrals» already exist, and the reception of music is developing more and more into an immersive sensory experience. The pronounced use of technology also captures the composers' sense of aesthetics. They are capable of evoking technological changes on the basis of new requirements on their part. The conception of new forms of interaction with these «sound machines» alters the creation process considerably. A new breed of performers is joining forces with the already highly specialized instrumentalists. They see their instruments as flexible, functional objects that follow their own ideas, and they creatively transform them accordingly.

2.2. Historical overview

Spatiality in music is more than a parameter for the realization of aesthetic concepts. Spatiality aids in the presentation, the perception, and also the comprehension of music, and is thus by no means an end in itself.

The shamans of the Yanomami, which the ZKM visited in the context of the Amazonas project planned for the 2010 Munich Biennale, tell of the vital importance of spatial hearing for survival in an impenetrable jungle that is overgrown with trees and plants. Their explanation makes sense: The hostile creatures in a jungle region can be detected more quickly by the sounds they make than by their visual appearance. In addition to the identification of a noise, the correct perception of direction determines their success or failure in the hunt, and can also be a matter of life and death.

This underlying aspect of perception is also reflected in cultural activities. A visitor that spent seven days in the jungle with the Yanomami told of nightly ritual dancing and singing. The darkness made the dancing impossible to see, yet the many moving voices created a musical scenery that made direct use of motion and spatial distribution as a musical resource.

The intentional incorporation of spatiality into the composition of European art music was first undertaken by Francesconi Ruffino d'Assisi in the 16th century and was continued by Adrian Willaert at St. Mark's Basilica in Venice (Blankenburg 1995:771). The spatial division and distribution of the voices that were invented in these contexts led to the emergence of concepts that incorporated the effect of spatialization into the musical experience. Examples of this include experiments by various composers with distant orchestras or sounds from neighbouring rooms, etc.

The topic gained particular relevance with the emergence of electronic music, through the introduction of the loudspeaker as a universal sound converter. There were various currents in this area, from Pierre Henry and Jacques Poullin's *Pupitre*

d'Espace in 1951 to Stockhausen's rotating loudspeaker in 1958 at the West German Radio, or the approaches that encompassed the Philips Pavillon in Brussels, built by Le Corbusier and Iannis Xenakis for Edgar Varese's electronic work *Poème électronique (Meyer and Zimmermann 2006: 345)*, and the spherical auditorium at the World's Fair in Osaka, which altogether extended the tonal dimension of music into space. Soon afterwards, John Chowning first developed the method of simulating motion in sound by using digital algorithms.

These developments in the 1960s and 1970s constitute the precursors for a global trend around the turn of the century. The primary focus of research and reception was no longer found in sound synthesis, but rather in how sound is performed and initiated. Consequently, the most important innovations in the development of new interfaces, which will be addressed in more detail later, are found in virtual acoustics and especially in spatial music.

All of the indications point to the increased use of space in future music. Many concert halls now have multichannel audio systems at their disposal. Multichannel hifi systems are regarded as standard in the consumer domain. Decisive developments have taken place in computer hardware. While there were only a few professional interface systems with multichannel sound at the end of the 1980s, most sound cards today are equipped with at least six channels. Moreover, a comprehensive series of affordable production tools, storage devices (such as DVDs and hard drives), and playback technologies, such as 8-channel amplifiers, now exist. Multichannel functionality is now considered an industry-standard prerequisite for acoustic projections in space. This development alone, which was no doubt initiated by the film industry, shows that spatial hearing has verifiably moved more into the focus of the consumer. As a result, the listener gains a greater capability for experiencing spatial perception. The latest cinema productions already display astonishing precision in the positioning and motion of sounds. It is therefore not surprising that research institutions and artists - spurred on by these circumstances - increasingly strive to include and make use of the parameter of spatiality and push the possibilities of perception to their limits both technically and acoustically.

On the basis of this historical and practical body of knowledge, a team of software and hardware engineers at the IMA developed the concept of the Sound Dome under the direction of the author between 2003 and 2009. The composers' need for straightforward usage, in conjunction with the concrete conditions of the routine concert environment, played the most important role in the project's conception. The spatialization software must be able to easily adapt to different spatial conditions and changing loudspeaker installations for the sake of the concert setting.

The result was the Sound Dome, installed in the Cube theater of the ZKM, and the interactive control software Zirkonium (Brümmer, Gossmann and Ramakrishnan 2006:3, Ramakrishnan 2009) (Brümmer, Ramakrishnan et al. 2007/8). The Sound Dome in the Cube is composed of 47 loudspeakers that surround the listeners in the shape of a dome. Using Zirkonium, it is possible to send sounds across any given room with unprecedented precision, for example, or to have the sounds circle around the listener. The audience is surrounded by sounds, as they would be in any natural environment. A detailed description of Zirkonium can be found in the article by Sekhar Ramakrishnan (Ramakrishnan, S. 2009).

Composer Karlheinz Stockhausen often expressed his visions and conceptions of spatial music during the production of his work LICHT-BILDER at the ZKM. These were put into practice for the first time in high quality. Unfortunately, he was never able to use the Sound Dome.

2.3 Why space?

In order to pursue this question, the term «space» must be more specifically defined. Firstly, sound is not possible without space. Every tonal process, from the vibration of the string and the sound board to spatial sound, is an articulation of space. In addition to sound synthesis, spatial phenomena exist that are most commonly subsumed under the concept of acoustics. The size of the room, its geometry, and the reflecting surfaces are perceived in the form of reverberation and echo. The size of a space is ascertained by the time interval between the direct sound and the first reflection (Neukom 2003:85), as well as by a few other parameters, such as how the reverberation progresses. If this interval is short, the listener in effect intuitively develops the sense of a small room.

Sound synthesis and architectural acoustics are complemented by the determination

of the position of a sound in space. The process of determining position is made up of the perception of the distance and the direction from which the source sound is emanating. Human hearing is capable of simultaneously perceiving several independently moving objects or detecting groups of a large number of static sound sources and following changes within them. Spatial positioning is thus well suited for compositional use. While the acoustics of different rooms cannot be perceived simultaneously, the parameters of position and movement can be polyphonically used in highly complex formations.

What persuaded musicians to orchestrate sound events using different spatial locations and movement? The observation that nearly all sound sources in our environment are in motion is of particular interest in this context. The most diverse moments or objects can serve as examples for this, such as birds, automobiles, speech, or song; the sources of these sounds cannot be attributed to a fixed position. Smaller movements or gestures in space, such as are carried out by strings, woodwinds, etc., as an element of their musical interpretation, are constantly perceptible during the production of sound. As a result of this movement, the sound obtains a constantly changing phase configuration (Roads 1996:18), which gives rise to a vitality in the sound. In contrast, static, immobile instruments appear uninteresting; their sound seems flat and unreal. This problem is even compensated for in an organ through the slight detuning of its pipes, thus creating beats. A similar technique is used in the tuning of a piano, whereby the piano tuner detunes the strings slightly amongst themselves in order to achieve a stronger and thereby fuller sound. These aspects indicate that the movement of sounds and the accompanying phase shifting belong to the normality of acoustic perception. This leads to the conclusion that the movement of sounds in space most certainly corresponds to our acoustic patterns of perception, and that the use of these parameters therefore naturally suggests itself for musical contexts.

The use of spatial information within a composition clearly has an impact on compositional decisions. Examples from the 16th century demonstrate a clear logic in the use of these parameters. Spatial information aided in providing additional form to musical information and helped to structure the course of the music far more effectively than phrasing, articulation, and instrumentation. The best example for the use of spatiality within a compositional structure is a duet, or the concerto grosso

(Scherliess and Fordert 1997:642), whose compositional form is perceived as being clearly structured through the use of spatiality in conjunction with instrumentation. The expanded and more differentiated approach to the spatial area available to the sound, as well as the integration of motion, allow new possibilities to emerge for the dramatic development of a composition.

A further aspect that speaks in favor of the deliberate use of spatiality has its foundation in the fact that human hearing is capable of perceiving more information when it is distributed in space than when it is only slightly spatially dispersed. The reason for this phenomenon lies in the fact that sounds are capable of concealing, or masking each other (Bregman 1990:320). For example, if one plays back the signal of a loud bang and the signal of a quiet beep at the same time, the bang would normally completely conceal the other signal. If both sounds were equally loud, they would blend together in the ideal case. However, both sounds would remain separately perceptible, without merging with or masking each other, if they were to be played back on the left and right sides of a listener's head. This example can be multiplied, until a sound situation arises in which 20, 30, or more sounds are audible, distributed throughout the space. Spatially distributed, such a situation sounds transparent and clear, while the stereophonic playback of the same sounds would appear muffled, with little detail. The listener would be capable of geometrically grouping different events and perceiving spatial formations. This «active listening» would have various alternatives depending on the position of the listener, resulting in multiple variants of how the sound is received. In addition to this, the brain also has the ability to focus on specific sound objects, in what is called the «cocktail party effect» (Roads 1996:469). However, the brain only has this ability in conjunction with spatially positioned sound objects. If the listeners are ideally surrounded by sounds, they are able to dissect complex sound structures, in a sense. This is impossible even for the frontally spatial setup of an orchestra.

If one summarizes the various acoustic and psycho-acoustic aspects of human hearing, it becomes clear that the ear's ability to differentiate sounds increases considerably with the use of spatial information. If sounds are distributed over a large area, complex sound information can be designed in a transparent and easily audible manner. The listeners are thus able to grasp more acoustic information and flexibly structure their listening.