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ARRAY2022 – Space. A frontier?

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space

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Index.....	p. 3
Editorial	
Miriam Akkermann.....	p. 4
Spatial Audio in Online Presentations	
Kerry Hagan	p. 5
Vertigo of the ears and eyes: Embodied experiences of hybrid spatiality in Brice Pauset's <i>Vertigo/Infinite Screen</i> (2021)	
<i>Margarethe Maierhofer-Lischka</i>	p. 8
Stereo and Ambisonics: A reflection over parallel spatialization techniques in the piece <i>Scie Luminosissime</i>	
Giuseppe Pisano	p. 14
Emergent Spaces – <i>Subjective Sonification of Spaces. An Artistic Approach</i>	
Lula Romero	p. 22
<i>Chaos in the Garden. Human-assisted AI Composition in Experimental Spatial Music</i>	
Henrik von Coler	p. 33
Music is in the air. Sounding performances in hybrid and virtual space	
Miriam Akkermann.....	p. 46
Authors of this issue.....	p. 52

Imprint

Main Editor *Array*: Miriam Akkermann

Published by the International Computer Music Association ICMA 2021

1819 Polk Street, San Francisco, California 94019, USA

DOI: <https://doi.org/10.25370/array.v2022>

<https://journals.qucosa.de/array/>

www.computermusic.org

Editorial

The concept of *space* appears has always been a pivotal aspect to music. The emergence of spatial thinking can already be seen in the Venetian polychoral style (*cori spezzati*) of the 16th century when multiple choirs where spatially displaced at St. Mark's Cathedral.

Today, we have expanded and maybe even removed the notion of spatial confinement with the aid of technology. Physical and architectural space as well as displacement (seemingly) has no longer the same meaning as it did to church composers of 16th century Venice. However, with the complex combination of real and digital spaces arise new challenges which consolidate in a huge variety of aspects taking influence on a musical piece.

Some of these concepts of *space* are rather inherent such as the (studio) space music is created in, the conceptual space in the composer's mind, the space audible in a sound sample, and the audible but virtual space within a musical work created by a composer as part of an artistic vision; other aspects are more explicit such as the sonic and archi-

tectural features of the space a musical work is performed in, as well as the design of the presentation within a performance space with eventually specific seating of the audience and (technically adjusted) spatialization of appearing sounds within this space. An interplay of these aspects influences then how a musical piece is created, how its compositional structure and the required performance environment and technical set-up looks like, which strategies for documentation and preservation apply, and how we talk about a composition.

This issue of Array presents how composers and sound artist consolidate these aspects in their works, how concepts of *space* can be framed from an analytical perspective, and what it means to create artificial (virtual) spaces to present current practices and technical discourses in hybrid settings such as an ICMC.

A special thank goes to Martin Ritter, who initiated and outlined this wonderful topic.

Miriam Akkermann (Editor)

Spatial Audio in Online Presentations

By Kerry Hagan

The pandemic forced conferences to evaluate hybrid and online alternatives for academic and artistic presentations. Although many conference activities adapted quickly to online formats, e.g., paper presentations, some elements suffered more severe losses when moved online. In particular, online formats significantly impacted spatial music concerts.

Considering binaural recordings are currently the only method for reproducing spatial music in two channels, it made sense that conferences for spatial music relied on delivering binaural audio in various ways. Previous to ICMC 2022, I attended several online concerts that tried to provide spatial audio. In some cases, artists created VR simulations of their works. VR was especially interesting for spatial compositions with visual elements, but it was a convoluted method for creating binaural recordings for audio-only pieces. Additionally, composers without access to VR engines could not present with this method.

In other cases, the conferences relied on the artists to provide two-channel recordings of their work, and the organizers hosted those recordings. Several participants provided their works binaurally instead of mixing down to stereo. Given that most electronic and computer music audiences would attend online concerts with headphones, the results were relatively acceptable. The onus to encode binaural recordings fell on the composers.

In the case of the *Klingt Gut* festival of spatial music, the organizers acquired the multi-channel works from the composers and used a dummy head for binaural capture in their sound dome. This stream led to a more realistic experience, partly because the dummy head picked up the environment. Adding room noise may be counterintuitive since composers often try to reduce the physical space to create a virtual space in their work. But for an audience member, the experience felt more live, present, and engaging.

Due to this experience, ICMC 2022 organizers chose to stream audio from a dummy head for its spatial audio concerts. The feedback from

online delegates matched the experience of *Klingt Gut*. One audience member also mentioned that there was more intimacy because we positioned the dummy head inside the audience. Therefore, the stream contained environmental noises and applause from the audience's perspective, giving the online delegate a realistic concert experience.

The trade-offs of these different ways of presenting spatial audio online may be apparent. If the host requires composers to mix their binaural versions, some artists may find this restrictive depending on their software, hardware and laboratory access. Also, composers with more knowledge of virtual systems may find it easier than early career researchers or composers who work entirely in audio-only media. The dummy head solution requires nothing more than what a composer would supply in any other multi-channel presentation. However, despite the positives of audience integration, composers may wish to have more control over the mix than the dummy head provides. Additionally, good dummy head microphones can be prohibitively expensive for concert or

conference organizers.

There is one more factor that none of these solutions address. Spatial concerts delivered online also face the same problem as regular online concerts: streaming audio requires compression, and most streaming services compress audio as MP3 or comparable. Although some online platforms may enable 'original audio', other common platforms compress audio significantly. When combined with the simulation HRTF that binaural audio employs, compression can hurt spatial images. Many composers are vocal in their disappointment with compression through standard channels.

Ultimately, conferences and festivals attempt to provide the best approximation of the in-person experience. Audiences, composers and organizers seem to have different needs regarding online spatial audio concerts, and there currently isn't an ideal solution that satisfies all stakeholders.

ICMC 2022 chose the dummy head solution. The compression that came from streaming didn't impact too severely, though there were some instances where the format was not ideal. Though the pandemic is slowly ending, permitting more

travel, other issues, such as climate change, motivate organizers to continue employing online or hybrid options for delegates. It stands to reason that future research should address the composer and audience experience and the technologies for streaming audio, especially for electronic and computer music and spatial audio.

**Vertigo of the ears and eyes:
Embodied experiences of hybrid
spatiality in Brice Pauset's *Ver-
tigo/Infinite Screen* (2021)**

By Margarethe Maierhofer-Lischka

Recent research on musical performance highlights music listening as an embodied activity strongly influenced by and connected to mental representations of music-related movement schemata (Cox 2016). Listening thus can be considered an inner "dance on memorized schemata" (Stahnke 2001, 25) that combines inputs from hearing, touch, vision and bodily motion (Schroedter 2017). Especially composers of contemporary music challenge their listeners by creating complex tonal, temporal and spatial impressions (Utz 2016, 602-609), a phenomenon which is brought further by the increasing use of electronic audiovisual media. Being immersed into an audiovisual performance can be pleasurable, but it can also make listeners feel painful or sick. This article examines the perceptual phenomenon of vertigo in regard to musical intermedia performance, demonstrated by a brief analysis of *Vertigo/Infinite Screen* (2021) by French composer Brice

Pauset, an intermedia piece in homage to Alfred Hitchcock's iconic film *Vertigo* (1958). Many current intermedia compositions call into question the distinction between "live" and "mediatized", physical and virtual, resulting in a growing body of scholarship on musical multimedia or intermedia performance (cf. Auslander 2008, Chapple & Kattenbelt 2006). The following analysis shows how *Vertigo/Infinite Screen* plays with sensations of vertigo by blurring the boundaries between experiences of real and virtual space through sound and moving images.

Vertigo describes disorders of the gravitational sense located in the inner ear, resulting in partial loss of spatial orientation and movement coordination. Those can be caused by turning motions of the body (motion-induced vertigo) or they can appear as somatoformic vertigo related to mental disorders. Somatoformic vertigo can result from phobias, depression and schizophrenia, as well as from the consumption of media (Brandt et al. 2013, 146ff.). Vertigo as media sickness results from incoherent and excessive sensory stimuli that create sensory traumata resulting in somatic reactions

of the nervous system. Recent studies show that vertigo appears in a significant number of people in correlation with experiences of virtual (VR) environments. It can be also caused by wearing noise-cancelling headphones (Dan-Goor & Samra 2012, Chattha et al. 2020). Virtual reality can be defined generally as a medially created environment that employs several modalities (vision, hearing, touch) to imitate or implement sensory features, behaviors and qualities of known physical environments, thus allowing for understanding and purposeful interaction (Doerner et al. 2014, 3ff.). Following Eric Clarke (2013), a musical piece can also be considered a virtual space, making listening an effort of balancing between the real and the virtual. Sociologist Shuhei Hosokawa had already described negative effects when listeners' attention navigates between virtual and physical sonic environments, which he dubbed as the "walkman effect" (Hosokawa 1984). While Hosokawa had referred to urban contexts, Nicholas Cook later on suggested three categories to describe intermedial relations in performance: conformance, complementation and contest (Cook 2001).

Media-induced vertigo can be understood as a result of states of contest between hearing and vision as well as between virtual and real-world experience.

Hitchcock's *Vertigo* is considered a landmark of suspense cinema. The film tells the story of a policeman falling in love with a woman who commits suicide. In an attempt to relive his failed relationship, he starts an affair with a young girl which also ends tragically. *Vertigo* is considered one of Hitchcock's main works and has received considerable attention in film studies for its intricate visual language. The loss of perspective and orientation captivating the characters throughout the film is presented as visual force that destroys their attempts to regain individual agency (Cavalletti 2022). Hitchcock used a special camera technique, the Dolly-Zoom (later also called *Vertigo effect*), to represent vertigo by distortion of perspective and visual space (Hasche & Ingwer 2016, 148f). The iconic film score by Bernhard Herrmann presents an auditory maze made of constantly looping motives, avoiding a tonal centre or formal direction (Gelly 2021).

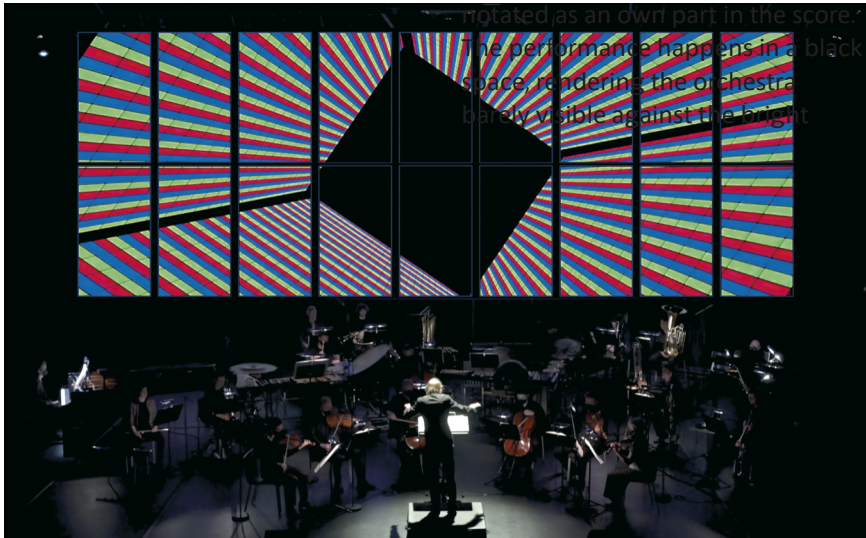


Fig. 1: *Vertigo/Infinite Screen*, performance by Klangforum Wien 2021¹

Vertigo/Infinite Screen screen was premiered 2021 at the Wittener Tage für Neue Kammermusik. It features an orchestra in six groups, electronic sounds and a visual installation. The composition follows closely the form and structure of the film, incorporating elements of Herrmann's soundtrack as well as sound snippets from the film's dialogue and foley. The visual part of *Vertigo/Infinite Screen* is a video installation presented on a giant projection wall made up of a grid of 9x2 LED panels. The visuals are performed live on

screen. In the beginning, swirling chords cross all instrumental groups. Sudden appearances of film-stills create moments of incarnated perception (Kaltenecker 2008), followed by darkness and color flashes disturbing the sense of time, body and space. Unlike in the film, visuals and music do not create a common narrative but two parallel sensory inputs (Auslander 2013). While Pauset's music has nuanced dynamics, the visuals retain high contrast, strong colours and high speed.

One scene in Hitchcock's *Vertigo* features recorded music playing from a gramophone. Hitchcock wanted the record to sound fragile and blurred, almost hallucinogenic. In *Vertigo/Infinite Screen*, Pauset picks this up and lets fragments of the gramophone music appear in the electronics (Pauset 2021, bar 42ff., 288ff.) These inserts are a key element for creating sound-related impressions of vertigo: they are clearly tonal and melodic, marking a shift from the harmonic and temporal disorientation happening in the beginning section towards a moment of recognition of known elements (Schroedter 2017, 225). Throughout the piece, the inserts become longer, dislocating and warping the orchestral sounds until the spatialized electronics sometimes take lead over the acoustic instruments. The recognizable acoustic and visual features of the physical room are constantly blurred and overwritten by the fast-changing flashes of light and dark and the changing sonic space created by the electronics. When entering the performance, the listeners arrive with a perception of the physical space that gets subsequently confused by the virtual audiovisual environment which

remains inconsistent and fluid, introducing slips of perceptual disorientation, a "Tasten und Zögern" (Waldenfels 2007, 19). Like the "walkman effect", a subtle estrangement happens between the listeners' proprioception and the impressions of the virtual space. Throughout the piece, electronic sound and visuals are used in conformance – to speak with Cook – to create a situation of sensory overload, competing for attention. The fast-changing visual and auditory spatialities challenge the perceptual capacity of the audience, stimulating embodied experiences similar to VR-induced motion sickness. Unlike artists who intended their piece to pose a critique against contemporary media accesses, the actual use of audiovisual media in *Vertigo/Infinite Screen* appears like a "psychic apparatus", a term Friedrich Kittler (1995, 352ff.) introduced to describe electronic media's potential to modulate the psychic states of an audience. *Vertigo/Infinite Screen* is not only a bare retelling of Hitchcock's movie. It uses the unsettling potential of excessive visible and audible movement dynamics to transfer the film's visual effects into the sonic and spatial domain. It draws from embodied

listening to place motion sickness, or vertigo, at the heart of an intense spatial and audio-visual experience.

Notes

[1] Brice Pauset / Arotin & Serghei: *Vertigo/Infinite Screen* (2020-21), intermedial composition based on Alfred Hitchcock's "Vertigo" for ensemble in 6 groups, 18 pictures and electronics. Foto from a performance played by Klangforum Wien, Centre Pompidou, Paris 2021; Photo: AROTIN & SERGHEI Contemporary Art 2021.

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Stereo and Ambisonics: A reflection over parallel spatialization techniques in the piece *Scie Luminosissime*

By Giuseppe Pisano

As a composer of acousmatic music, I have often presented my work on a variety of different loudspeaker systems whose can be subdivided in two macro-families: those intended for the playback of multichannel pieces – often symmetric systems, in the shape of a circle, a dome, or a regular polygon – and those intended for acousmatic diffusions – the loudspeaker orchestras, mainly employed for the diffusion of stereo pieces, where the performer spatializes sound in real time. In this practice, it is not uncommon to listen to re-adaptations of pieces, presented in different formats to suit different types of systems, and I have always found the Ambisonics workflow a very successful approach to scale my pieces on systems belonging to the first macro-family. However, when I first faced the need of presenting my multichannel pieces on systems meant for stereo diffusion, I was very unhappy with the results I achieved through the typical methods employed to adapt Ambisonics

to stereo, such as rendering my pieces in Ambisonics UHJ format, or using virtual microphones to record the sound field in stereo. Based on this experience, I decided to compose a piece in two versions in parallel, for stereo-setting and Ambisonics.

This process initiated a reflection process on how I would manage sonic materials differently according to the format to emphasize their characteristics and has become an acquired strategy in my compositional practice.

The first piece I composed in parallel as a stereo- and Ambisonics-version was *Scie Luminosissime* (2018-2020)¹. In this paper I outline the compositional process of this piece, and highlight some conceptual differences that determined my choices in the use of the materials and the approach to spatialization.

Scie Luminosissime was inspired by the album *Fratello Mare* by Mike Cooper and the poem *Sii dolce con me. Sii gentile* by Mariangela Gualtieri. This inspiration is rather indirect but provides the setting in which I wanted to compose. The materials used in *Scie Luminosissime* include field recordings ob-

tained during the summers of 2016 and 2017 – mostly fragments of human agencies in different reverberating spaces – in dialogue with concrete and synthesized sounds – the *scie*, usually distorted and/or convoluted trails of synthesized sound tones – and a few bits of sound sampled from different guitar pieces by Mike Cooper. My goal was to generate momentary and elusive visualizations of human interactions in an otherwise diffused blur of gestures and fragments.

The time-structure of the piece can be divided in two parts, each subdivided in two sections.

The first section is mainly characterized by simple tones (1) to which other concrete elements are gradually added, occupying wider portions of the spectrum (2). The cumulation ends with a gesture (3) that opens a new section and reiterates later (4) with a different organization of the materials. The idea was to create a new perspective, as if the same picture was seen from a different angle. After this, the space dissipates fading back into luminous trails again.

In his article “Space-form and the Acousmatic image”, Denis Smalley

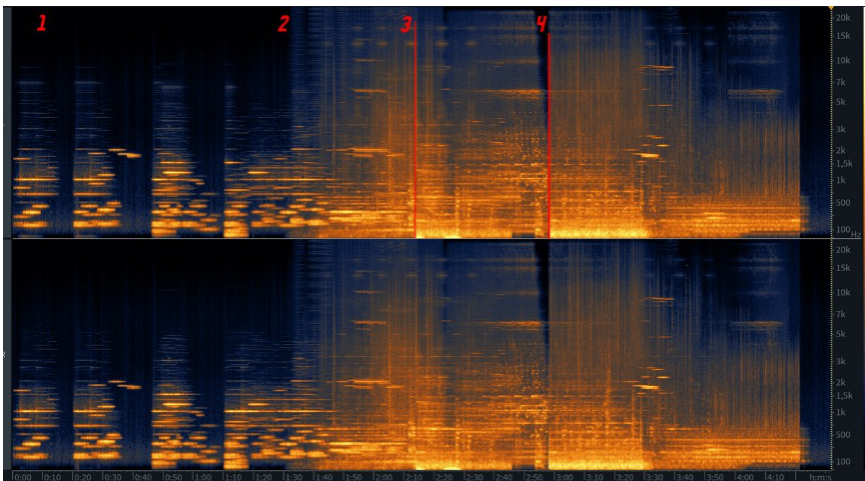


Figure 1: spectrogram of *Scie Luminosissime*, the numbers highlight the four sections of the piece.

(2007) describes a soundscape he listens to sitting by his window. He is inside, and the whole world is outside, beyond the fourth wall. The idea of being a spectator of sound from a vantage point reinforces once again the parallel between acousmatic music and cinema which has been structural in the discourse originated in the French literary and musical school (Chion 1990; Normandeau 1992). This connection is even more important now that the expansion of sound from stereo to more immersive formats is becoming a widely available technology, especially through the film industry and other audio-visual media, and demonstrates how Smalley's front-based approach to the description of the soundscape in the article is in reality much more techno-centric than openly intended.

In Smalley's narration, the window is the point from which the sound radiates in the listening space, it is both an access to the external sonic environment and a filter that facilitates the localization of the different sound sources.

When we listen to music in stereo, loudspeakers behave in a very simi-

lar way as this window. They define a front from which sounds radiates in our listening space, a two-dimensional surface on which a three-dimensional illusion is represented as in a *trompe-l'oeil* (more a *trompe-l'oreille* in our case) that uses perspective to generate depth. This changes radically when we are surrounded by loudspeakers. We do not sit by a window, we sit under a "glass dome", we can still have a frontal perspective, but our perception responds to stimuli coming from every direction. In this situation, music is then not merely projected in the listening space, but it becomes the listening space. The listener is in the sound field, immersed, and the sound is an architecture.

Materials in an immersive sound-field context are hierarchically organized in a figure/ground relationship. This gestalt notion, that has been applied before to many other fields such as soundscape analysis (Porteous and Mastin 1985) and acousmatic music (Santarcangelo and Wanke 2020), is of course still relevant for immersive formats where music-space and listening space overlap. A good example might be the nomenclature used to

distinguish between the two types of sound sources in Dolby Atmos: Beds and Objects. Beds are multi-channel sources, meant to establish a scene, while Objects are mono sources that would benefit from a more precise positioning and from panning.² This distinction is not just practical or operational, but reflects a difference in the perceptual and musical roles of the sound materials, which can also be applied to other immersive formats. When composing in Ambisonics, authors can adopt a similar approach. Some sounds can be treated as structural pillars of a scene, establishing the environment. Other materials can have more prominent roles, not only in terms of levels and clarity, but also in their spatial behavior with faster trajectories, swift movements, dramatic panning. However, the absence of a structural distinction between sources and their roles allows for more nuanced musical solutions and alterations in the roles of the materials.

An example of how I apply this paradigm is at the beginning of *Scie Luminosissime*, where, in the beginning, every single tone is a fixed position, like in a constellation, where

every star has its own place. These become spatial references, describing and defining the sonic environment with their presence.

As the piece develops, more resonances add up together with similar elements of different timbres, moving slightly or appearing in opposite positions to the sound they originate from. These new materials generate a movement around the original structure, and every new tone is introduced with similar copies of itself, each presenting slightly different characteristics. The original instances are still fixed in space, as solid statements of presence. The other ones emerge from the background, creating a shapeshifting environment.

In the stereo version of the piece, this effect was achieved by determining a position for each original source on the horizontal plane, choosing to leave low frequency sounds in the middle and to enlarge the picture progressively at higher frequencies. Resonances were obtained with a stereo reverb, inverting channels after a low pass filter. In the Ambisonics version, I used a different technique encoding the original mono sources with different

instances of IEM MultiEncoder,³ creating new copies of some of them to fill the entire space.

For the additional sounds emerging, I decided to create small alterations in their position modulating the values for the coordinates with a random LFO at a very small amplitude, which generated an organic liveliness.

Lower frequency sounds and resonances which I wanted to sound bigger and further away were encoded using the AmbiX suite by Matthias Kronlachner (2013). This software presents an additional parameter called size that can be used to adjust spatial directivity, adjusting the ratio between the levels of the omnidirectional signal and those of the other spherical harmonic components. At higher values of size, the sound sources are spatialized as more omnidirectional, equally distributing the sound to all loudspeakers, making them appear bigger, but also less directional. Adjusting this parameter, I was able to spatialize sounds with a weaker sense of directionality which played a different role.

Gestural sounds which, in the stereo version of the piece, were spatialized using traditional linear panning, in Ambisonics expand their movement to the second and third dimensions, swooshing from one side to the other of the sphere. These movements are achieved using crossfades between two encoded monophonic sources, and are presented over multiple diameters, to increase the sense of tridimensionality.

Another important difference between 3D Ambisonics and stereo is the introduction of verticality. However, while real height can only be found in three-dimensional sound formats, different techniques can be employed in stereo to generate a perceptual illusion of height. Denis Smalley provides some good examples for this when introducing the concept of gravitation, referring to the work of French composers such as François Bayle, François Delalande, and in particular to Bernard Parmegiani and his piece *Geologie Sonore* (Kronlachner 2013). In his writings, Smalley addresses height from a spectromorphological standpoint, claiming that the illusion of vertical movement is based on the

quality and the behavior of the sonic materials. A psychoacoustic approach to the production of vertical panning illusions is provided by Curtis Roads in the book *Computer Music Tutorial* where he stresses the role of the pinnae in sound localization on the vertical plane. Showing the Head Related Transfer Function spectra of sounds coming from above and below ear level, he describes the functioning of vertical panning (Roads 1996).

In Ambisonics, I found it very useful to spatialize sounds over the vertical plane trying to imitate or to refer the behavior and spectral characteristics of sounds that I am most likely to perceive above or below ear level in real life. For example, there are sounds of birds or sounds that “behave like” birds, there is the sound of rain and a sound that “behaves like” rain. Exploiting the vertical plain to spatialize sounds can provide an extra layer of realism to unreal sounds. Similar effects are much more difficult to achieve in stereo. As pointed out by Roads (1996, 10), realistic vertical panning illusions depend on too many factors such as speaker placement and listener’s position, and are therefore extremely situa-

tional and very fragile. But Roads also describes that sound localization on the vertical plane is stronger for sounds above 6 kHz. Keeping this in mind, I found it useful to split sounds with very complex spectra over different frequency bands using a set of EQs, and spatialize these bands individually. Increasing the width of high frequency components did not provide any clear illusion of a vertical panning movement, but it widened the stereo image, giving more air and a stronger sense of openness to the sound image. I found it also useful to combine this frequency-based approach to the material- and spectromorphology-based approach described by Smalley, and to see them as two sides of the same coin which together contribute to create an illusion of height in a stereo mix. Spatializing filtered components of sound sources is a technique that was used extensively in *Scie Luminosissime*, especially for granular materials, where multiple monophonic sources are processed using the GRM Space Grain⁴ a multi-channel granulator whose resulting signals are then filtered and encoded using multiple IEM Multi-Encoder with some personal presets.

Scie Luminosissime was the first piece I composed using this parallel method, which I later adopted for other works, too. I found this compositional process of creating two versions of the same piece very useful to thoroughly exploit the strengths of both formats. The versions share the same materials, the same structure and the same duration, but manifest themselves animated by very different spirits.

While the stereo version appears more compact, perhaps with a stronger body, more punch and a concrete foundation, the Ambisonics version is more enveloping and relaxed: gestures are perhaps less dramatic, but more realistic.

When working in Ambisonics, my feeling was that certain sounds did not require the same dynamic presence that I was using in stereo. Instead, they could interpret their role in the narrative development of the piece much more successfully with just a different organization of the space.

Another relevant aspect is how the relationship between full and empty space was managed differently in the two versions of the piece. Filling space in Ambisonics simply requires “more sound”, and adding multiple

voices of a sound material, if correctly positioned, will rarely results in the space feeling crowded. It was therefore necessary to double some sound sources in the Ambisonics version or to cut out few others in the stereo version to balance the sense of fullness and emptiness in different moments of the piece to make sure that the same impression was achieved.

In conclusion I think that my approach to the composition of this piece has perfectly filled the purpose of making the two versions perfectly functional to the two different types of loudspeaker systems and performance styles. Expanding this workflow to other pieces has made possible to present the entirety of my work in all possible contexts.

Notes

[1] www.giuseppepisano.com/fixed-media/ (last access Feb. 16, 2023).

[2] Dolby Atmos Renderer v3.0. Dolby Lab. Inc, 2 August 2018, 116.

[3] IEM – Plug-in description “multiencoder”, 2022. <https://plugins.iem.at/docs/plugin-descriptions/#multiencoder> (last access Feb. 16, 2023).

[4] InaGRM – Spaces, 2022. <https://inagr.com/en/store/product/15/spaces> (last access Feb. 16, 2023).

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Emergent Spaces – Subjective Sonification of Spaces. An Artistic Approach

By *Lula Romero*

Introduction. Space and Spaces

Different conceptions of space involved in computer music practices influence the aesthetic result of the musical work differently. Post-serial space understood as structure has different aesthetic results than the concept of space as place, as it has been conceived of in sound art, the abstract and acoustic space of practices that employ technologies such as ambisonics, or the notion of space as bodily presence and embodiment. In what follows, I describe the concept of space inherent to my practice and how it is concretized in my artistic approach to the practice of sonification that I have called *subjective sonification* of spaces. Finally, I discuss and exemplify this practice and its aesthetic consequences in a case study, the work *Dérive* (2017) for live electronics and string quartet.

In my practice, space plays an important role in creating a multiplicity of experiences and understandings for the listeners. For me, space,

instead of a frontier to conquer, is an opening. Parameters and networks of relations have a spatial dimension and materials are the results of combinations of spatial processes instead of merely being distributed in space. This implies a relativist and relational conception of space similar to the concept of space described by the sociologist Martina Löw, which she sets off against absolute and relative or phenomenological conceptions (Löw 2016). Löw describes space as a relational arrangement (*An-Ordnung*) of social goods and bodies that are in constant motion, so that the arrangement itself is always changing. Beings have an agency to shape and create spaces but also social goods, such as sounds or odors influence the creation of space and the arrangement of beings (Löw 2016, p. 129). In Löw's conception, space is not preexistent but rather emerges by virtue of elements and their relational connections. Moreover, the perception of spaces, how they are imagined, regulated and institutionalized, plays an important role in its constitution and continuous transformation. Space is not only a placement of bodies and their actions but also its perception, conception and

institutionalization. All these aspects influence the constitution of space, its characteristics and its transformations (Löw 2016, p. 189). In my compositional work, I understand space similarly to Löw's relational concept, as a dynamic system of interactions between objects, structures, social relations, and actions. Therefore, material but also space itself emerge in the encounter between the network of relations, listeners, sound sources, performers and the acoustics and dimensions that constitute the performance space. Space is also in continuous transformation during the compositional work. There is not a prior space that remains the same throughout the course of the whole piece, rather the different relations established by sound materials and sound sources among themselves, create and transform space. The listener, due to their position in relation to the sound sources, establishes their own links and relations with the sound material. In turn, the listener's perception, expectations, and understanding of sound events modifies their experience of subsequent sounds events of the musical work. Space in my compositional practice emerges in performance

and it is not equal to its geometrical representation. Still, the emergence of an open space is not granted by merely positioning sound sources and listeners in a hall. To allow for the emergence of an open space, I use specific compositional strategies, one of them is that of *subjective sonification* of spaces.

Subjective Sonification, case study Dérive

Subjective sonification explores the aesthetic consequences of three different ideas: the role of subjectivity in sonification processes, the concept of *dérive* (Debord 1958), and the notion of musical structure as a translation of a real physical space. In sonification processes, there is always an element of subjectivity in the interpretation of the data into musical parameters or musical transformations. However, as the molecular biologist and philosopher Hans-Jörg Rheinberger points out, the data collected in scientific experiments are not themselves strictly objective (Rheinberger 1997). Data do not present the phenomenon in itself; they rather represent it, hence, they include an element of interpretation and thus

subjectivity. Following this idea, *subjective sonification* explores the repercussions of this element of subjectivity, not only in the translation of the data into music but also in the collection and creation of the data themselves. Hence, the method has two parts: the collection and creation of subjective data and their sonification in a sound work.

Collecting Data and Mapping

Dérive (2017) for string quartet and live electronics is the sonification of a walk in Berlin.¹ The *dérive* is a situationist method proposed by Guy Debord, which “entails playful-constructive behavior and awareness of psychogeographical effects;” (Debord 1958, 7). In a *dérive* “one or more persons during a certain

period drop their motives for movement and action, their relations, their work and leisure activities, and let themselves be drawn by the attractions of the terrain and the encounters they find there” (Debord 1958, 7). The data to be sonified in the composition of the piece are the data collected by my subjective *dérive* with the duration of an hour in the city of Berlin. To document my *dérive*, I installed a tracking application on my smartphone that recorded my path. The application also provided different tools for recording and attaching data and media files like text, video, and audio recordings, that were used to record particular observed details, impressions, thoughts, and decisions. This method generates two sets of data:



Figure 1: Map of the walk. Movements and area covered during the walk marked in red. The beginning of the walk is signified with a small red arrow, the end with a square. Blue dots signify pauses, while green dots signify changes of trajectories, impressions or events.

Quantitative data

- Movements, trajectories, and the area covered as collected by the tracking application (figure 1).
- Duration and velocities of the trajectories and pauses.

Qualitative data – “Walk diary”

- Events and motivations for each change of direction.
- Subjective impressions recorded in photos, texts, sound recordings, videos.²
- Field recordings (audio files).

A subjective mapping is applied to the collected data during the composition of the piece. The sounds of the walk – either as direct recordings or as my transcriptions-interpretations of the events of the walk

– are the sound material of the piece. The data collected – the different stages of the walk and their velocities and durations – provide the basis for the development of the macro- and meso-structure of the work, while trajectories and movements are a model for the spatialization of the sound. The 60 minutes temporal range of the derive, its different speeds and rhythms are reduced by dividing them by four (around 15 minutes). The total area covered by the walk is reduced to the dimensions of the performance space in which the sound sources are placed in such a way that they trace the contour of the walked area.

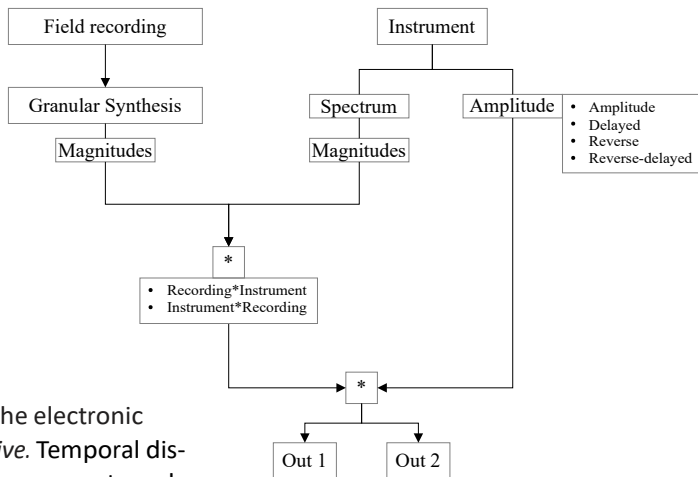


Figure 2: Flow chart of the electronic process in *Dérive*. Temporal distribution of places, events and impressions during the walk

Transformations of the Field Recordings

The different field recordings collected during the walk are not presented as such but they are live processed with granular synthesis at different moments in the piece. The grains of the synthesis are considerably large – 2.5 seconds – while the density of grains is low – on average of 5.5 random impulses per second. After the processing, the transformed field recording retains some of its sonic characteristics while its referential content is blurred. I processed the results of the granular synthesis process further by convolving it with the sound of the string instruments (figure 2).

The sound of the instruments is recorded and their amplitude envelope and spectral content is analyzed during the performance. I used a process that multiplies the magnitudes of the frequency spectrum of two signals and applies the phase of the first input. Two outcomes are possible:

- 1) field recording * instrument – the sound result is the field recording spectrum multiplied by the magnitudes of the spectrum of the instrumental sounds – and
- 2) instrument * field recording – the

signal of the instrument works similarly to a resonant filter of the spectrum of the field recording. The piece alternates between these two options for each instrument. Afterwards, I multiplied the resultant four signals – one for instrument – with the amplitude envelope of each instrument. Still, the amplitude envelope of the instrument is used in four different ways: amplitude without processing, delayed amplitude envelope, inverted amplitude, or inverted and delayed amplitude. These four possibilities are applied at different moments to the electronics.

The sound of the instruments modifies and transforms the field recordings. Instead of a juxtaposition of field recordings with an instrumental material, *Dérive* displays the outcome of the interference – *intra-action* (Barad 2007)³ – between the field recordings and the instrumental material. Moreover, the piece shows the intra-action between the spaces of the walk and my subjective perception of them.

Emergence of Spaces

The electronic processing generates four two-channel signals which are each distributed differently in space

and time during the piece. The musicians are positioned around the audience, each one in the center of each side. The speakers are positioned in front of the musicians and around the listeners (figure 3).

The form of the piece traces the walk and is linked to the localization of the sound sources. A main instrumental line, characterized by fast figurations and a louder dynamic level, is defined as the “walker.” During the fifteen minutes of the piece, the main line moves together with its electronic transformation, slowly describing a circle from the front left corner of the venue and violin I, going through front, right and rear to arrive on the left side and cello. During the *dérive* of the main line, the other instruments play secondary lines defined by softer dynamics and low activity (figure 4). The sound transformations of these secondary lines are localized on the pair of speakers closest to the instrument playing it. The main and secondary instrumental lines transform the same field recording at each moment. Therefore, the field recording is modified four times by different sound materials and actions and then sent to

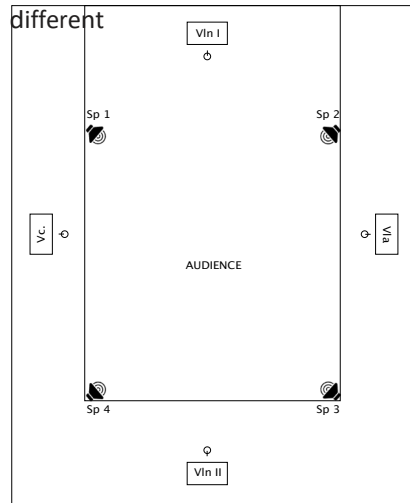


Figure 3: Positions of musicians, speakers and microphones in the performance space (Villa Elizabeth, Berlin).

speakers. The audience is submerged in an open space of multiple transformations of the field recording and different instrumental lines, while they can still follow the slow movement of the “walker” through this space. Still, the immersion proposed in this work is not a passive and uncritical form of listening (Schrimshaw 2015), but rather an active listening of an event that manifests itself differently in their relations when heard in different positions.

A total of nine field recordings are used in *Dérive*. Figure 5 shows a table of the temporal distribution of the different field recordings used and their content.

The performance hall and its acoustic characteristics influence and shape the sounds and spaces proposed by the work. Instead of trying to abolish its influence, I tried to enhance its characteristics and include them in the work. The premiere of *Dérive* took place in the Villa Elizabeth in Berlin. The hall has very distinct acoustics, since three of its sides – left, right and back – are covered by galleries. I positioned three of the musicians – viola, violin II and cello – under the galleries, while the loudspeakers are on the galleries facing down. The sound of the instruments under the gallery is filtered, but also reflected and projected forward. This is important when these instruments are playing the main line. Further performances in different venues will include the specific characteristics of each place in the disposition of sound sources.

As I mentioned previously, my compositional concept of space is a relational one. Space in *Dérive* is a net-

work of sound sources, sound material, their movements among the sources, the musicians' actions, the listeners' positions and their perception, the acoustic characteristics of the performance hall, but also the spatial characteristics of the field recordings, the pitch space, my subjective mapping, and my understanding of space. All these elements have an agency. Moreover, the spaces are not static in time. They are not intended to create a mere immersion of the listener in sound, but they rather develop during the work. Sounds and space – in their developments and different manifestations – offer different perspectives and understandings to the listeners. The piece involves an exploration of different spaces by different strategies during its composition. Furthermore, in its performance, the work proposes the listener an aesthetic exploration of the acoustic, perceived and virtual spaces without imposing any one of them. By doing so, *Dérive* situates itself in a no man's land between experimental electroacoustic composition, instrumental chamber music, sound art, and sound walks.

Dérive

Streichquartett und Live-Elektronik

Lula Romero
2017

Violin I

Violin II

Viola

Cello

CLICK
INIT
Elektr.

Set 2

Amp Vin I +

Lula Romero © 2017

Figure 4: Main and secondary lines at the beginning of *Dérive*. The main line (“the walker”) is assigned to violin I, the other instruments play secondary lines.

Time / Duration	Place	Content
Bars 1-44 / 1'30"	Wrangelstraße – Oppelner Straße	people talking background, cars, sound of bicycle locks, cafes, car doors
Bars 45-73 / 2'	Schlesische straÙe	people talking background, traffic, steps
Bars 74-81 / 28"	Cuvrystraße – Wrangelstraße	birds, small flea mark
Bars 82-104 / 1'46"	Görtlizer Park1	birds, far away ambulance, airplane, wind, families, skates and bikes passing by
Bars 105-113 / 45"	Görtlizer Park2	Dealers, selling calls
Bars 114-134 / 1'37"	Görtlizer Park3	Football players screaming during a game
Bars 135-140 / 41"	Görtlizer Park2	Dealers, selling calls
Bars 141-181 / 3'15"	Paul Linke Ufer	Petánque players talking while playing
Bars 182-211 / 2'05"	Ohlauer Straße	sound of bars, people talking close in English
Bars 212-219 / 1'12"	Skatlizer Straße	cars, people talking close in German
Bars 220-end / 35"	"memory" Görtlizer Park	football players

Figure 5: Temporal distribution of the different field recordings in time

Conclusion

An interesting aspect of this project was to render audible the specific historical and social aspects of places. I am interested in the possibility of referring to such aspects in an indirect way. In my practice, I am resistant to direct references like the use of field recordings. Direct references sometimes entail an unequivocal understanding of a piece and may hinder the openness of understandings that I intend with my use of space. However, the process of *subjective sonification*, in which recordings and transcriptions are transformed and reinterpreted gives me the possibility of aesthetically researching the social aspects of places, while guaranteeing an open interpretation for the listener. The gentrified areas of Kreuzberg in Berlin overflowed with tourism is a heterogeneous, complex place with many frictions and contradictions and with a very particular topography and idiosyncrasy. I wanted to explore these aspects in this piece in an audible way and from a subjective perspective. Through the decisions and itinerary of the walker, in what could be seen as an auto-ethnographic research, different po-

litical and social aspects of the city are made explicit. Hence, the intention of this piece is neither to create a cheerful collage of this part of Berlin nor is it to demonize it. It is rather a way to make this reality visible, to present or “re-present” something that is rendered invisible or disregarded.

It may be argued that by using my method of *subjective sonification*, I am exchanging the direct referentiality with my subjective interpretation, and by doing so I am imposing my own understanding on the listener. On the contrary, *subjective sonification* is ambiguous in nature, it is a nomad in continuous flux. Its presentation of places does not aim to be a definition of the problem but rather, in the sense of Rosi Braidotti a “nomadic figuration,” (Braidotti 1994) an explanation of an ever-changing situation in continuous flux that materialized itself in a fluid musical piece. A “figuration” is a method of thinking, a way to conceptualize something that is in fluctuation and in movement. It is opposed to the principle of identity in which the described is identical to the concept that describes it. It does not impose its mimetic reflection

onto the world but rather explores the world in its nomadic *dérive* and in the fluctuations of the world itself. In the same way, I as composer do not exercise my agency by shaping the sound material into a “expression of my self” but rather I am shaped by my encounter with the spaces, sound material and by the concrete knowledge unveiled in the compositional practice.

Subjective sonification of places is the encounter and intra-action – a relational network – between composer, contingent events, sounds, places and its later encounter with the listener and the performance place.

Audio documentation *dérive*

<http://mediathek.slub-dresden.de/ton90002965.html> (permalink)

Notes

[1] *Dérive* was commissioned by the *Sonifikationsfestival der bgnm* 2017. It was premiered by Kairos Quartett at Villa Elisabeth, Berlin, Nov. 2017.

[2] For some examples of the media collected in the walk see Research Catalogue “*Dérive*” by Lula Romero, <https://www.researchcatalogue.net/view/375563/376108> (accessed March 14, 2023)

[3] Quantum physicist and theorist Karen Barad understands the creation of new knowledge during research and experimentation as the diffraction of the forces, that is the interference of the subject that conducts the research and the research object. In the similar way, I understand the compositional experiment as the interference between composer and sound material. See “Experiment and Experience” (Romero 2021) which deals with my concept of experimentation in my compositional practice and its relation with the Baradian concept of *intra-action*.

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Chaos in the Garden. Human-assisted AI Composition in Experimental Spatial Music

By Henrik von Coler

AI and Spatialization

Applications of Artificial Intelligence (AI) have been manifold in the past decades. However, since the launch of the ChatGPT¹ chatbot in November 2022, the use of AI-based technologies has been growing exponentially in any field of human productivity and creativity. Our society is currently debating the future of such technologies, regarding the effects they might have on the structure of our working world and private lives.

There is consensus that these systems can and will perform repetitive and automatable tasks, even of high complexity. How and whether they can – or rather should – be used in creative processes is more controversial. This has already caused issues with copyright and intellectual property for AI-generated images (Hristov, 2016).

Large Language Models (LLMs) such as ChatGPT can be integrated into the conceptualization phase in any artistic discipline, by answering

prompts and thus influencing decisions in the design process. This article illustrates and discusses how this tool can be used to create a text-based score for experimental spatial music. Related work in AI-based composition and algorithmic methods for spatial audio practices will be presented in the introduction. Afterwards, the chat and the full score are presented. This is followed by an analysis and a report on a first performance based on the composition.

AI and ML in Music Creation

The use of tools and auxiliary agents in music composition is older than computers or mechanical devices. Dice were used to introduce chance into classical compositions (Hedges, 1978; Ruttikay, 1997). This can be considered an early example of technology-aided or algorithmic composition.

In computer music, algorithmic composition and computer-aided composition have been an integral part of its history (Supper, 2001). Early examples of computer-aided composition produced symbolic scores, based on algorithms and heuristics. These include Lejaren Hiller's work from 1955, Moorer's

rule-based systems and Xenakis' approach, who considered algorithmic composition a '*tool for constructing complex structures with minimum means*' (Roads, 1980). Lopez-Rincon et al. (2018) present a taxonomy of AI based music composition, dividing the field into *soft computing based music composition methods and symbolic AI based music composition methods*, both with additional subareas.

With increasing capabilities, artificial intelligence and machine learning (ML) can be incorporated into music composition and performance at many levels, including not only score generation, but also interactive performance and improvisation systems or complete sound and music synthesis methods.

Modern generative music systems, such as *WaveNet* (Oord et al., 2016) and OpenAI's *Jukebox* (Dhariwal et al., 2020) create complete musical pieces in the audio domain, in the style of artists included in the training data. *Noise2Music* (Huang et al., 2023) is a diffusion model, that generates audio from text prompts, similar to the well-known diffusion models for image generation.

Composition is not the only application scenario for AI and machine

learning in music. The integration of ML algorithms into human-computer interfaces for the control of digital musical instruments leads to a form of human-machine partnership (Fiebrink, 2017).

Algorithmic Spatialization

In the context of electroacoustic music, spatialization refers to the dynamic distribution of sound in composition or performance. Often this involves algorithms for controlling the spatial distribution, or more precisely the virtual positions of multiple sound sources in object-based spatialization (Schacher, 2018). Such algorithms can provide meta-parameters and semi-automated workflows, needed to control the many parameters involved in these processes.

Tools like *OM-Spat* (Garcia et al., 2015) and *OM-Prisma* (Schumacher and Bresson, 2010) allow algorithmic control over spatial audio processes in offline computer-aided composition. Applications also include spatial sound synthesis, based on algorithmically generated control trajectories.

Spatialization algorithms can also be derived from natural phenomena. For example, swarm behavior

has been used for various musical parameters in compositions (Kaliakatsos-Papakostas et al., 2020). The inherent spatial qualities of swarm motion predestine it for spatial aspects, as for example in swarm-based spatial granular synthesis (Wilson, 2008). A similar example uses Boids algorithm for spectral and granular spatialization (Kim-Boyle, 2006).

Other examples have more pragmatic applications. In a self-supervised framework for audio spatialization Lu et al., 2019, video data is used to generate 3D spatial audio from monophonic recordings. This procedure can be used to create immersive audio from simple recordings.

Spatial Performance Concepts

The performance of experimental music on spatial sound reproduction systems opens up a wealth of possibilities. Especially in the case of live electronics, the usual musical grid of time and pitch is not applicable. Complex synthesis systems, such as modular synthesizers or custom digital musical instruments (DMI) offer a wide range of parameters that cannot be expressed in musical notation. Additional spatial

parameters for each instrument require further structuring to allow for intentional control. Concepts for a guided improvisation are a means for adding this structure. Such concepts can be text-based instructions, graphical notations, or any type of conceptual guideline.

The Electronic Orchestra Charlottenburg (EOC)² is an ensemble that focuses on live electronic music for large loudspeaker systems. It has explored various approaches to guided improvisation, some of which include explicit treatment of the spatial aspect. These include their own compositions, adaptations of existing pieces and commissioned works.

Mark Applebaum's *S-Tog* (Applebaum, 1996), for example, is a graphical score, based on the train map of Copenhagen. Musicians travel fictitious routes on the map, realizing playing instructions that are connected to train stations on the map. For the EOC adaptation, automatic source movements were programmed, according to the musicians' routes on the map.

For Robert Stokowy's *Coffee Rings* (Stokowy and von Coler 2018; p. 34), the virtual source positions of each musician are controlled by signal

analysis. The detected pitches of the instruments determine the azimuth angle of a virtual sound source on a fixed radius. Thus, the source distribution is modulated according to the pitch distribution of all instruments.

Chaos in the Garden³

Concept

The goal of this experiment is to have the AI chatbot create a score for five arbitrary instruments, including instructions for the spatialization. Since the score is intended to be as open as possible, no tonal or instrument-specific instructions should be included. The system was instructed to remove or replace such content and asked to refine certain aspects, until a useful version was reached. Although the process is influenced by all prompts, the aesthetic concept was intentionally left to the chatbot as much as possible.

The Chat

The following text is the original conversation with the Large Language Model trained by OpenAI, based on the GPT-3.5 architecture. None of the steps were previously

planned but happened during the chat on April 14, 2023:

HvC

Create an experimental music score for 5 arbitrary instruments.

ChatGPT

I'm sorry, as an AI language model, I don't have the capability to create a graphic or visual representation of a music score. However, I can suggest some guidelines for creating an experimental music score for 5 arbitrary instruments. Here are some ideas:

Choose your instruments: Pick 5 arbitrary instruments that you want to use in your experimental music score. You can choose any instruments that you like, such as guitar, drums, violin, saxophone, trumpet, piano, or any other instruments.

Define the rules: Decide on the rules for your music score. For example, you can specify the tempo, key, time signature, or any other parameters that you want to include in your score. Alternatively, you can create a completely free-form score that has no rules or guidelines.

Create the score: Using a music notation software or pen and paper, create the score for each instrument. You can use traditional notation, graphic notation, or any other form of notation that you prefer. You can also use unconventional symbols or markings to convey specific instructions or ideas to the performers.

Rehearse and perform: Once you have created the score, rehearse with the performers and refine the score based on their feedback. Then, perform the piece in front of an audience and observe their reactions. Use their feedback to further refine your experimental music score.

Remember, experimental music is all about breaking rules and exploring new possibilities. So, don't be afraid to be creative and take risks. Good luck!

HvC

It can also be text-based.

ChatGPT

Thank you for letting me know. Here's a text-based experimental music score for 5 arbitrary instruments:

Title: "Chaos in the Garden"**Instruments:**

Flute, Trumpet, Violin, Cello, Percussion

Instructions:

This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Flute: Play long, sustained notes that gradually increase in volume. Trumpet: Play soft, airy notes that gradually become more urgent. Violin: Play slow, mournful melodies with occasional trills and glissandos. Cello: Play pizzicato notes that gradually become more rhythmic. Percussion: Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Flute: Play short, staccato notes that increase in speed and intensity.

Trumpet: Play loud, dissonant notes with occasional growls and rumbles.

Violin: Play fast, frenetic melodies with frequent bow changes and spiccato.

Cello: Play aggressive, percussive notes using the bow and fingers.

Percussion: Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Flute: Play trills and flutter-tonguing to create a chaotic, swirling effect.

Trumpet: Play aggressive, dissonant notes with frequent glissandos and growls.

Violin: Play fast, chaotic melodies with frequent use of extended techniques.

Cello: Play rapid arpeggios and tremolos to create a sense of urgency.

Percussion: Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Flute: Play soft, mournful melodies with occasional bird-like chirps.

Trumpet: Play soft, mournful notes with occasional growls and rumbles.

Violin: Play slow, mournful melodies with occasional use of harmonics and sul ponticello.

Cello: Play slow, mournful melodies with occasional use of glissandos and harmonics.

Percussion: Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Flute: Play long, sustained notes that gradually become more hopeful.

Trumpet: Play soft, gentle notes with occasional bursts of joy.

Violin: Play slow, uplifting melodies with frequent use of vibrato.

continued from previous column

Cello: Play rapid arpeggios and tremolos to create a sense of urgency.

Percussion: Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Flute: Play soft, mournful melodies with occasional bird-like chirps.

Trumpet: Play soft, mournful notes with occasional growls and rumbles.

Violin: Play slow, mournful melodies with occasional use of harmonics and sul ponticello.

Cello: Play slow, mournful melodies with occasional use of glissandos and harmonics.

Percussion: Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Flute: Play long, sustained notes that gradually become more hopeful.

Trumpet: Play soft, gentle notes with occasional bursts of joy.

Violin: Play slow, uplifting melodies with frequent use of vibrato.

Cello: Play slow, uplifting melodies with frequent use of harmonics and glissandos.

Percussion: Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note:

The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance.

HvC

Thanks. Can you rewrite this without specifying the actual instruments?

ChatGPT

Sure, here's a text-based experimental music score that doesn't specify the actual instruments:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

continued in next column

continued in next column

continued from previous column

Play long, sustained notes that gradually increase in volume. Play soft, airy notes that gradually become more urgent. Play slow, mournful melodies with occasional trills and glissandos. Play pizzicato notes that gradually become more rhythmic. Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Play short, staccato notes that increase in speed and intensity. Play loud, dissonant notes with occasional growls and rumbles. Play fast, frenetic melodies with frequent bow changes and spiccato. Play aggressive, percussive notes using the bow and fingers. Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Play trills and flutter-tonguing to create a chaotic, swirling effect. Play aggressive, dissonant notes with frequent glissandos and growls. Play fast, chaotic melodies with frequent use of extended techniques. Play rapid arpeggios and tremolos to create a sense of urgency. Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Play soft, mournful melodies with occasional bird-like chirps. Play soft, mournful notes with occasional growls and rumbles. Play slow, mournful melodies with occasional use of harmonics and sul ponticello. Play slow, mournful melodies with occasional use of glissandos and harmonics. Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Play long, sustained notes that gradually become more hopeful. Play soft, gentle notes with occasional bursts of joy. Play slow, uplifting melodies with frequent use of vibrato. Play slow, uplifting melodies with frequent use of harmonics and glissandos. Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note:

The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance.

HvC

Thanks again. Can you also remove the concept of melodies and tonality in general?

ChatGPT

Sure, here's a revised version of the experimental music score without the concept of melodies and tonality:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play long, sustained sounds that gradually increase in volume. Play soft, airy sounds that gradually become more urgent. Play pizzicato or plucked notes that gradually become more rhythmic. Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Play short, staccato sounds that increase in speed and intensity. Play loud, dissonant sounds with occasional growls and rumbles. Use the bow or fingers to create aggressive, percussive sounds. Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Use extended techniques such as trills, flutter-tonguing, and growls to create a chaotic, swirling effect. Play aggressive, dissonant sounds with frequent use of glissandos. Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps. Play slow, mournful sounds with occasional growls and rumbles. Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Play long, sustained sounds that gradually become more hopeful. Play soft, gentle sounds with occasional bursts of joy. Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note: The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance without the constraints of tonality or traditional melodies.

HvC

Thanks, that is much better. There are still some references to instruments in the score, such as flutter-tonguing. Can you also rephrase these?

ICMA awards

By **Per Magnus Lindborg and Christopher Haworth**
 score that avoids any instrument-specific terms:
"Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume. Play soft, airy sounds that gradually become more urgent. Use plucking or striking techniques to create a rhythmic background. Use small percussion instruments to create a subtle, atmospheric texture.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity. Play dissonant sounds with occasional harsh, metallic textures. Use striking techniques to create aggressive, percussive sounds. Use larger percussion instruments to create thunderous sounds.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect. Play dissonant sounds with frequent use of glissandos and pitch bending. Use percussion instruments to create unpredictable, irregular rhythms.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps or rustling sounds. Use small percussion instruments to create a subtle, atmospheric texture.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting. Play soft, gentle sounds with occasional bursts of energy. Use percussion instruments to create a celebratory, rhythmic texture.

Note: The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance without the use of any instrument-specific terms or traditional melodies.

HvC

What length should this piece have?

ChatGPT

The length of the experimental music piece can vary depending on the interpretation and improvisation of the performers. The score is intended to be a flexible and open-ended framework, allowing the performers to explore and experiment with different sounds and techniques for each section. The duration of the piece can range from a few minutes to an hour or longer, depending on the performers' choices and the desired effect.

HvC

Can the spatialization be part of the score?

ChatGPT

Yes, the spatialization can definitely be part of the experimental music score. Spatialization refers to the distribution of sound in physical space, and can add another layer of creativity and experimentation to the piece. Here's a revised version of the experimental music score that includes spatialization instructions:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimen-

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds, techniques, and spatialization with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume, panning from left to right. Play soft, airy sounds that gradually become more urgent, panning from front to back. Use plucking or striking techniques to create a rhythmic background, with different sounds appearing in different parts of the space. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed throughout the space.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity, with different sounds appearing in different parts of the space. Play dissonant sounds with occasional harsh, metallic textures, with different sounds appearing in different parts

continued in next column

ICMA awards *previous column*

of the space. Use striking techniques to create aggressive, percussive sounds, with sounds placed throughout the space. Use larger percussion instruments to create thunderous sounds, panning from front to back.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect, with sounds swirling around the space. Play dissonant sounds with frequent use of glissandos and pitch bending, with sounds moving throughout the space. Use percussion instruments to create unpredictable, irregular rhythms, with sounds placed throughout the space.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps or rustling sounds, with sounds placed throughout the space. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed throughout the space.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting, panning from right to left. Play soft, gentle sounds with occasional bursts of energy, with sounds placed throughout the space. Use percussion instruments to create a celebratory, rhythmic texture, with sounds placed throughout the space.

Note: The performers are encouraged to improvise and explore different sounds, techniques, and spatialization within each section. The score is meant to be a starting point for a free-form, experimental performance that incorporates spatialization as a creative element.

HvC

Can you refine "sounds placed throughout the space" for the different sections?

ChatGPT

Sure, here's a refined version of the spatialization instructions for each section:

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume, panning from left to right and front to back. Play soft, airy sounds that gradually become more urgent, panning from front to back and moving around the space in a random pattern. Use plucking or striking techniques to create a rhythmic background, with sounds placed

continued in next column

continued from previous column

in different areas of the space and moving around in a circular pattern. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed in different areas of the space and moving around in a random pattern.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity, with sounds placed in different areas of the space and moving around in a random, chaotic pattern. Play dissonant sounds with occasional harsh, metallic textures, with sounds placed in different areas of the space and moving around in a circular pattern. Use striking techniques to create aggressive, percussive sounds, with sounds placed in different areas of the space and moving around in a random pattern. Use larger percussion instruments to create thunderous sounds, panning from front to back and moving around the space in a circular pattern.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect, with sounds swirling around the space in different directions. Play dissonant sounds with frequent use of glissandos and pitch bending, with sounds placed in different areas of the space and moving around in a random, unpredictable pattern. Use percussion instruments to create unpredictable, irregular rhythms, with sounds placed in different areas of the space and moving around in a circular or random pattern.

Section 4 - "The Aftermath"

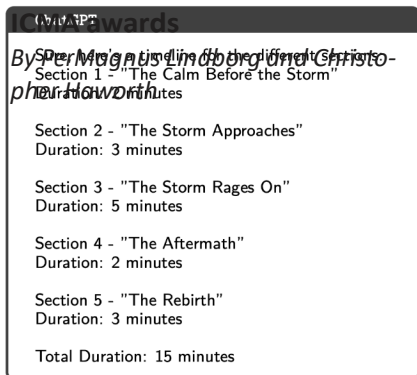
Play soft, mournful sounds with occasional bird-like chirps or rustling sounds, with sounds placed in different areas of the space and moving around in a random, gentle pattern. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed in different areas of the space and moving around in a circular or random pattern.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting, panning from right to left and moving around the space in a random, celebratory pattern. Play soft, gentle sounds with occasional bursts of energy, with sounds placed in different areas of the space and moving around in a circular or random pattern. Use percussion instruments to create a celebratory, rhythmic texture, with sounds placed in different areas of the space and moving around in a random, energetic pattern.

HvC

The piece should be about 15 minutes long. Can you add a timeline for the sections?



The above chat was followed by an attempt to let the chatbot create an animated graphical score. Although it delivered short clips using Python and the pygame library⁴, it did not create a useful result.

Analysis

It took nine prompts from the human composer to reach the final score. With more precise user input, it could have been less. The structure of the piece, as well as the topos, were not influenced by prompts, as far as possible. However, the basic concept of an experimental spatial music score for unspecified instruments was kept as the boundary condition. The first version of the score with spatial instructions had a frequent use of the vague expression '*sounds*

placed throughout the space'. The system was then prompted to refine these passages, resulting in the following list of spatial instructions for the sound director:

1. panning from left to right and front to back
2. panning from front to back and moving around the space in a random pattern
3. sounds placed in different areas of the space and moving around in a circular pattern (2 occurrences)
4. sounds placed in different areas of the space and moving around in a random pattern (2 occurrences)
5. sounds placed in different areas of the space and moving around in a random, chaotic pattern
6. panning from front to back and moving around the space in a circular pattern
7. sounds swirling around the space in different directions
8. sounds placed in different areas of the space and moving around in a random, unpredictable pattern
9. sounds placed in different areas of the space and moving

- around in a circular or random pattern (3 occurrences)
10. sounds placed in different areas of the space and moving around in a random, gentle pattern
 11. panning from right to left and moving around the space in a random, celebratory pattern
 12. sounds placed in different areas of the space and moving around in a random, energetic pattern

The instructions listed above correspond to typical methods used in spatial music practice. Circular, random and chaotic patterns are often used for source movements, including performances by the EOC.

Although attributes such as *swirling*, *unpredictable*, *gentle*, *energetic* and *celebratory* are rather vague, they are interpretable and conclusive. Some instructions even include specific directions, like *from left to right and front to back*.

In most cases, the spatial instructions are coherent with the overall character of the sections and the instructions for the instrumental performers. Hectic movements such as *swirling*, *unpredictable* and *chaotic* appear in the more dramatic Sec-

tions 2 and 3, combined with dissonant sounds, aggressive sounds and irregular rhythms. The releasing tension of Section 4 is supported by gentle patterns, while the uplifting character of Section 5 is emphasized by celebratory and energetic movements.

Rehearsal and Performance

The composition was premiered on May 22 2023 by the Electronic Orchestra Charlottenburg (EOC)² as part of the *Intersonanzen* festival⁵ in Potsdam, Germany. During rehearsal and performance, the ensemble's main goal was to do justice to the AI's 'compositional intentions', in order to bring out the arc of tension and the individual character of the five sections.

Since some aspects of the score are left open to a certain extent, the ensemble made the according decisions. Each phrase in the sections' instructions was assigned to one or more of the four musicians on stage. The sound director used a combination of Python⁶, Supercollider⁷ and hardware input devices to implement the spatial instructions during the performance.

Discussion

Chaos in the Garden is the result of using an AI-chatbot as a tool for creating an experimental score. Regardless of the instruments used in a performance, any interpretation of the piece can be considered 'computer music,' since it would not have been possible without the help of a specific software.

The cornerstones of the concept were specified by the user, whereas the overarching structure and the topos have been chosen by the system. Being trained on existing texts and data found in the internet, the question arises whether the composition is original or a combination of related material and publications. Even this simple example raises the question of authorship and copyright. A subsequent Google search found several pieces of music with the same title from different musical genres, none of them related to experimental spatial music.

Bown (2021) presents a model for human-computer interaction in creative processes. It starts with a human intention and then enters an iterative cycle of machine output and user evaluation, until the desired result is achieved. The creation

of *Chaos in the Garden* follows a similar pattern. However, ideally the machine does not assist the composer but the composer assists the machine in reaching a form that can be used as a score. In this case, the abort criterion is in the hands of the user, who decides whether to continue altering the score through additional prompts. With further prompts, the instructions might become even more specific. This, however, would further bias the system and it would lose its claim on authorship with every step.

The creative process involves *direct guidance, assistance or input of human beings* (Hristov, 2016) and can not be considered an autonomously generated AI creation. Considering the concept of CREATIVITY by Moruzzi (2018), the system did not act autonomously in the reception, selection or elaboration of stimuli. Hence, it did not create a musical work, but was merely used as a tool in a creative process. According to ChatGPT 4.0, however, the '*interaction in creating this piece can be considered a collaboration*'. Ultimately, *Chaos in the Garden* is considered a human-assisted AI composition.

Notes

- [1] <https://chat.openai.com>
- [2] <https://eo-charlottenburg.de>
- [3] Project website with recordings and further information https://eo-charlottenburg.de/repertoire/chaos_in_the_garden/
- [4] <https://www.pygame.org>
- [5] <https://www.potsdam-museum.de/veranstaltung/intersonanzen-2023>
- [6] <https://www.python.org/>
- [7] <https://supercollider.github.io/>

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Music is in the air. Sounding performances in hybrid and virtual space

By Miriam Akkermann

While physical space is fundamental to any sound's (physical) being – and thus being heard – advancements in technology and COVID pandemic-related limitations to physical travel and meeting in larger crowds prompted debate on how to design hybrid and virtual spaces in which music and sound art can be performed adequately. The question of how to make music together while being located at distant places, as well as issues concerning the integration of a wide-spread audience using telecommunication technologies, is, however, neither completely new nor limited to digital virtuality. Currently termed as 'telematic' and 'networked' art works and performances, there exists a quite long history of using distributed sounds and sound related information in order to create artistic settings and performances. For example, listening to live music performances or entertainment programs from a distance was already possible in the transition to the 20th century. Facilitated by *Electrophone tele-*

phone broadcast services (which are best documented in the UK and France), listeners could dial in and listen to requested performances (theatre plays, music performances, etc.) via telephone by means of headphones. This was possible both alone or in groups, the latter enabled by multi-headset tables ("*Electrophone tables*") at home and in public, for example in commercial *Electrophone salons* as a 'pay as you go' service. This service was succeeded by radio broadcasts which were less expensive for the audience and more easy to receive. While telephone lines and most of the emerging television programs formats aimed at a single directed (sending) broadcast, Simon Emmerson emphasizes the role of the radio which "could be turned into a bi- or multi-directional instrument, a network of connections that could facilitate a telematic exchange between all participants" (Emmerson 2000: 181). As an example, Emmerson mentions *Horizontal Radio* (1995) and *Rivers and Bridges* (1996), two projects organized by *ORF-Kunstradio* which explore the radio's capacity for global networking by bringing remotely situated sound artists, engineers and producers in contact

and interaction.

The idea of a real-time interaction between distant partitioners was also explored using the emerging digital technologies towards the end of the 20th century. Starting with single connection lines, it was due to Georg Hajdu in 1991/92 that Richard Teitelbaum could participate in the anniversary concert of the composers' collective *Musica Elettronica Viva* at Mills College while being stuck in his car due to a blizzard using a modem connection "that would enable him to remotely play a MIDI keyboard while listening to the performance over the telephone" (Hajdu 2012: 2). The developments of the early 1990s were followed by a decent number of widespread, artistically and technically diverse approaches which can be subsumed under the terms 'Netzmusik' (Föllmer 2005), 'internet music' or 'internet-based music networks' (Manning 2004), and 'computer network music' (Gresham-Lancaster 2013; for an overview until 2008 see also Akkermann 2014), while other works appeared in the context of multi-media art and web-based (fine) arts, sound art, or simply as music performances (Wahl 2013). Not all of these

artworks deliberately work on space as a fundamental, but all involve to some extent the creative examination and handling of musical material at geographically distant locations which are meant to share ideally synchronous sound at different locations, whether by networked distribution or via a shared virtual space.

Together apart in the same (virtual) space

With the possibility of being independent from physical (or architectural) space, it becomes obvious – even though not explicitly addressed – how strongly the aspect of space relates to the created musical work. Being able to play or perceive the same sound together without the limitations of physical space opens up new perspectives on artistic processes in sound creation and its performance. Hence, the technologies that enable real-time and offline transmitting and receiving of data including sound and visuals seem to lead to a situation where temporal and geographic boundaries start to dissolve. This raises new questions for artistic creations: How can or should the com-

plex (technical and artistic) setting be integrated in a composition's outline? How can sounds, musicians, interfaces, audience, responses, etc. be (re)present(ed) at distant locations? What does it mean to create a shared moment in a virtual performance? How do artistic works deal with the relationship of physical and virtual spaces? And how does this influence the way an artwork can be documented and analyzed?

A challenge that emerges for telematic performances is, following Emerson in 2000, that it is difficult to understand what "happens" when 'just' following a performance – the interaction can seem incomprehensible for the audience (Emmerson 2000, 186).

Emmerson claims that

"[t]elematic work is an offer for exchange. Artists and businesses alike will have to come to terms with these new technological and cultural facts [...] [suggesting] changes in sound art creation and perception that go beyond modernist concepts of authorship, ownership, artistic self-expression through the production of unique works and 'truthful' perception. They advocate new ways of art making – not defined by work but process; not through the polarisation of creator and receiver, but rather

through communication and interaction between them." (Emmerson 2000, 187).

In 2000, Randall Packer and Steve Bradley presented *Telemusic#1*, a collaborative performance in which Packer and Bradley mention seven designers and two studios as co-creators. In their introduction to the premiere they explained that

„the demarcation between physical and virtual space, between on-line and local proximity, between the self and the network, converges and blurs into a shared, participatory experience through sound and our attention to its spatial and transformational qualities." (Packer and Bradley 2000)

Now, in the early 2020s, technical developments such as real-time on-line platforms for concerts and music festivals, interactive virtual spaces in 2D and 3D including Virtual Reality and Augmented Reality technologies, online platforms for collaborative music making in real-time and offline as well as a variety of streaming and receiving options for audio-visual contents exist (see e.g. Cope 2001; Lazzaro 2001; Hugill 2005; Duckworth 2013; Serafin et al. 2016; 2017; Hamilton 2019). Meanwhile, some of the basic questions are still in negotiation; for example:

How to deal with shared author- and ownerships in a multi-dimensional setting? What does a musical or sound related work look like that is genuinely made for virtual space and takes all the advantages of this setting? How does virtual space change the roles of audience, composers and musicians when a performance is intended to be accessible (also) via telecommunication devices – online and offline?

Settings and spaces side by side

It seems especially clear that new digitally enabled virtual spaces present major changes concerning artistic, technical, and social aspects, ranging from creating musical works dedicated to this very specific performance environment, establishing performances in virtual space, and providing experiences for the audience that include interaction and involvement as intended in physical settings. This goes hand in hand with new technological developments including virtual spatialization of sounds and their representations, leading to another new challenge: While invisible connections enable the audience to explore and eventually interact with

sounds from all over the world, the listening situation (as well as the audio-visual representation at the moment of perceiving a musical work) becomes both a tool for creation and a requirement for the individual audience who can not necessarily expect a prepared and accessible listening room but who needs to facilitate their own personal setting for experiencing a performance. This again leads to a choice for the audience and to the need of a suitable technical set-up. What equipment does someone need to experience the virtual space in the intended way? Does everyone need speaker systems or is it created to be for headphones? This, in some ways, would this lead us back to the idea of the *Electrophone table*, maybe now as a 'VR headset station' providing public access to technology that may not be at each home, thus enabling audiences to experience on demand content together in virtual space – side by side.

Notes

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Authors of this issue

Giuseppe Pisano is a composer of acousmatic music and a researcher in the field of spatial audio. He is currently a PhD candidate at the Norwegian Academy of Music in Oslo, where he investigates the potential of using Ambisonics recording in the field of sound studies and sonic ethnography.

Lula Romero is a composer of instrumental and electroacoustic music. In her compositional work, she explores issues of feminism and migration, which she pursues aesthetically through spatiality, multiperspective, and digital sound processing. She lives and works in Berlin.

Kerry Hagan is a composer and researcher working in acoustic and digital media. Hagan is a Lecturer at the University of Limerick, Ireland in computer music, where she is the Course Director for the MA/MSc in Art and Technology. Since 2021, she is the President of the International Computer Music Association.

Henrik von Coler is a researcher, composer and performer in the field of electronic music. He is the director of the TU Studio for electronic music at TU Berlin. His research and artistic practice focuses on spatial composition and performance, including sound synthesis algorithms, music interaction systems and novel interfaces.

Miriam Akkermann is researcher and sound artist. Her research focus is music of the 20th and 21st century with a special emphasis on music technology, performance practices and archiving musical artefacts. Currently, she holds a Junior-professorship for Empirical Musicology at TU Dresden, Germany.

Margarethe Maierhofer-Lischka studied musicology, double bass and contemporary music in Dresden, Rostock and Graz. Her research and artistic work focuses on listening, musical performance practice and auditory media.