MANIPULATING SPACE, CHANGING REALITIES: SPACE AS PRIMARY CARRIER OF MEANING IN SONIC ARTS

Frank Ekeberg, Trondheim, Norway. E-mail: <mail@frankekeberg.no>; Web: <http://www.frankekeberg.no>.

Abstract

Space is an essential element of human experience. In our daily lives we move about in a multi-dimensional sound field, constantly processing spatial cues in our encounters with our surroundings. Awareness of space as a fundamental component of sound is nevertheless limited among artists and listeners. This paper presents a framework for recognizing, analyzing and working with sonic space, based on identifying and categorizing spatial components from the level of the individual sound, via the combination of sounds in virtual spaces, to the experience of the fusion of composed space and the listening environment.

Keywords*:* space, sound, spatialization, acousmatic, sonic art, aesthetic experience, spatio-structural theory

There is a spatial context to any listening, with respect to where the sound is heard, one's listening position relative to the sound, whether it is heard indoors or outdoors, whether recognition of the source of the sound necessitates action based on the perception of its relative movement or placement, and so on. Further, there are conventions, expectations and specific use patterns related to the space in which the sound is presented – is it a public or private space, gallery or concert hall, art or non-art space, urban or natural environment … ? The space that we hear and perceive is quite complex, in that it combines many factors: spatial elements of the individual sound and any associations it carries, spatial characteristics of the room that the sound excites, the spatial relationship between you, the listener, and the sound - that is, where is it coming from, and is it stationary? If you recognize the source, what images does it trigger? Is it likely to change position – towards you, away from you? What does it tell you about the space you are in – its size and extent, if it is empty or filled?

In this paper I outline a framework for recognizing and manipulating sonic space, developed as a result of my work as a composer of acousmatic music, a musical genre in which the work is typically composed onto a fixed medium, for listening solely over loudspeakers. Space has been a focus of practice and thought in acousmatic music, and integral to composition and presentation of the genre, since its very beginning. Spatial considerations in the composition process – the choice and arrangement of sound material in terms of spatial characteristics and associations – are fundamental to the creation of acousmatic work. The 'spatio-structural theory' outlined here seeks to classify the individual spatial components of sound. It is primarily intended as an aid for artists in developing an increased awareness of sonic space, and unlocking possibilities for implementing space with greater depth and effect in works of sonic art. Using digital technologies, spatial aspects of sound can be manipulated and controlled to an extent where auditory space becomes the primary carrier of meaning in sound-based works, and a powerful tool for artistic expression and communication.

Theoretical background

Space is an essential dimension of human experience. We move about in relation to objects and other people, and hear sounds in a multi-dimensional sound field. Our interpretation of spatial relations is largely shaped by cultural knowledge and experience of spatial communication in everyday life, such as patterns of interpersonal communication, experience of rural and urban life, and the architectural environment in which we live, as well as the manner in which space is represented in language. This knowledge informs our encounters with each other and with our surroundings, both visually and aurally. Space communicates and establishes types of relationships between participants in situations of interpersonal interaction, and shapes the individual's relationship with the surrounding natural and cultural environments.

Anthropologist Edward T. Hall studied intercultural variations in the meaning and use of space in communication [1, 2]. To Hall, culture is defined by communication itself, in which the uses of time and of space are fundamental elements of a 'silent language' [3]. Based on his findings of spatial organization and interaction within and across cultures, Hall defines interpersonal distance-setting as a psychological, dynamic space that moves with the person and varies in size according to situation. This is characterized by the four spatial distance zones of 'intimate space', 'personal space', 'social space' and 'public space', which are based on interactional relationships and circumstances.

Lyman and Scott [4] propose a theory centered on the notion of 'personal territories', which they describe as various types of marked-off areas within which intrusion will be responded to, either as internal, emotional reactions or as external, physical actions. In contrast with Hall's dynamic spaces, personal territories are relatively stationary and do not necessarily follow the individual person. Lyman and Scott categorize personal territories into four groups, which can be seen in parallel with Hall's four distance zones: 'body territory', 'interactional territory', 'home territory' and 'public territory'. Body territory is then further separated into 'internal space' and 'external space'; with the former being an internal, psychological space, the most private and intimate of spaces.

Hall points out that many of the communicational aspects of space and distance-setting are so deeply embedded in the individual's personality that they exist outside of awareness, and are rarely subject to conscious thought. Space is, in some form, always present, and spatial processing and decision-making are constantly carried out, whether or not we are actually aware of it. Thus, the artist's choice and organization of spatial elements in the creation and presentation of a work, as well as the audience's perception and experience of it, are influenced and shaped by their own knowledges of space from everyday life. Recognizing that these unconscious factors exist, and developing an understanding of key aspects of space as a communicative element, are fundamental to successful integration of space as a powerful device in artwork.

In addition to the high-level processing of spatial information outlined above, knowledge of fundamental mechanisms of spatial hearing and auditory perception, as well as a basic understanding of acoustics, are helpful for knowing the limitations of our hearing. Such knowledge can also assist an artist to find the most effective ways of presenting a work in a given place, in order to convey spatial information in the work as intended.

Spatio-structural theory

The spatial elements of sound are intertwined, and cannot be experienced in isolation. However, they need to be identified and discussed separately in order that the different expressive and communicative aspects of sonic space can be considered and emphasized.

The framework of spatio-structural theory is comprised of three basic levels corresponding to source material, creative process and listening experience,

Please reference as: [Author(s)-of-paper] (2013) [Title-of-paper] in Cleland, K., Fisher, L. & Harley, R. (Eds.) ***Proceedings of the 19th International Symposium of Electronic Art*****, ISEA2013, Sydney. http://ses.library.usyd.edu.au/handle/2123/9475**
Page numbering begins at 1 at the start of the paper.

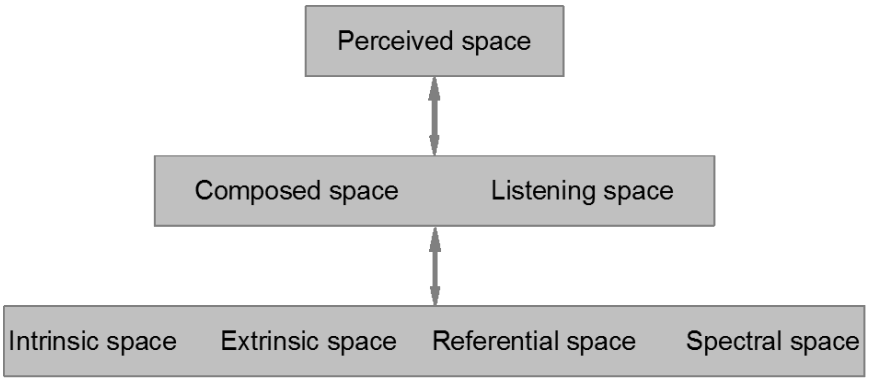

Fig. 1. Levels of Spatio-structural theory. (© Frank Ekeberg.)

respectively: 1) spatial elements of individual sounds in terms of 'intrinsic space', 'extrinsic space', 'referential space' and 'spectral space'; 2) the spatial arrangement of individual sounds and events into a 'composed space' which is played in, and becomes affected by, the 'listening space'; and 3) 'perceived space', which constitutes the listening experience of the combination of composed space and listening space (fig. 1).

An element of the individual sound, intrinsic space concerns the sound as space, and comprises components such as 'magnitude', 'density' and 'morphology'. These aspects can be discussed independent of any external acoustic environment, although the sound's interaction with the surroundings in which it is heard might still influence the spatial interpretation of it. Magnitude is a subjective characteristic which refers to the perceived size of the sound, and is based on a number of variables related to listening circumstance, source recognition and spectral makeup. A sound's magnitude is in particular affected by intensity and low-frequency energy: magnitude seems to increase as the frequency goes down, and as intensity increases. Duration is another important factor, as a sound of longer duration is given more time to interact with, and spread in, its acoustic environment, and thereby increase its perceived magnitude. Density refers to the compactness or solidity of the sound. A sound of high density seems hard and impenetrable, while a low-density sound can be experienced as having a hollow or resonant quality. The notion of density can also be based on associations with the perceived source of the sound, or the gesture behind its excitation. Finally, morphology refers to how the spectral composition of the sound varies over the course of its existence, and can be tied to changes in magnitude or density.

The element of extrinsic space concerns the sound *in* space, and refers to the sound heard in a sound field, where it can be localized in terms of 'distance', 'direction' and 'movement' relative to a listening position. The sensory information is derived from the interaction between the sound and its surroundings. How we perceive direction and distance is based on a complex combination of inter-aural time differences (ITD), inter-aural intensity differences (IID) and head-related transfer functions (HRTF) [5], phenomena that can be manipulated electroacoustically to steer localization. In addition, we utilize acoustic cues such as the Doppler effect, reverberation, diffraction and absorption. Normal spatial hearing is extremely accurate, and even the slightest deviation can be detected with a spatial resolution that varies somewhat according to the direction, distance, loudness, duration and spectral makeup of the sound. There are important instinctive and associative differences in the experience of sounds localized in front of, above, or behind the hearer, or of sounds that are nearby or far away. Movement adds another aspect to extrinsic space, by incorporating changes in distance and direction, as well as elements of speed, range, acceleration, deceleration and perspectival change.

Referential space is the sound *of* space, that is, sound that contains environmental cues that point to a valid spatial setting, whether real or surreal. Referential space can be a powerful device in sonic arts, as it is tied to a recognizable source that carries with it associations with spaces known from real-life experience. Such associations arise in relation to physical, spatial settings, and also in relation to other properties that are related to such settings, for example social, psychological or historical phenomena, by incorporating cues to specific events, situations, persons or activities associated with such phenomena. Referential space can influence the experience of intrinsic space and extrinsic space, and indicate possible dimensions of a virtual space, as well as the listener's point of view relative to it. For instance, outdoor environmental cues can suggest a much larger virtual spatial setting than an indoor listening space implies.

The fourth element of the individual sound is spectral space. This spans the lowest to the highest audible frequency, and is a vertical space where sounds are localized based on spectral focus, such as pitch or nodal spectrum [6], spanning the continuum from 'note' to 'noise' and covering a certain 'spectral range'. It is a psychologically and psychoacoustically based sense of elevation and vertical placement, and as such, physical localization of the sound is less relevant. It is primarily a space where sounds are described as 'high' or 'low' in relation to some frequency reference, whether relative or instinctive. In pitch-based tonal music, high and low notes have historically had important metaphorical functions related to meanings of ascent and descent. Spectral space is an influential factor in the spatial experience of sonic art, and must be considered in any investigation into sonic space.

Composed space

Composed space is the organization of the sound material into an artistic context in which spatial relationships are established, and virtual spaces based on the sounds' intrinsic, extrinsic, referential and spectral spaces are set up. It is a temporal space in which spatial configurations connect and evolve in a structural manner as the work progresses. Structure, in the context of composed space, concerns temporal shaping of spatial parameters as variations in intensification, motion and growth. These are important aspects of directivity that guide expectation and anticipation in listening, and form the basis for evolution and expression in a work. Spatio-structural content can be expressed in terms of spatial references, spatial interrelations among the sound material, extent and intensity of spatial movement, boundaries of virtual spaces, clarity and definition in spatial placement, and vertical organization in spectral space.

On a high structural level, the spatial composition tends to be focused toward one or more of four spatio-structural categories built on combinations of

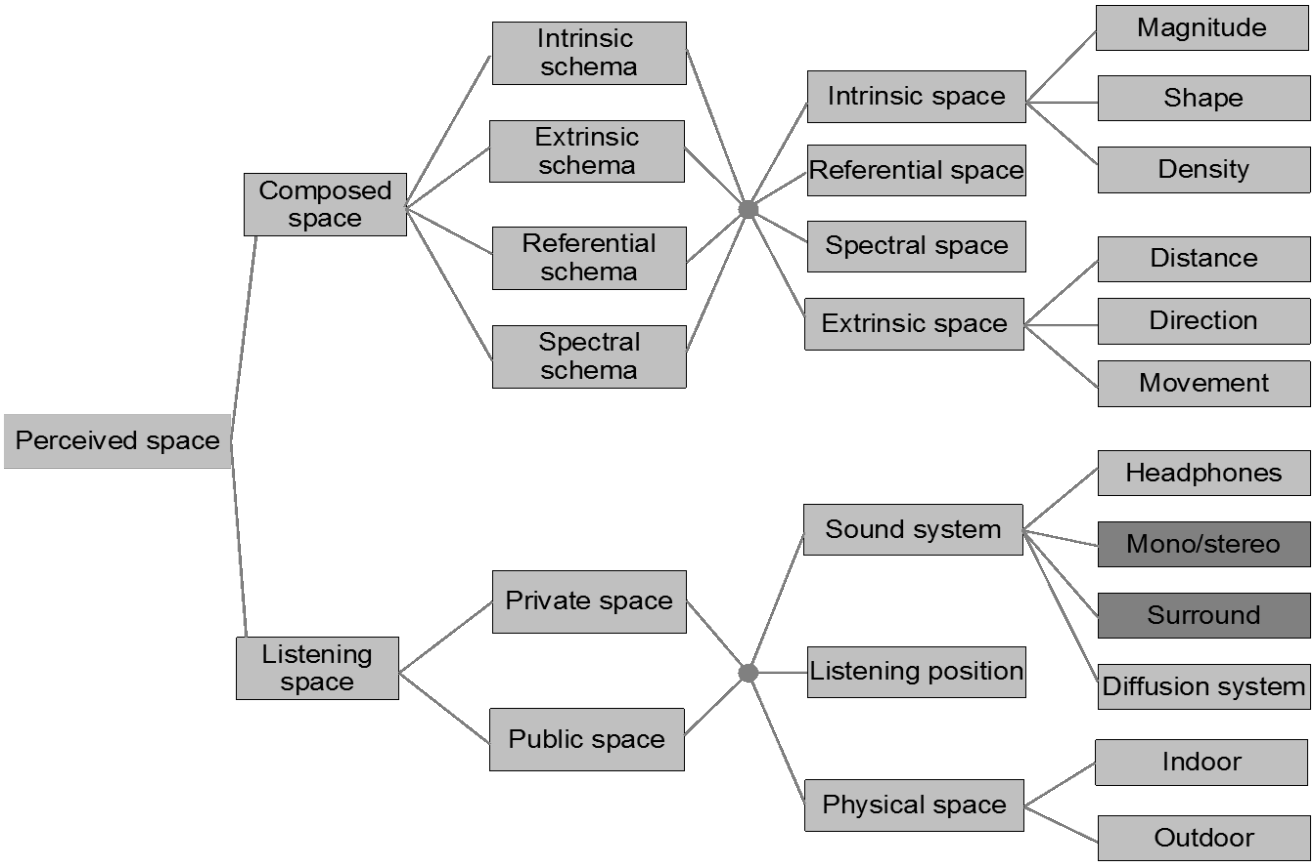

Fig. 2. Schematic overview of Spatio-structural theory. (© Frank Ekeberg.)

sounds into larger-scale contexts that I refer to as 'schemas'. The notion of schemas is established on the basis of spatial characteristics identified on the level of the individual sound, and extended into identifying tendencies in spatial configurations of sounds over longer time spans: 'Intrinsic schema' is when spatial development is carried by temporal change in spectral distribution and spatial shaping inherent in the sound material. 'Extrinsic schema' is when the focus is on placement and movement of the sound material, and locational relationships among sounds. 'Referential schema' is based on referential spaces as creations or re-creations of known sonic environments, including cues to dimensions of virtual space and extensions into real space, as well as the listener's perspective relative to a sound stage. Finally, 'spectral schema' is where sounds are primarily organized in a vertical space based on pitch relationships or pronounced nodal spaces. Shifts from one spatio-structural schema to another can occur in composed space, and a layering of two or more spatio-structural schemas can also take place.

Within the schemas, relationships are established on the basis of the nature of the individual sounds – their spectro-morphological qualities as well as associative qualities regarding source and context – and on the basis of the sounds' spatial behavior relative to each other and to the space they are in. Spatial movement, envelopment and distance are effective structural devices, and different directions and combinations of movement can incite different psychological reactions in the listener, and be of different communicative significance in the artistic context. Sequences of spatial counterpoint, and other combinations of movements, can effectively underline or counteract spatial and other types of expressive elements, such as dynamics and tempo, and function as intensifying or de-intensifying devices in the compositional structure. In addition, speed and the extent of movement are effective means for conveying energy levels and spatial dimensions in the work. Virtual spaces that are set up are dynamic, can undergo transformations over the course of the work, and can be juxtaposed into a multi-spatial sound field.

A vocabulary for labeling spatial properties of sounds is helpful in the process of discovering and identifying those properties. Based on the notions of intrinsic, extrinsic, referential and spectral space, a number of descriptors come to mind that specifically reference spatial properties of individual sounds:

- small/large
- dense/transparent
- dispersing/converging
- succinct/diffuse
- stationary/mobile
- directional/non-directional
- distal/proximal
- elevating/falling
- oscillating/circling
- pointed/enveloping

To further describe properties related to composed space and virtual spaces, the following descriptors may be added:

- spatial dimensions
- perspective
- sparseness/crowding
- pace/energy
- definition/diffusion
- collaboration/opposition
- references/associations
- envelopment/encirclement
- vastness/smallness
- intrusion/distance
- directions/paths of movement
- range/speed of movement

Listening space

The spatio-structural intelligibility of the

work is often dependent upon a successful interaction between the spaces composed into the work, and the space in which the work is heard. Variations in the spatial potential of different listening environments pose different possibilities with respect to how the work acoustically reaches the listener, and ultimately how it is perceived and experienced. The best sonic result comes from the best possible combination of sound material, listening environment and sound system. The room and the loudspeakers operate as one acoustic system. I use the term 'listening space', therefore, to mean the combination of listening environment and loudspeaker configuration.

There are significant differences in spatial potential between mono, stereo and surround systems. Mono is limited in terms of spatial depth, but flexible with regard to listening position. Stereo relies on a symmetrical configuration and a fixed listening position, but can convey a convincing frontal spatial image. Both techniques provide portability, although often at the expense of spatial complexity and precision. 2D and 3D surround sound techniques add the dimension of a real space by providing an arena for environmental cues that allows for complex spatial treatment, decorrelation and envelopment of the sound material. They also have the potential for covering a greater listening area with a higher spatial resolution, but require multi-loudspeaker systems that are often large and complex.

Differences in listening circumstance between private and public space, indoor and outdoor space, and any combinations or variations thereof, can significantly influence the listening experience with regards to acoustic characteristics, size and layout, and available listening position, but also social context, and expectations and conventions associated with space and circumstance.

In a typical concert situation each audience member is oriented differently toward the position of the loudspeakers, and thereby receives a different spatial image. Installing a loudspeaker system in a public space such as a concert hall or an art gallery often requires compromise in order to create a spatial average of the highest possible quality for as many listening positions as possible. In contrast, for headphone listening room acoustics are bypassed, and the spatial image becomes unaffected by listening position. The mobility of headphones further implies that any environment can be a listening environment. The use of headphones as a listening format has great potential for spatialization, as realistic simulations of 3D space can be created. However, the influence of sensory information external to the audio still apply, and must be taken into account.

Perceived space

The space the listener hears is the combination of composed space and listening space. The aesthetic experience is based on this resulting 'perceived space', and depends on how spatial cues in the work are understood in terms of communicational function in the artistic context. Perceived space is a multi-sensory space influenced by a complex web of factors, such as visual and tactile information, the circumstance of where and how the work is presented, cultural and experiential background, social context, interpersonal space and territory in the listening situation, and the listener's mood and receptivity. Familiarity with the genre and its expressive devices is often helpful in order to connect with and comprehend the various structural levels in the work.

Hall argues that people from different cultures inhabit different sensory worlds in which spaces are not only structured differently, but also experienced differently [7]. Hence, spatial interpretation and response are likely to vary among listeners, and also vary with listening space and context. Even with all the variables involved in spatial listening, space remains a powerful tool for artistic expression, and an essential element for aesthetic experience.

Conclusion

Space in sonic arts permeates aspects of the work at all stages of creation, presentation and appreciation, from choosing and manipulating the individual sound through to the overall listening experience of the work in a private or public setting. Space as an element of individual sounds and virtual spaces can be represented by means of spatial localization, as well as references to real spaces associated with the sound source, or with the composed virtual space, and can be articulated in terms of placement, envelopment, movement, opposition, enclosure, distance and intimacy, all of which can be treated as structural devices in the work. Even though spatial elements have been part of sonic artworks for a long time, awareness of the potential and complexities of space remains limited among art practitioners and audiences alike. However, because space is such an omnipresent part of communication in daily life, as well as in artistic contexts, it demands the artist's attention. Identifying spatial elements of sound, their interrelations and communicative significance is crucial for fully appreciating space as an artistic tool. I hope my spatio-structural theory is beneficial in that regard. See fig. 2 for a schematic overview of spatio-structural theory.

References and Notes

1. E. T. Hall, 'Proxemics', in S. Weitz, ed., *Nonverbal Communication: Readings with Commentary* (New York: Oxford University Press, 1979).

2. E. T. Hall, *The Hidden Dimension* (New York: Anchor Books, 1966, reprint 1990).

3. E. T. Hall, *The Silent Language* (New York: Anchor Books, 1959, reprint 1990).

4. S. Lyman and M. Scott, 'Territoriality: A Neglected Social Dimension', *Social Problems* **15,** No. 2 (1967).

5. J. Blauert, *Spatial Hearing: The Psychophysics of Human Sound Localization* (Cambridge, MA: MIT Press, 1997).

6. A term originally coined by Pierre Schaeffer (referenced in Smalley [12]). It refers to sounds with a strong spectral emphasis, but without a clear identifiable pitch.

7. Hall [3].

8. A. H. Benade, *Fundamentals of Musical Acoustics* (New York: Dover, 1990).

9. A. Bregman, *Auditory Scene Analysis: the Perceptual Organization of Sound,* (Cambridge, MA: MIT Press, 1994).

10. S. Handel, *Listening: An Introduction to the Perception of Auditory Events* (Cambridge: MIT Press, 1989).

11. F. E. Henriksen, *Space in Electroacoustic Music – composition, performance and perception of musical space*, PhD thesis, (London: City University, 2002).

12. D. Smalley, 'Spectro-morphology and Structuring Processes', in S. Emmerson, ed., *The Language of Electroacoustic Music* (London: Macmillan, 1986).

13. D. Smalley, 'Spectromorphology: Explaining Sound Shapes', *Organised Sound* **2,** No. 2 (1997).

14. D. Smalley, 'Space-form and the acousmatic image', *Organised Sound* **12,** No. 1 (2007).

15. J. Tenney, 'Temporal Gestalt Perception in Music', *Journal of Music Theory* **24,** No. 2 (1980).