Distributing Music in Space:

Exploring the Impact of Spatial Directionality on Musical Material in a Composition Portfolio of Instrumental/Vocal Music

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1 Music Works Included in the Score Portfolio

1. ***Syria*, 2018, for string quartet, ca. 5' 20''**

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Total Duration: ca. 79' 20''

2 Abstract

This research focuses on exploring how the spatial division of musical material can affect the perception and interpretation of music. Specifically, the study examines how allocating fragmented musical material to different musicians positioned around an auditorium can alter the listener's overall experience. To investigate the questions of how the spatial distribution of musical material affects its perception in terms of distance and directionality and what compositional strategies can be employed to enhance the spatial experience for listeners in a live performance setting, I have created a portfolio of instrumental/vocal compositions experimenting with different approaches to distributing musical material in space.

Each of the pieces explores a different arrangement of musicians to create a spatially dispersed sound. Through this arrangement, I aim to examine the impact of the spatialisation of musical elements, focused more on their directional orientation (though I also consider distance), on the listener's perception of various musical features, including structure, timbre, texture, rhythm, and harmony.

The research may contribute not only to music composition and performance but also to aspects of spatial sound design. By clarifying how spatial distribution shapes musical material, the study offers techniques for composing and performing instrumental/vocal music that is sensitive to its spatial context. Ultimately, it seeks to enhance listener engagement by opening new avenues for immersive and dynamic musical experiences. Practically, these findings can inform repertoire planning, staging and rehearsal strategies for ensembles that use spatial placement as a perceptual structuring device in live performance.

3 Introduction

> ‘In my opinion, the spatial placement of sounds, whether instrumentally or electronically, has about the same potential for aesthetic differentiation as loudness. Compared to pitch and timbre, localisation yields far less potential for aesthetic differentiation. Still, on the other hand, no one would deny that in quite a few pieces, loudness is an important, highly sophisticated, composed part of music. And the same could be said for the distribution of sound in space’ (Edwards et al., 2001, p. 9).

The consideration of physical space in the live performance of instrumental and vocal music could take many forms, depending on which specific characteristic of sound interaction in space a composer chooses to use (see Harley, 1994; Bates, 2009; Barrett, 2003). My approach to the use of space in my submitted works comes from the thought of viewing the path that the music travels to the listeners’ ears from two separate perspectives, distance and direction. Although manipulating these elements does not directly affect the easily noticeable aspects of the composed material, such as pitch and timbre, their treatment plays a crucial role in the musical aesthetic of a piece as it can affect how the audience perceives the music.

The pieces of my submitted portfolio explore this idea and, influenced by spatial techniques from other composers mentioned below, demonstrate how the spatial arrangement of musical elements affects our perception during a live performance. The specific combinations of spatial and musical parameters used in each submitted piece aim to make distance and direction more pronounced elements of the composition.

While my pieces emphasise spatial directionality over distance, I will still discuss and investigate the element of distance. This is because distance and direction are closely

interconnected in sound perception since ‘localising a sound source requires the auditory system to determine its direction and its distance’ (Akeroyd, 2014).

Therefore in this commentary, I will:

- Discuss the concepts of distance and direction, as this reflects my compositional approach, and comment on how these could be applied to a musical performance.
- Present examples of composers who have influenced the use of space in my compositions by viewing their works from the previously mentioned perspective.
- I will discuss how each of my submitted pieces incorporates the element of space and compare the spatial characteristics among them.

Nevertheless, this study will not examine the vertical axis of directionality (hearing the music from above or below us), as it is not included in my submitted portfolio. My decision to steer clear of it was primarily driven by practical considerations. Placing the musicians both above and below the audience limits the available options for locating a performance venue that can accommodate such a setup.

Finally, the commentary, as well as my submitted pieces, will not include the exploration of natural echo and reverb generated from the performance space, which are essential elements in manipulating sound within a space. This is because they are considered a subcategory/combination of distance and direction, and in the absence of amplification, they are reliant on the unique design of each concert hall or performance venue. Thus, it is challenging to consider natural echo and reverb as deliberate components of music unless the music is specifically written to be performed in a particular space or created using electronic production techniques.

4 Research Context

4.1 Distance and Direction

The perception of direction and distance in sound is shaped by various factors, including changes in sound intensity and apparent source motion (Blauert, 1996; Zahorik, 2002). Research suggests that listeners often overestimate the closeness of sounds that are approaching them compared to those that are moving away. This perceptual bias likely developed as an adaptive advantage for survival, as it allows individuals to react more swiftly to potential threats. As a result, sounds that increase in intensity are perceived as closer and louder than those decreasing in intensity, even when the actual intensity changes are equivalent (Neuhoff, 2001). Broadband sounds generally support more accurate distance and directional judgments than steady pure tones, which can produce front-back and distance ambiguities (Blauert, 1996). This indicates that our auditory system has evolved to prioritise certain types of sounds, particularly those signalling approaching objects or potential dangers, by enhancing our ability to accurately estimate their distance and direction.

In reverberant environments, our perception of sound direction and distance is influenced by spatial attributes related to the listener's position and orientation (Blauert, 1996; Zahorik, 2002). Distance perception primarily depends on the balance between direct sound and reverberant sound, with closer sounds perceived as having a higher proportion of direct sound, while distant sounds are characterised by a stronger reverberant component. Directional cues are derived from the timing and intensity of early reflections and the directionality of reverberation. Notably, changes in the listener's head orientation can significantly alter the perceived direction of sound. Certain orientations enhance the

perception of lateral reflections, increasing the sense of envelopment and source width (Băcilă & Lee, 2019).

Additionally, our ability to perceive the distance and direction of sounds relies heavily on specific auditory cues, such as the direct-to-reverberant energy ratio (DRR) and interaural level difference (ILD). The DRR, which measures the balance between direct sound and sound reflected off surfaces, is particularly important in environments where loudness may not accurately indicate distance. Studies utilising brain imaging have shown that specific regions of the posterior auditory cortex are involved in processing these cues, demonstrating the brain's adeptness at determining the origin of sounds, even when loudness is not a reliable indicator (Kopco et al., 2020).

Understanding how we perceive direction and distance in sound has significant implications for music composition and performance, particularly when music is performed from different directions relative to the audience. Composers and performers can leverage this knowledge to create spatial effects that enhance the listening experience. By manipulating the DRR and ILD through strategic placement of instruments or speakers and by controlling sound reflections within a performance space, musicians and sound engineers can craft a more immersive auditory experience. For example, sounds can be made to appear as if they are moving toward or away from the audience or even circling around them, thereby enhancing the emotional impact of the performance.

By understanding how the brain processes auditory spatial cues, composers and performers can design music that deeply engages the audience, using spatial dynamics to tell a story or evoke specific emotions. For instance, an approaching sound is typically perceived as more salient than a receding one (Neuhoff, 2001), while a gradual reduction in level with increased

reverberant energy signals increasing distance (Zahorik, 2002). This mechanism appears in many of the submitted pieces and in numerous passages. For example (the following passages serve as examples, not a complete set), in *Sahara* (bars 60 to 63 and 95 to 100) rear entries crescendo against diminuendos at the front of the stage to produce a rear takeover before the material returns to the front.

In summary, the knowledge of how the brain decodes auditory space through cues like DRR and ILD allows for a more sophisticated and intentional use of sound in music, leading to performances that are not only heard but also felt in a multidimensional way. This can transform a listening experience from simply hearing music to being fully immersed in it, fostering a powerful connection between the performer and the audience. Across the portfolio, DRR is shaped by front-rear placement and opposed dynamics. For example, in *Syria* and *Requiem* (Figs. 10, 21-25), while ILD and lateral motion are foregrounded in *Spin* through clockwise and anticlockwise allocation. These choices steer foreground versus background and cue sectional transitions. The passages cited are illustrative rather than exhaustive since the same behaviours recur throughout the pieces. However, perceptual effects vary with seat position, room acoustics, and individual listener factors, so these examples describe tendencies rather than uniform outcomes. For performers, this translates into practical choices about staging (front-rear balance to shape DRR), rehearsal (paired cresc./dim. to clarify handovers), and projection (lateral allocation for ILD cues), which the commentary applies piece by piece.

4.2 Influences

So, using the distance characteristics in music mentioned above, composers have utilised this spatial element in their music compositions to either elevate the narrative or concept of a piece or to accentuate particular “dramatic” moments by establishing a feeling of perspective and distance. Some examples that influenced my submitted portfolio from that perspective are:

4.2.1 New York Counterpoint

The performance and recording of *New York Counterpoint* discussed here were developed as part of a research project at McGill University (Pras et al., 2009). This version was produced with a specific focus on spatialisation as a compositional and perceptual parameter, incorporating techniques such as multi-channel diffusion, dynamic spatial placement, and detailed post-production editing. These aspects go beyond the spatial configuration typically encountered in standard performances of the piece, which are often realised in stereo or with minimal spatial differentiation. The McGill recording placed the ten pre-recorded clarinet parts around the audience, behind the performer, and above the stage, creating a three-dimensional field that allowed for enhanced perception of polyphony, directionality, and psychoacoustic interaction. The aim of this performance was not only to preserve Reich’s compositional intent regarding rhythmic and textural complexity, but also to explore how spatial placement could further clarify and enrich the listening experience.

New York Counterpoint is composed for clarinet and tape, and is structured in three movements (fast, slow, fast). Reich’s compositional technique is grounded in minimalism, employing repetitive motifs that gradually evolve and interlock. The work is noted for its

complex polyphony and the emergence of resulting patterns, new rhythmic and melodic figures that appear through the superimposition of layered material. The solo clarinet plays alongside ten recorded parts to produce a dense, stratified texture that constantly shifts in foreground and background relationships.

In the McGill performance, spatialisation played a central role in shaping the perception of these patterns. By placing similar motifs in different spatial locations, it became possible to differentiate overlapping material more easily. The use of multiple loudspeaker positions also created an immersive listening environment in which audiences could perceive the work from a variety of spatial perspectives (Ahveninen et al., 2014; Băcilă & Lee, 2019). The ten recorded parts were diffused through a multi-track sound system, with voices assigned to different zones in the concert hall: surrounding the audience, positioned behind the performer, and elevated above the stage. This three-dimensional layout allowed motifs to be perceived as emerging from specific directions and depths, enhancing both the clarity and the dynamism of the musical texture.

To accentuate the rhythmic complexity, the spatial placement of similar or identical motifs was designed to create contrast. For instance, if two clarinets were playing similar figures, they were positioned on opposite sides of the hall (e.g., front-left and rear-right). This approach produced phase-shifting effects and contributed to a heightened sense of movement, even within otherwise static patterns. By carefully distributing each line across the loudspeakers, the performers and producers sought to make the polyphonic structure of the piece more perceptible. Spatial separation also enabled the emergence of psychoacoustic effects, where listeners might perceive new patterns, directions, or shifts not explicitly

written in the score, an outcome that aligns with Reich's aesthetic interest in perceptual multiplicity and structural ambiguity.

The recording process for this version of *New York Counterpoint* presented specific challenges. The piece relies on exact rhythmic coordination between voices, but the performers intentionally avoided using a metronome or looping systems in the overdubbing process. Instead, the recording was divided into two stages: first, a reference track was recorded with one or two clarinet parts using a metronome; then, the remaining parts were overdubbed without metronomic support, guided only by the reference. This method allowed for natural fluctuations in timing and articulation while maintaining overall precision.

Post-production editing was used to fine-tune the balance and spatial clarity. Repetitive sections were not looped; instead, multiple takes were assembled and edited to create a cohesive but varied performance. The spatial positioning of each part was finalised during this stage, allowing the producers to reinforce directional relationships, contrast, and motion between parts. This process aimed to present the pre-recorded ensemble as both unified and spatially distributed, enhancing the interplay between the live soloist and the surrounding textures.

The resulting version of *New York Counterpoint*, while remaining faithful to the original score, introduced a performance model in which spatial design became an integral interpretive layer. The attention to both temporal and spatial detail in this realisation reflects a performance practice developed specifically within a research framework, and not necessarily representative of typical concert renditions of the work. This version is significant within the context of the present portfolio because it illustrates how spatial placement can clarify

texture, enhance pattern distinction, and shape perceptual focus. However, unlike the McGill realisation, the works in this portfolio do not treat spatialisation as an interpretive or post-production layer. Instead, spatial trajectories and positional contrasts are embedded directly into the compositional fabric from the outset. Whether realised acoustically (*Syria*, *Requiem*, and acoustic versions of *Spin*, *Deadline*, *Greek Étude*, and *Life*) or with electronics (*Sahara* and the electronic versions of the same works), each piece was conceived with space as a structural and expressive parameter. In this context, "electronics" refers to pre-recorded material, either VST-based or captured recordings, diffused through a speaker array as part of the performance design. For example, in *Spin*, rotation is composed into the score itself. Eight fixed loudspeakers encircle the audience and the point of origin advances by a measured scheme (clockwise, anticlockwise, and counter-rotations). This offers a composer-led alternative to the McGill *New York Counterpoint* diffusion (where placement was shaped in post-production) while serving the same aim of clarifying polyphony through space. The McGill version of *New York Counterpoint* therefore offered a useful precedent, but the portfolio develops its ideas further by treating spatialisation as an integral compositional tool across diverse ensemble types and performance formats.

4.2.2 In iij. Noct.

Georg Friedrich Haas's *In iij. Noct. (String Quartet No. 3)* is widely noted for its performance in darkness and spatialised quartet layout that challenges traditional notions of music, both in its composition and its performance. Composed in 2001, this piece exemplifies Haas's engagement with microtonality, spectral music, and the spatialisation of sound. The quartet is performed entirely in the dark, creating a distinctive auditory experience that emphasises the spatial and temporal dimensions of the music.

The musicians are seated as far apart from each other as possible, often positioned in the four corners of the auditorium, around the audience. This spatial arrangement is critical as it breaks the conventional close proximity of a string quartet, creating a significant physical and auditory distance between the performers.

One of the most distinctive aspects of *In iij. Noct.* is that it is performed in complete darkness. The performers are positioned around the audience, which creates an immersive sound environment. This spatialisation of sound is crucial to the work's impact, as it disorients the listener and forces them to focus entirely on the auditory experience without visual cues. The absence of sight intensifies the listener's perception of pitch, timbre, and the spatial relationship between sounds. Analytically, that immersion shifts attention from timbral identification to spatial tracking. Directional handovers become the events that carry tension and release. I adopt the same mechanism in *Syria*, using opposed cresc./dim. pairs to move sustained tones across the room.

The darkness also affects the performers, who must rely on their auditory senses to coordinate with each other. This creates a heightened sense of vulnerability and unpredictability in the performance, as the musicians navigate the complex microtonal landscape without the aid of sight. The result is a performance that is both intimate and intense, with the music's temporal and spatial aspects magnified by the conditions of its performance.

When I experienced the piece performed live by the Ligeti Quartet, the spatial elements of the performance influenced my approach to composing the piece *Syria,* which is included in my submission portfolio. The way Haas utilised space, not just as a physical setting, but as an integral part of the musical experience, was inspirational for me. The spatial arrangement of

the musicians created an immersive environment where sound seemed to come from all directions, enveloping the listener and breaking down the traditional boundaries between performer and audience. Perceptually, with the quartet surrounding the audience in darkness, spatial cues (location, distance, and apparent motion) become salient alongside timbre (Blauert, 1996; Zahorik, 2002). In performance, tension and release can be articulated by directional handovers, as one source recedes while another grows.

The spatial separation during the live performance also made me keenly aware of how sound travels and how different textures and dynamics can interact across a space. For example, in *Syria* bar 60 (Fig. 10) the crossover dynamics move a sustained G from right to left, making the directional handover audibly trackable. In *Syria* I experimented with these ideas by carefully considering how the sound of each instrument would interact within the performance space. I used spatial placement to create dialogues between the instruments, where they seem to call and respond across the room, echoing the fragmented communication and the sense of isolation that is so central to the piece's emotional impact. Furthermore, the immersive nature of Haas's work, where the audience is surrounded by sound, inspired me to think about how to engage listeners in a way that makes them feel like active participants in the musical narrative.

In conclusion, Georg Friedrich Haas's *In iij. Noct*. is an exploration of the interplay between space, sound, and listener perception. Its approach to performance, particularly the use of complete darkness and spatial separation, challenges both the performers and the audience to engage with music in a distinctive way. This work has left a lasting impression on my own compositional practice, as it demonstrated the powerful emotional and narrative potential that can be unlocked when space is treated as a fundamental element of musical expression.

4.2.3 The Unanswered Question

In *The Unanswered Question* (1906), Charles Ives deliberately uses physical distance as a key component of his composition. The piece is built around three distinct musical elements: the strings, the solo trumpet, and the woodwind quartet. These elements are not only musically distinct but are also intentionally placed at different locations within the performance space, creating a clearly spatialised dialogue.

The string ensemble is directed to be positioned offstage or at a considerable distance from the main performance area. This physical separation is essential, as it creates an auditory effect where the strings seem to come from a distant place, serving more as an ambient background than as an active point of the music. This distancing reflects the idea of an eternal, cosmic "silence" that remains unaffected by the other musical elements. As a result, the strings are perceived more as part of the sound environment than as a group of individual players, contributing to a sense of detachment and timelessness.

The trumpet, which plays the recurring "unanswered question," is typically placed in a central, visible position, either on stage or in a prominent spot within the audience's view. In some performances, the trumpet may be elevated or even positioned within the audience area to enhance the sense of direct communication. This central placement draws the audience's focus both visually and aurally. The trumpet's clear, penetrating tone sharply contrasts with the soft, distant strings, establishing a strong focal point in the performance space.

The woodwinds, which respond to the trumpet’s question, are typically placed in a different location from both the strings and the trumpet. They might be situated on the opposite side of the stage from the trumpet or elsewhere in the auditorium. This separation is vital to the spatial dynamics of the piece. The woodwinds’ distinct placement creates a sense of spatial

dialogue or call-and-response across the performance area. The physical distance between the woodwinds and the trumpet enhances the feeling of a fragmented conversation. As the woodwinds grow increasingly agitated and dissonant, their separation from the trumpet underscores the growing disconnect between the question and the attempted answers.

In *The Unanswered Question*, physical space is not about where the musicians are placed; it's about how this placement shapes the audience's perception. Ives uses space to control how sound reaches the audience and how they engage with the music. When musicians are placed offstage or at a significant distance, the sound they produce is not transmitted directly. Instead, it reflects off walls, ceilings, and other surfaces before reaching the audience. This diffusion creates a softer, more enveloping effect. In a concert hall or similar venue, the sound waves from the offstage strings reflect off surfaces, creating a sense of depth and distance. The reverberation and slight echoes can make it seem as though the sound is coming from an expansive, indistinct area rather than a specific point, enhancing the sensation that the music surrounds the listener rather than emanating from a single location. The absence of sharp attacks in the string parts also contributes to this illusion, making it harder for the audience to pinpoint the exact source of the sound.

The strings in *The Unanswered Question* play slow, sustained notes, often at a very soft dynamic level (pianissimo). This type of sound is less directional and blends more easily with the natural acoustics of the space. By placing the strings offstage and having them play soft, sustained notes, Ives creates a diffuse sound that merges with the environment, making it difficult for the audience to locate the source and creating a sensation of being enveloped by the music.

Charles Ives uses physical space as a critical element in *The Unanswered Question*, transforming the performance area into a multi-dimensional canvas where sound interacts with space to create meaning. The separated placement of the strings, trumpet, and woodwinds is intentional, designed to shape the audience's experience and make physical space as important as the music itself. This spatial design creates a psychological and emotional impact, drawing the audience into the existential themes of the piece and making the performers' physical arrangement an integral part of the musical narrative.

4.2.4 Gruppen & Carré

In *Gruppen* (1955–57) and *Carré* (1959–60), Karlheinz Stockhausen systematically treated space as a form-bearing parameter in instrumental music. The spatial segregation of three orchestras in *Gruppen* and four groups surrounding the audience in *Carré* enabled the projection of three/four concurrent layers with distinct material profiles. Stockhausen referred to this as group composition, emphasising the character and proportion of related material rather than individual note relations.

He also produced perceived spatial movement by staggering entries and overlapping crescendos/decrescendos across groups, yielding lateral handovers akin to the impression of panning, an approach informed by his electronic-music practice. More broadly, Stockhausen argued that spatial arrangement, direction, and motion are active compositional variables. The spatial effects in *Gruppen* and *Carré* both separate layers and generate dramatic transitions; e.g., a brass chord circulating the hall in *Gruppen*; the phonemic vocal layer in *Carré* interacting with the instrumental groups (Wörner & Hopkins, 1973; Bates, 2009). Elements of this thinking resonate in *Sahara*: rather than multiple live orchestras, material is

distributed between the live ensemble and three fixed-speaker streams, treating spatial placement and inter-group contrast as compositional parameters (see the *Sahara* commentary).

5 Methodology

The motivation for creating this portfolio was my desire to make my music sound more immersive, beyond the "traditional" compositional tools I used for that, such as dynamics, instrumentation, articulation, extended techniques, harmonies, rhythms, etc. By incorporating distance and direction, I was able to utilise all of these elements within the context of space and offer an alternative perspective to their manipulation. Therefore, influenced by the composers mentioned above, I condensed and classified space utilisation from their compositions into three broad categories that I merged and incorporated into my own works. These are:

- Using space for the creation of echo effects by the use of antiphonal textures with breakup phrases to achieve a motion in the musical material.
- Using space to create a sense of distance and perspective, emphasising dramatic effects and climaxes.
- Using space as a catalyst for the clarification of the multi-layered juxtaposition of different/contrasting textures.

A brief implementation note appears at the end of this chapter and is cross-referenced in each piece's commentary, where concrete examples are discussed.

Furthermore, viewing space from the perspectives of distance and direction allowed me to manipulate my musical material more accurately, emphasising precisely the directional element. In the case of two violinists playing the C Major scale in unison, one on stage and the other positioned behind the audience, the distance between them alters their combined tone quality. The sound reflects off various objects before reaching their ears, creating the impression for listeners that the sound envelops them. In this case, although placing the musicians in different directions, the element of distance is more noticeable due to the homogenous musical material (figure 1).

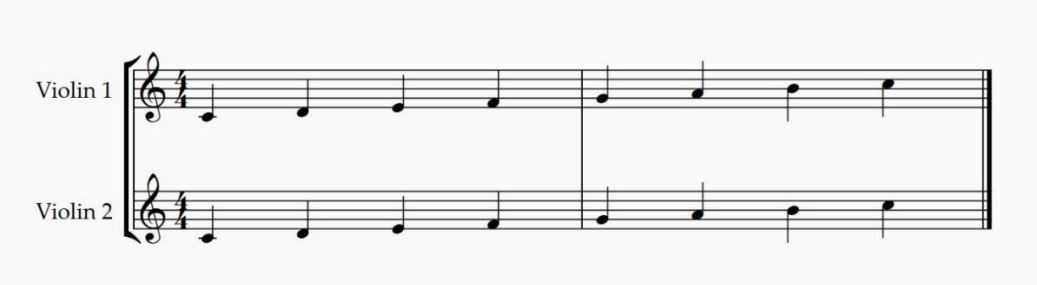

Figure 1: Both musicians on stage and behind the audience play the C Major scale in unison.

However, splitting the musical material and distributing it to the players makes the directional variant prominent, as it is the one changing, while distance remains steady (figure 2).

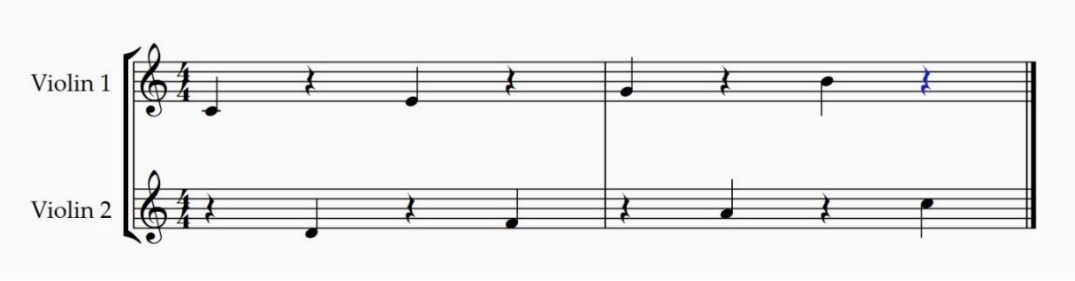

Figure 2: The C Major scale, divided in space, emphasises the directional element.

This manipulation also allows for handling the transition between the two directions accurately. In the above example, the change is relatively quick at a tempo of about 120 BPM as the sound changes direction seven times. Nevertheless, the transition speed can be lowered without changing the tempo by dividing the musical material differently (figure 3).

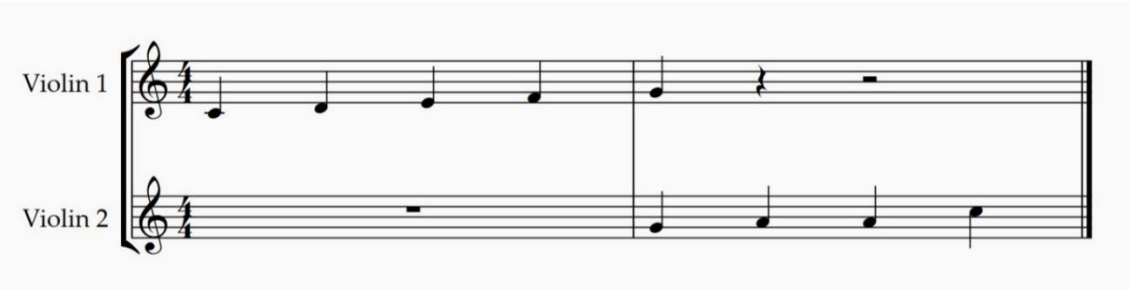

Figure 3: Slowing down the musical material's directional transition by changing the musical material's division.

Especially for slow transitions, the contrasting crescendos and diminuendos that Stockhausen used in *Gruppen* work very well, as they smooth the directional change. In that case, splitting the material would not be necessary, as the contrasting dynamics are enough to emphasise the directional differentiation (figure 4).

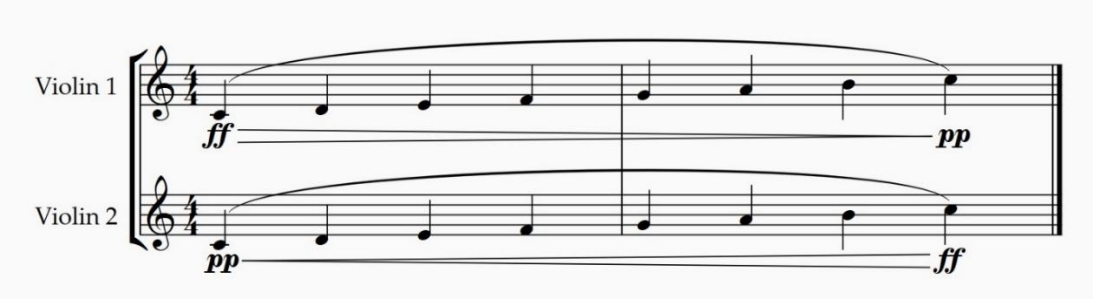

Figure 4: Moving the sound of the C Major scale from the front to the back of the hall using contrasting dynamics.

Finally, examining space based on distance and direction viewpoints allows the creation of more complex spatial relations with musical material by adding extra layers of sound

movement in space. In practice across the portfolio, spatial behaviour is written into the music rather than annotated graphically. Directional handovers are composed as overlapped entries**,** with one source in diminuendo while another enters in crescendo, so the change of location is audible without disturbing tempo. Echo and motion are realised as antiphonal offsets measured in beats or bars and adjusted in rehearsal to the room. Depth and focus are shaped through orchestration, register, and dynamic balance, and separated groups are used to keep concurrent textures clear. Any required performer placements are specified in the performance notes, otherwise standard stage positions apply. Across the portfolio, these strategies recur in many places; the following are representative but not comprehensive:

- Echo & motion: *Life* bars 179-180; *Requiem* "Dies Irae" (Figs. 28-30).
- Directionality as structure: *Spin* (sections A-D: clockwise vs anticlockwise rotation); *Syria* (Fig. 9: circular fragmentation).
- Separation for clarity: *Requiem* (Figs. 21-22: front woodwinds vs rear choir/strings); *Life* (Fig. 15: on-stage vs offstage layers).
- Front–rear handovers: *Sahara* bars 60-63 and 95-100.

6 Commentary on the Submitted Pieces

6.1 Syria, for string quartet

Syria is chronologically the first piece that has been composed in the context of this research, and it represents the first approach to the above techniques. *Syria* realises two of the portfolio's three spatial strategies: directionality as structure (circular fragmentation and

lateral handovers) and separation for clarity (four-way texture split). See Methodology and Figs. 8-11 for the operational models. The four instruments are placed in the four main directions around the audience. The piece's musical aesthetic expresses the dramatic change in Syrian people's daily life due to the war. The first section (bars 1-79) describes life in Syria before the war, mainly emphasising its sunny and joyful side. Musically, this is supported by using a vibrant pulse introduced at bar 6 (figure 5), Major harmonies, high registers, pizzicato techniques, and soft dynamics.

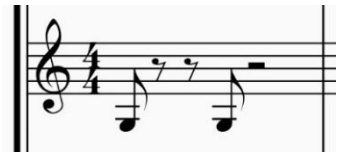

Figure 5: The initial idea of the pulse before its spatial manipulation.

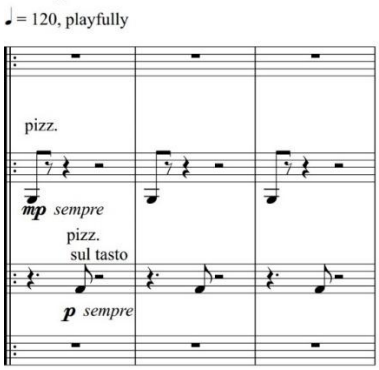

Figure 6: Spatialisation of the pulse. The pulse transitions between the second violin and viola (left and right of the audience). The slightly quieter dynamics and sul tasto on the viola aim to sound the second G, sounding upbeat, as a rhythmical echo of the first G which is played on the strong beat from the violin.

Starting from bar 118, the second and final section depicts Syria after the war, conveying a sense of destruction and fear. The music reinforces this mood by utilising low registers, polyrhythmic patterns, col legno battuto techniques, and varying dynamics characterised by irregular sforzando and marcato accents. In addition, the double stops on the cello and viola create a more substantial sound mass.

Finally, bars 80-117 function as a bridge between the two sections by combining some characteristic elements of the first section, such as the vibrant pulse and melodies, with distinctive features of the second section, such as low registers, polyrhythmic patterns (introduced at bar 93) and the double stops at the cello (figure 7).

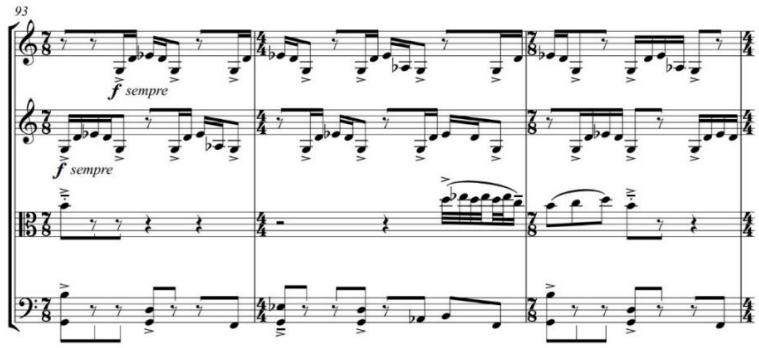

Figure 7: The rhythmic pizzicato pattern (which is actually in 4/4) transitions between the two violins (front and left), while the 7/8 and 4/4 rhythmic pizzicato pulse comes from the back (cello). The viola plays the main melody arco, emphasising the direction on the right.

The example of figure 7 also illustrates how the musical material can emphasise a specific direction in space. In this case, the direction at the right of the audience is emphasised because a) it is the only direction that has a melodic character, while the rest play rhythmic patterns, b) its sound has a high register, in contrast to the other directions that have low, and c) its sound is arco, in contrast to the pizzicato of the other instruments.

The piece generally uses two of the main spatial techniques mentioned above: a) the fragmentation and distribution of the musical material in different directions and b) crossover dynamics. An example of the first technique can be found at the piece's start. For example, the phrase in the picture below (figure 8) is divided and distributed to the spatially separated instruments (figure 9).

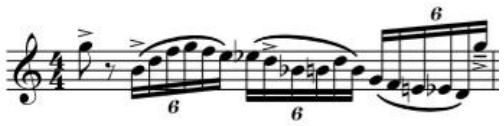

Figure 8: The original melodic phrase that starts the piece.

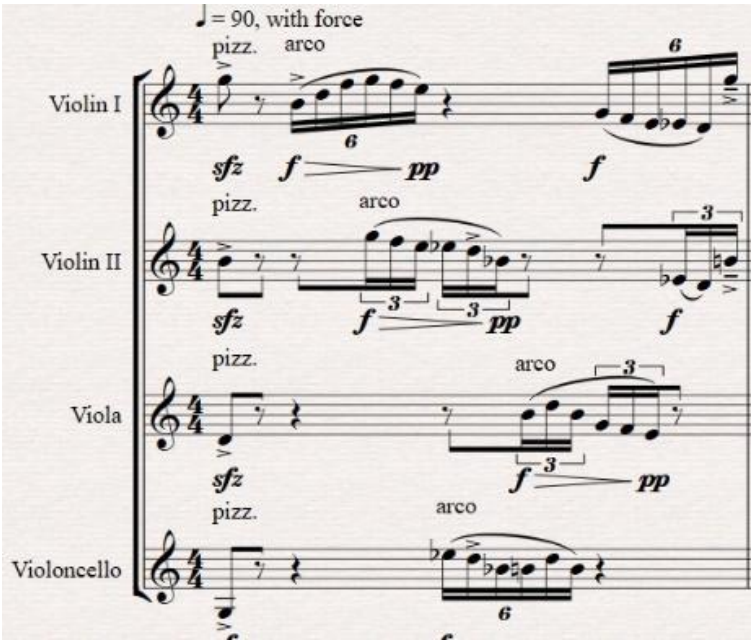

Figure 9: The phrase of figure 8 after its fragmentation and distribution to the four directions.

The aim of the arrangement in figure 9 is the creation of a circular movement of the melodic phrase, starting from the front of the audience (violin 1), moving to the left (violin 2), and then going behind the audience (cello), after that to the right (viola), and finally returning to the front (violin 1 again) where it started. This fragmentation results in a fast sound transition between the four directions.

An example of the second spatial technique can be found at bar 60 between the second violin and viola. While both instruments play the same sustained note, the use of crossover dynamics aims to move the sound linearly from the right side of the audience to the left side (figure 10).

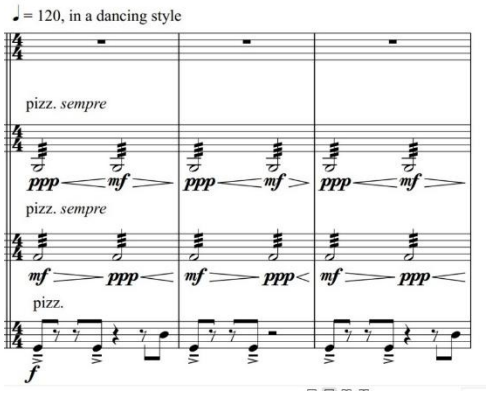

Figure 10*: **Moving the sound of the note G between the audience's left and right sides using contrasting dynamics. The pulse is now heard steadily from the back, in contrast with the piece's start, where it was moving right-left.***

Finally, the element of space is also used in this piece to clarify different textures. In the second section, for example, which is characterised by the simultaneous occurrence of different rhythmic and melodic textures, their spatial separation in four directions assists in their clarification to the listener's ear (figure 11).

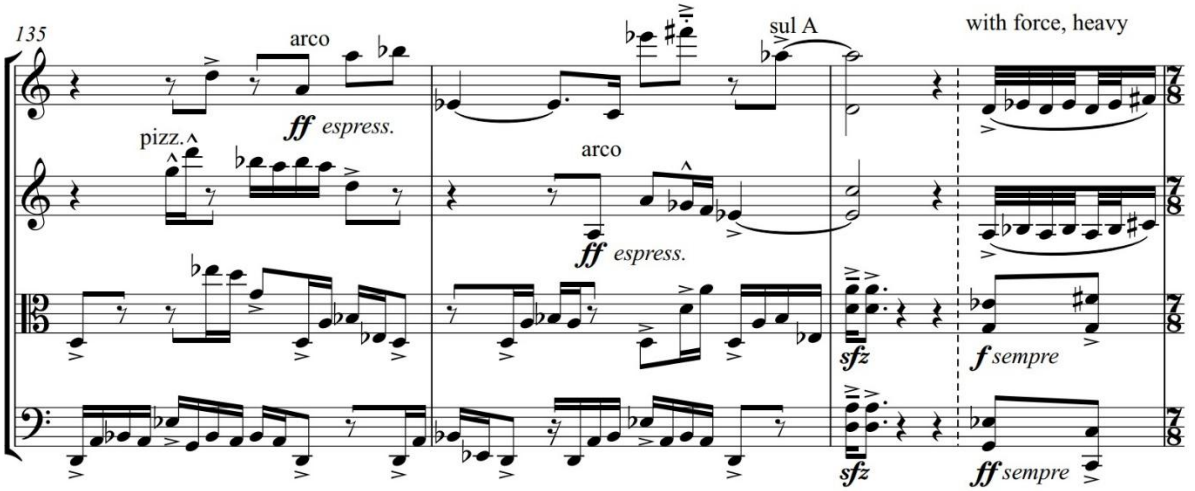

Figure 11: Using space to clarify the different textures. The textures begin to synchronise in the final bar.

In conclusion, the piece uses space to convey the narrative and emotions of the music by placing the instruments in different directions around the audience and using spatial techniques such as the fragmentation and distribution of the musical material in different

directions and crossover dynamics. The musical aesthetic of the piece is also used to emphasise specific directions in space, creating a sense of immersion and envelopment that enhances the emotional impact of the music.

These ideas were directly influenced by Georg Friedrich Haas's *In iij. Noct.*, which I experienced live prior to composing *Syria*. Both pieces share a spatial quartet configuration, with instruments placed in the four cardinal directions surrounding the audience. In Haas's work, this spatial design is heightened by darkness, independent temporal unfolding, and a microtonal harmonic language, contributing to a disorienting and meditative listening experience. By contrast, *Syria* retains a coordinated structure and tonal harmonic framework, using spatialisation to represent conflict, fragmentation, and emotional tension. Rather than dissolving structure, the spatial setup in *Syria* is used to dramatise its reassembly. This divergence reflects a core interest of the portfolio: to recontextualise spatial configurations as tools for emotional narrative and structural clarity, rather than purely immersive or ambient effect. A more detailed connection between the two works is outlined in section 4.2.2. The piece also corresponds directly to the spatial strategies outlined in the methodology chapter, particularly the use of echo and fragmentation to create spatial motion, and the use of directionality to clarify texture and contrast between musical layers.

6.2 Life, for five pianos (or one live piano and 4 recorded pianos / 4 loudspeakers)

This piece conveys the course of life from its creation to its end. Spatially, the offstage pianos introduce directionality while the on-stage piano remains fixed; this separation sets up a "world vs. protagonist" relationship that returns in bars 191-194, where the circular offstage motion contrasts the stationary harmonic layer (Fig. 15). Like *Syria*, *Life* has no distinct different movements/ sections. That being said, bars 1-53 describe the creation of life, bars

54-103 the youth, bars 104-161 the adulthood, bars 162-312 the maturity, and from the rubato section at bar 313 starts the final part of the piece which respectively describes the final stages of life. *Life* combines echo & motion (antiphonal delays) with separation for clarity (offstage ring vs on-stage piano), matching the 'world vs protagonist' model described earlier.

The piece's first section expresses the creation of life based on the theory that an explosive death of a star has triggered the formation of our solar system (and consequently the earth and life on it). The low register cluster chords during the first bars represent this explosion, while the use of soft dynamics adds the feeling of a long distance to this event, indicating that this explosion happened far away (regarding both senses: time and distance). In addition, the repetition of these chords (played from a different piano every time) functions as a means of introducing the different directions of the sound sources that are located at the front, back, left, and right sides of the audience (figure 12). In contrast, at the start of Syria, all directions are introduced simultaneously (figure 13).

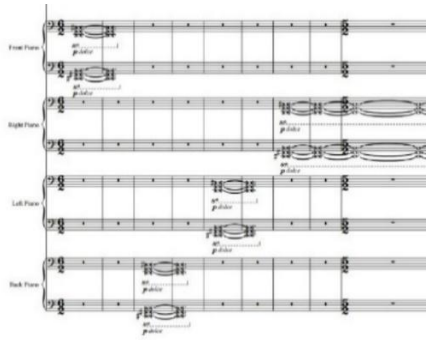

Figure 12: Introducing the four directions in the Life piece individually.

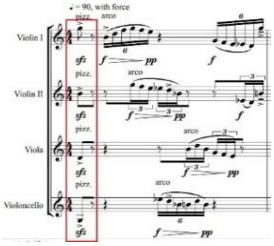

Figure 13: Introducing the four directions in the Syria piece simultaneously.

Life also uses directionality highlighting to separate the stage/live piano from the other four pianos. Since the live piano is placed on stage, its sound source is outside the spatial circle/cross formed by the other four pianos/loudspeakers, which are placed offstage and around the audience.

This spatial separation is also emphasised musically, as the stage piano during the start of the piece does not play the cluster chord. Instead, it introduces the piece's characteristic melody that appears at different moments but in a different context every time. The goal of this division between the spatial and musical aspects is to produce a spatial musical texture wherein one sound travels through a particular region of space while another stationary sound is produced from a sound source positioned farther away (figure 14).

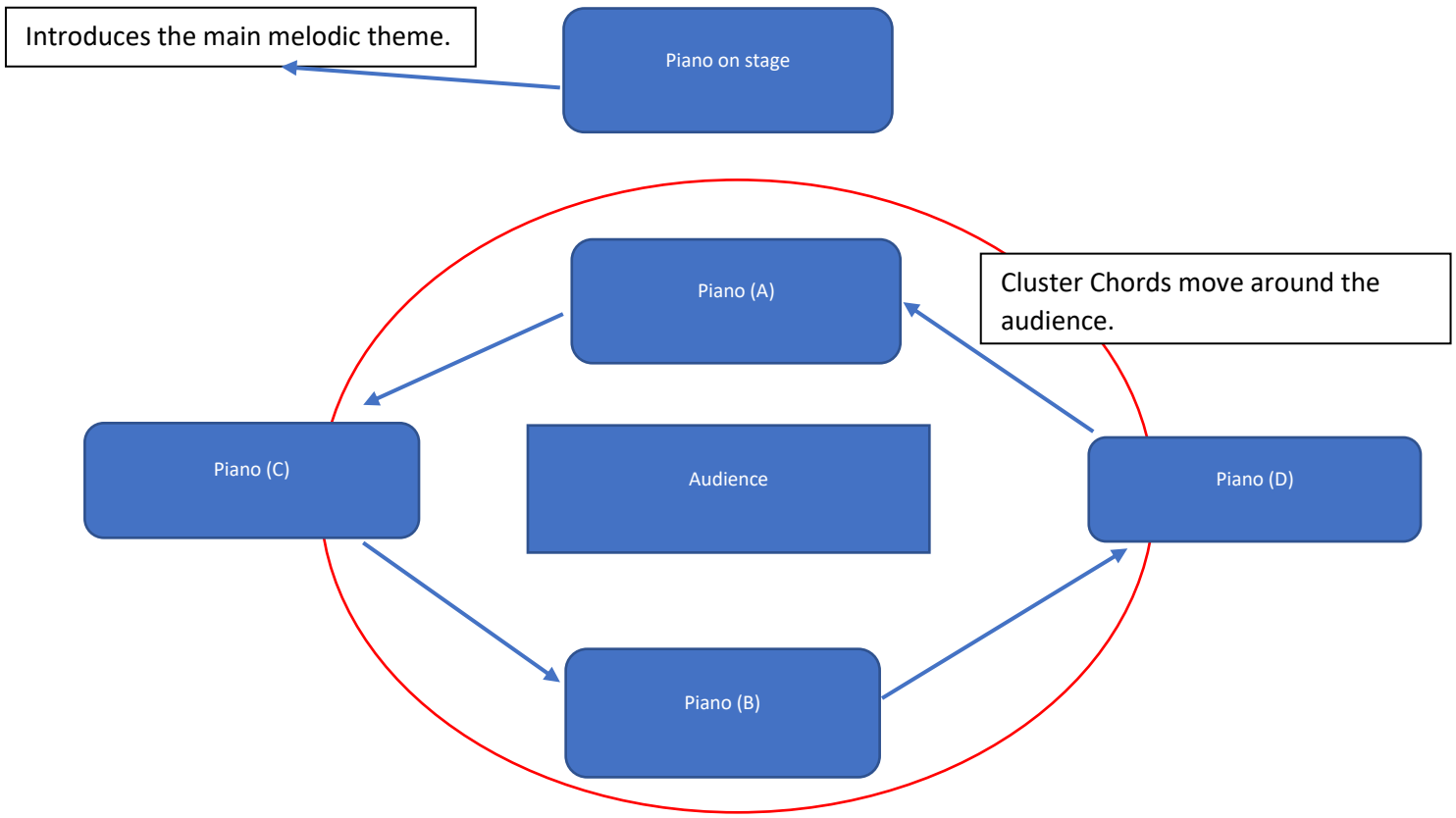

Figure 14: The main melodic theme is introduced outside the sound movement area in the distance.

A great example of this spatial multi-texture can be found in bars 191-194, in which the four pianos around the audience create a circular movement of a melodic phrase offstage while the piano on stage plays the harmonic and rhythmic background (figure 15).

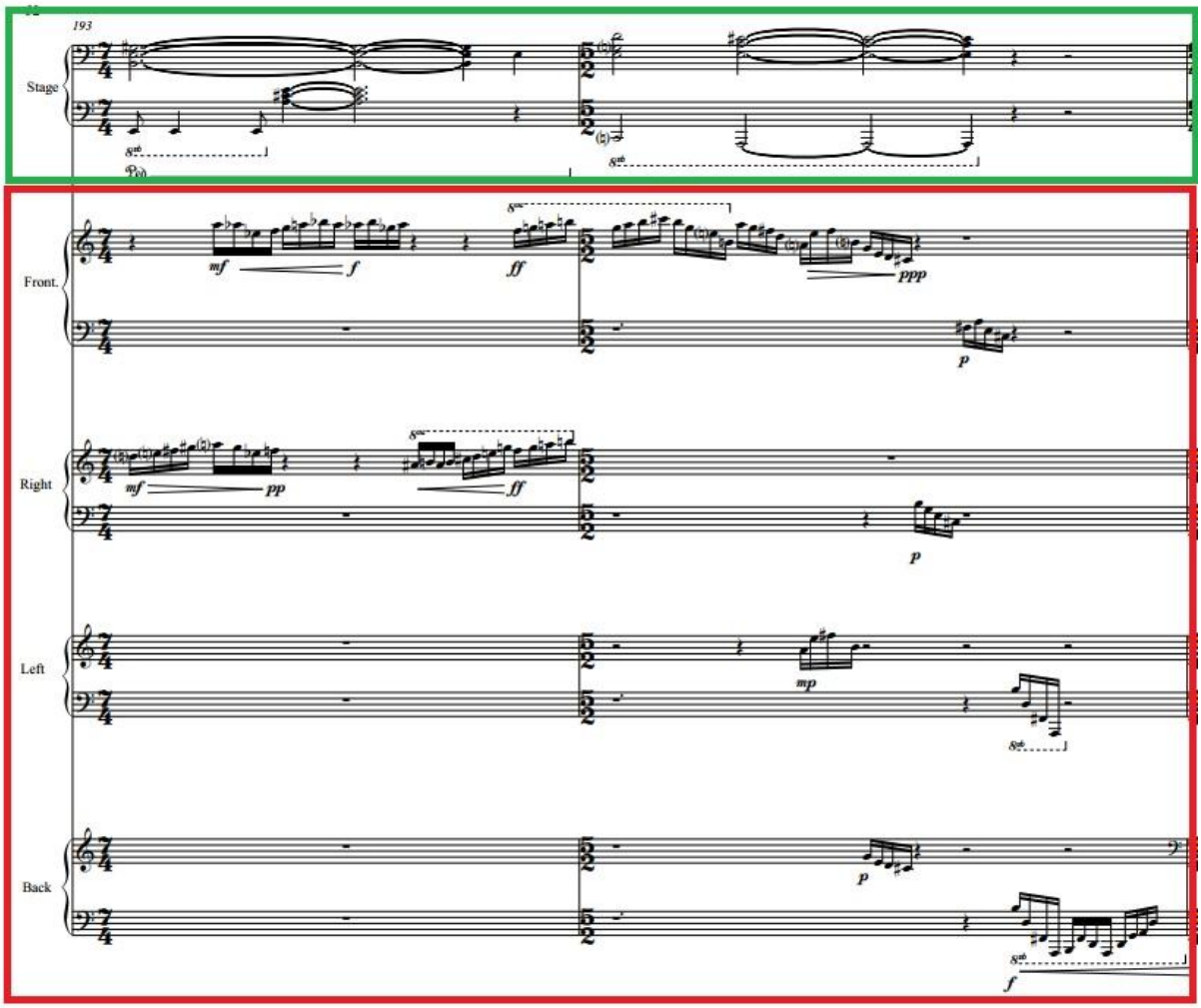

Figure 15: A rapid series of scalic sounds traverses the audience, weaving between the offstage pianos (marked in red). Dynamic variations accentuate the upward climb of this musical passage towards the higher range, followed by a swift descent back to the lower range. Meanwhile, outside of this motion, the onstage piano (indicated in green) offers a leisurely and low-pitched harmonic foundation.

This piece also uses the spatial technique that involves the creation of echo effects. For example, at bars 179-180, the left piano imitates the phrase of the right piano (but one octave higher) while starting one minim later, creating the impression of a spatial echo effect (figure 16).

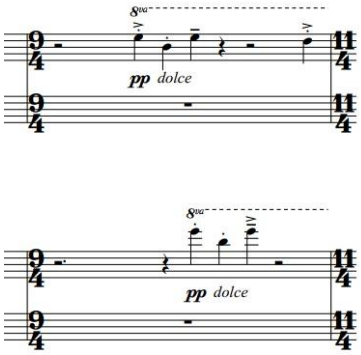

Figure 16: Creation of echoing effect between left and right pianos.

This motivic interplay is transferred later to the other pianos but with changes between the original musical material and its echo, creating this way multilayer echo and delay effects. This technique/effect characterises most of the "maturity" section (figure 17).

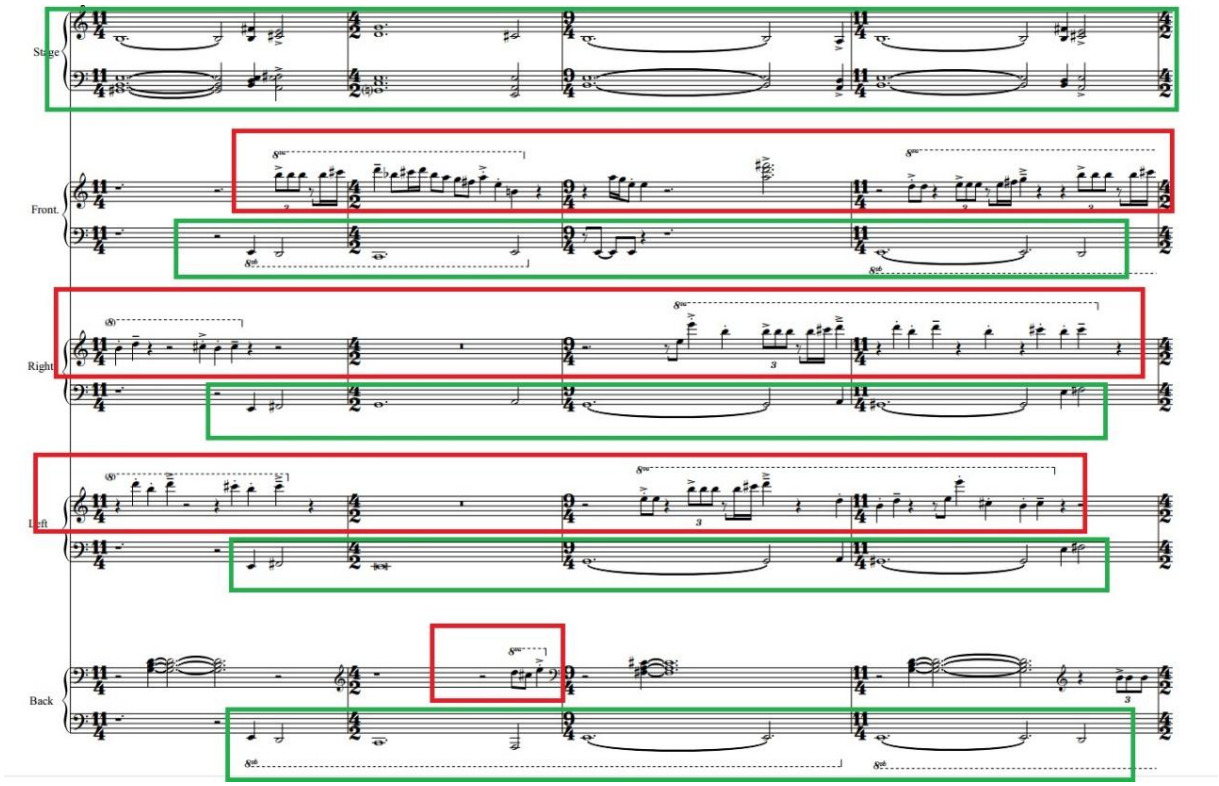

Figure 17: The musical development of the echo effect of figure 16 in the other directions (in red). The stage piano provides, again, a relatively slow harmonic background in a low register, complemented this time by an even lower register harmony played by the left hand of all pianos (in green).

Regarding the final section, the piece has an ambiguous closure, expressing the belief that life does not have a definite ending. At bar 357, the vertical directions (stage, front and back pianos) finally play the tonic (its dominant is underlined continuously from bar 349) while the horizontal directions (left and right pianos) play the cluster chord of the start of the piece. This mixture of chords provides the harmonic satisfaction of a closure on the one hand (this is also supported spatially as all pianos finally play the chords at the same time). Still, on the other hand, the cluster chord blurs the sound/meaning of the tonic and, thus, the feeling of complete closure. Moreover, the cluster chord's remaining sound at the piece's very end indicates that life ends as it started, implying that life circularly repeats itself (figure 18).

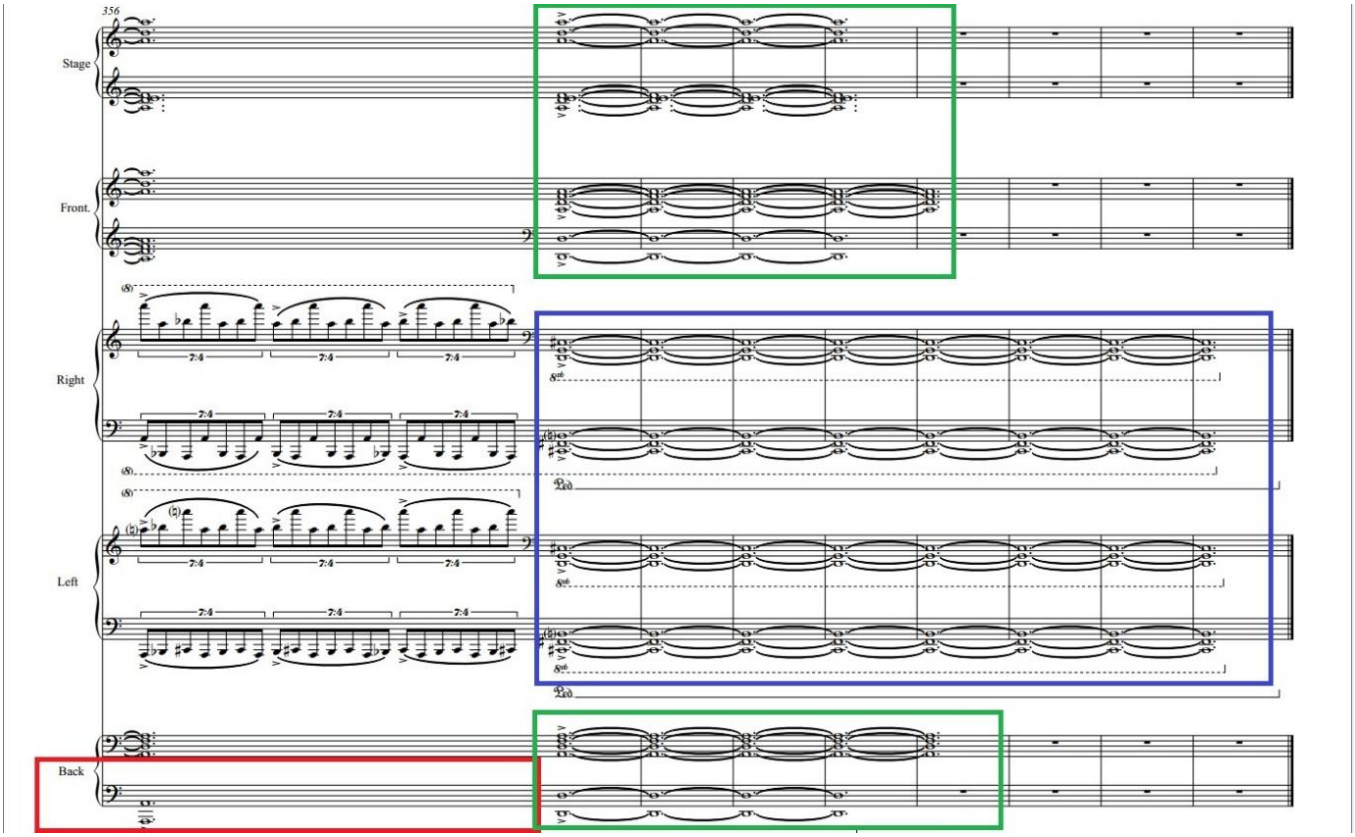

Figure 18: The final bars of the piece. In red is the underlying dominant. In green is its resolution, and in blue is the same cluster chord used at the piece's start.

Finally, this piece also explores the meaning of space from the perspective of time. A representative example can be found in the structure of the first two sections. The first section (the creation) is characterised by slow musical events, which create a feeling of open space (figure 19), while the exact opposite effect distinguishes the next section (youth). Successive fast musical passages generate the feeling of narrowness and pressure (figure 20).

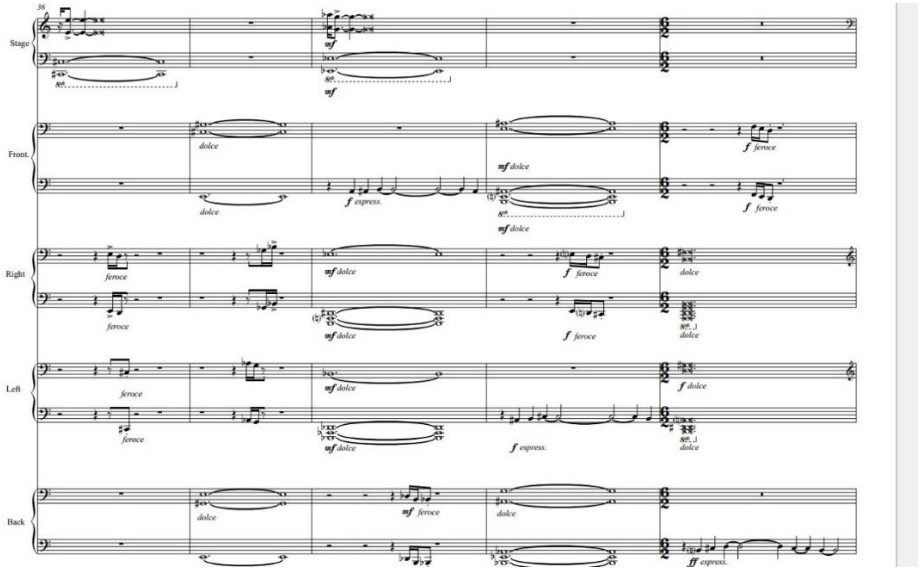

Figure 19: Extraction from the first section characterised by slow-moving events.

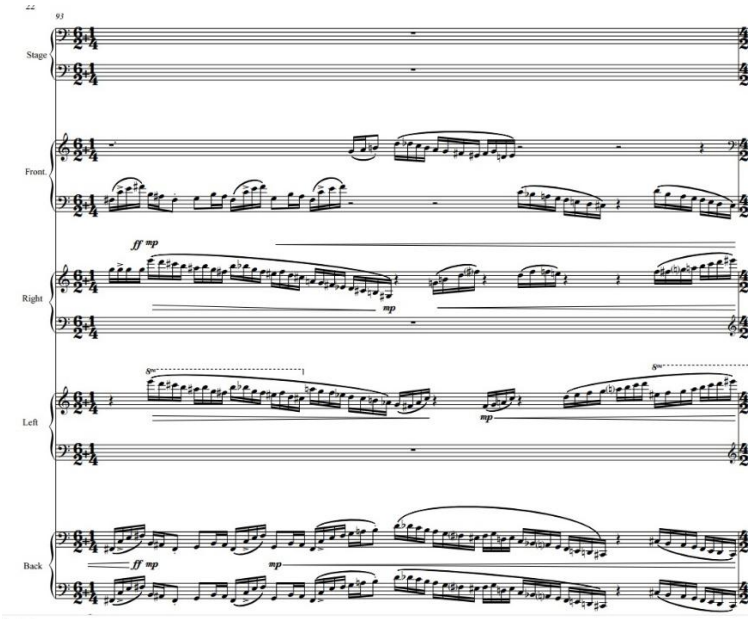

Figure 20: Extraction from the second section, characterised by fast-moving events.

In conclusion, *Life* utilises multi-dimensional space, incorporating musical and spatial techniques to represent the different stages of life. The use of spatial separation between the live piano on stage and the four offstage pianos creates a spatial musical texture, with sounds travelling through different regions of space. In addition, echo effects and the use of directionality highlighting further enhance the spatial experience for the audience. Overall, the piece explores the relationship between space and time, creating different music and spatial environments that reflect the different stages of life. These approaches correspond directly to the spatial strategies outlined in the methodology chapter, particularly the use of echo and delay to shape spatial motion, the use of directionality to construct contrast and progression, and the spatial separation of textures to clarify perceptual focus.

6.3 Requiem, for SATB choir and small ensemble

The instrumentation of the *Requiem* is divided into three sound group sources: a pair of woodwinds, a string quartet and a choir. All directional variables (front, back, left, and right) and their subcategories, such as front–right, front-left, back-right and back-left, discussed below are related to the audience's position.

At the Introit movement, the sound group sources are placed in two main directions, front and back. The woodwinds are at the front and split into individual sound sources between the right and left sides of the stage. This placement represents the setup shown in figure 22 and remains the same for the whole duration of the Requiem. The strings and choir are placed at the back and split right and left.

The musical material, inspired by Charles Ives's The *Unanswered Question*, is divided into three textures (one per sound group). The woodwinds have the foreground texture, the strings the middle/background texture and the choir the background. These different textures

become more evident in the first half of the following *Kyrie* movement before the singers start moving to the stage (figure 21).

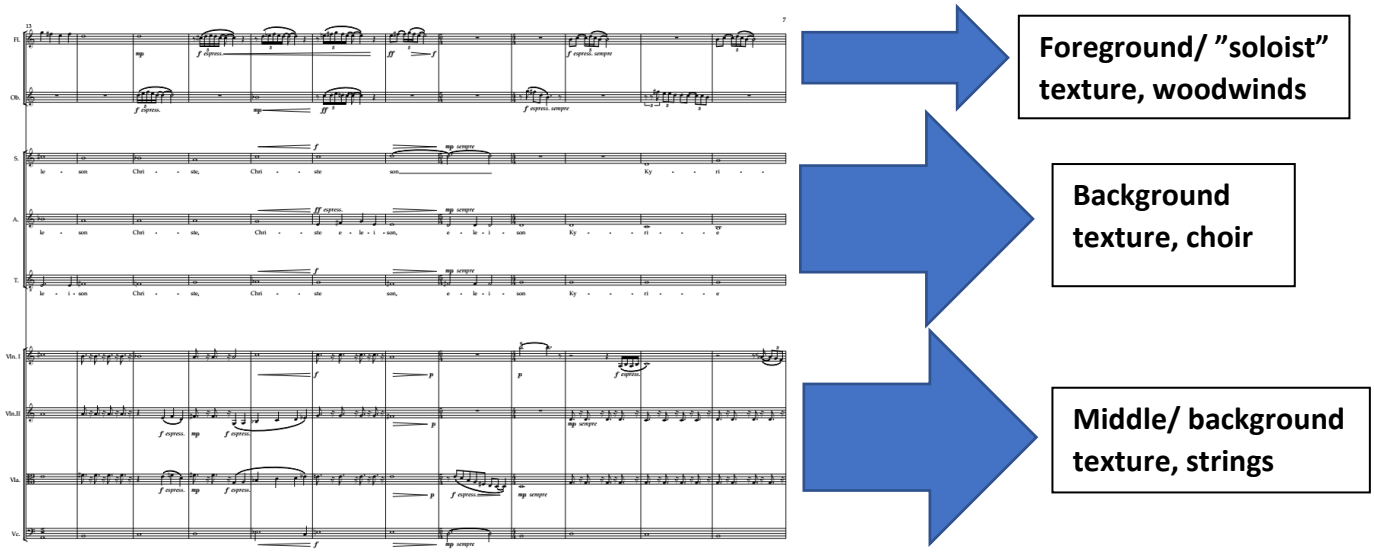

Figure 21: The three main textures of the Kyrie section.

Similarly to the *Unanswered Question*, distance is used to clarify the difference between the textures (which are not independent in contrast to the *Unanswered Question)*. However, in Requiem, the direction is used to highlight their textural roles. As discussed in the Research Context, placing the musicians outside the audience’s sight/focus enhances the choir and strings’ textural background role while emphasising the woodwinds’ textural foreground role by placing them alone on stage. Additionally, their separation on stage creates a distance between them, further emphasising their role as soloists (figure 22).

The textural role of the string quartet is continued to the second half of *Kyrie* and *Gradual* movements. However, at bar 55 of the *Kyrie* movement, the choir’s textural role shifts from background to foreground, and to reflect this change, the singers move to the centre of the stage. At that point, the textural role of the woodwinds changes to the middle/foreground. Despite this change, the woodwinds remain visible within the audience’s sight range but are positioned outside the main focus spot (the centre of the stage) by keeping the choir in the

middle. The choir's foreground role is further highlighted by this positioning, as the audience is now able to see the singers for the first time. Additionally, the walking motion of the singers towards the stage, accompanied by instrumental music, adds a theatrical element to the *Kyrie* movement (figures 23 and 24).

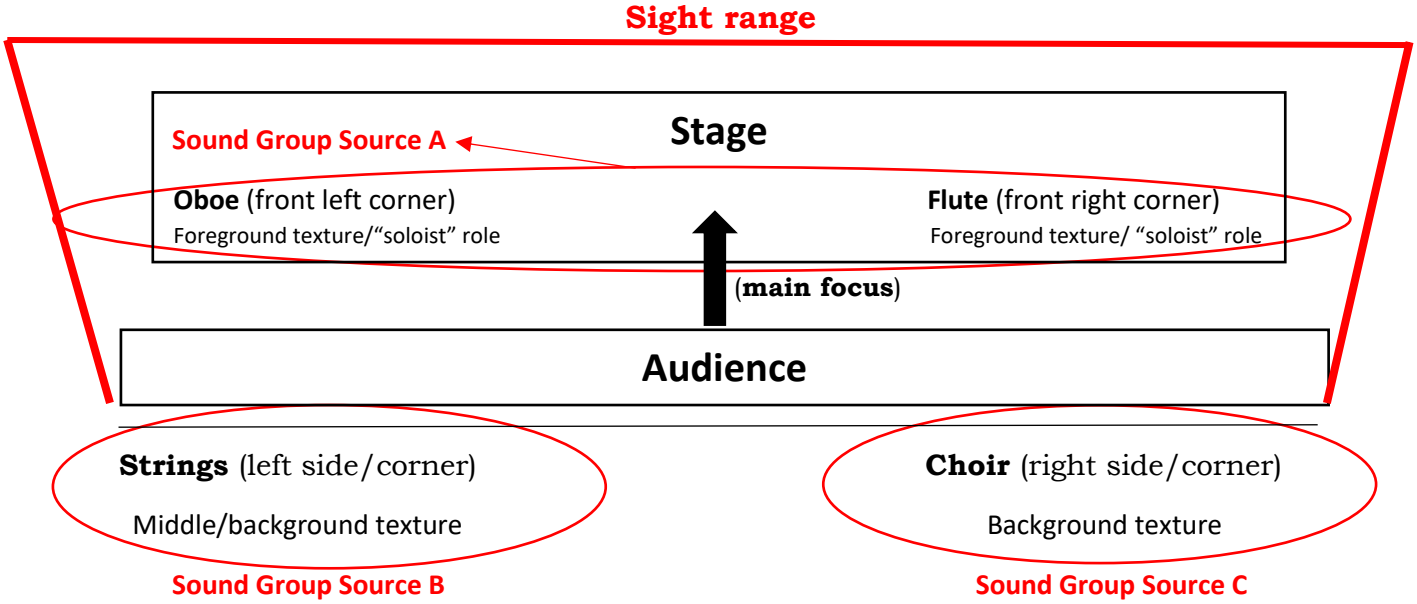

Figure 22: Using direction to enhance the textural role of each sound group.

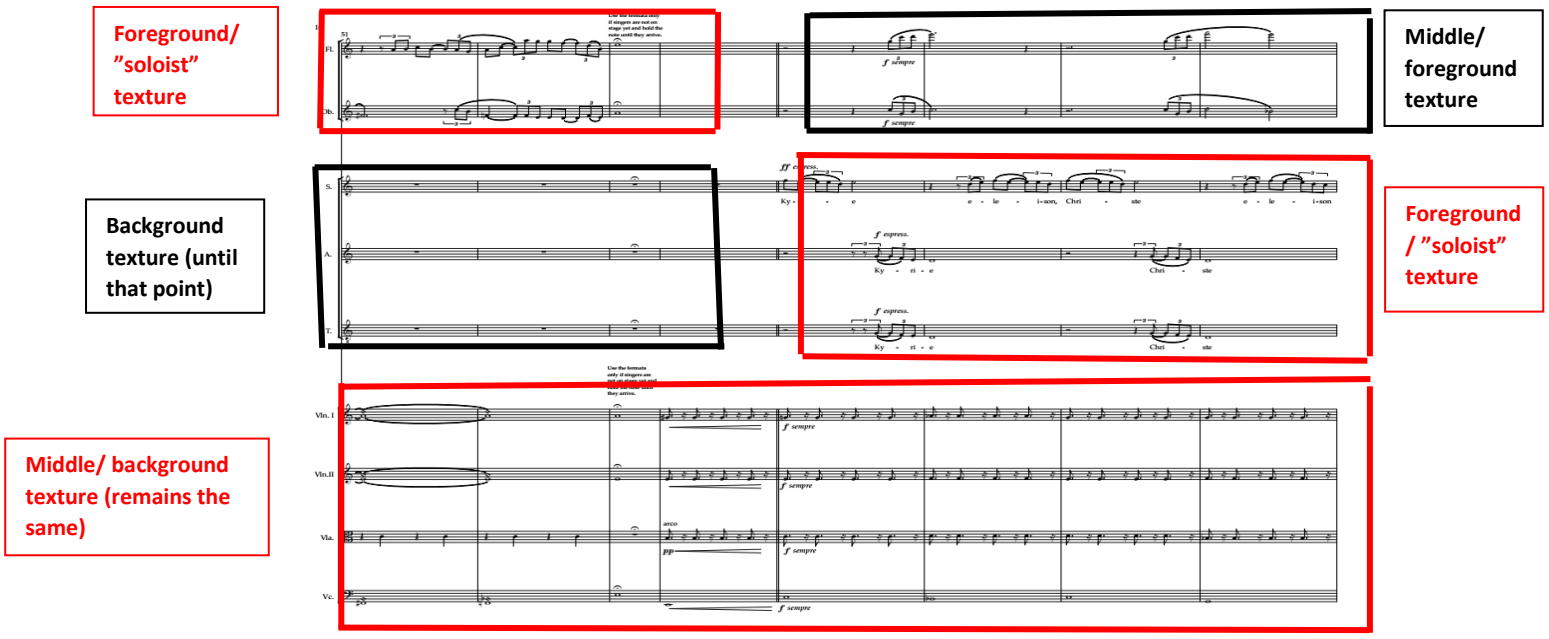

Figure 23: The change in the textural role of the woodwinds and choir, as illustrated on the score.

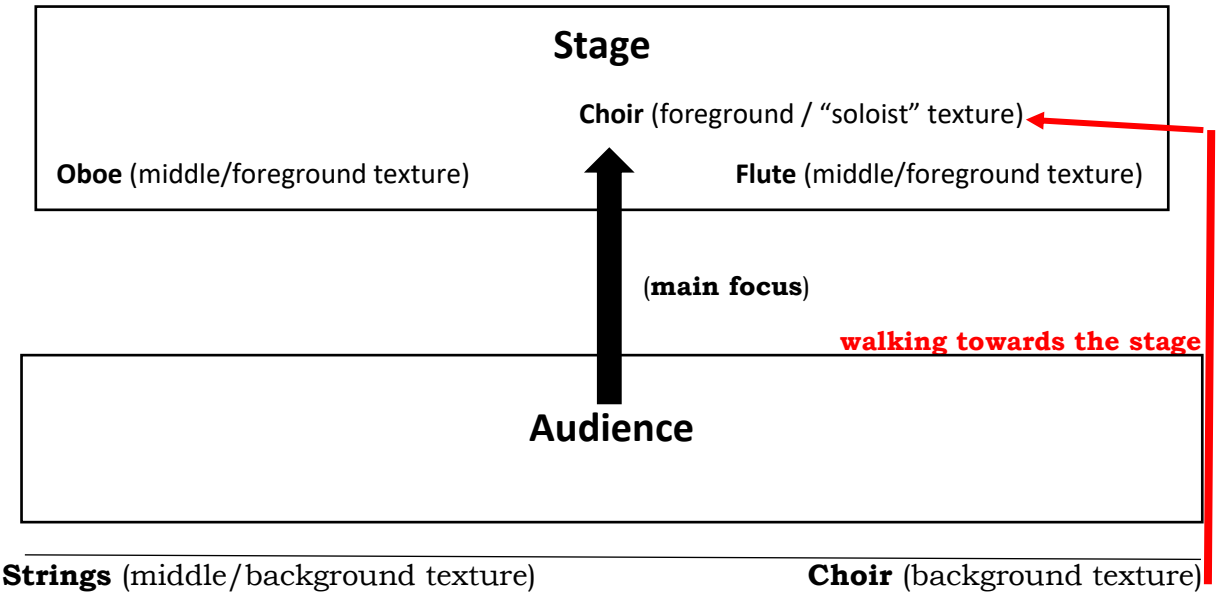

Figure 24: The musicians' spatial placement supports the change in the textural roles above.

At the two last movements of the *Requiem*, the textural roles of the sound group sources, along with the use of space, change drastically. For example, at the *Dies Irae* movement, even though the musical material is still divided into three textures (one per sound group source), strings and choir keep changing their textural roles (from foreground to background and vice versa) throughout the movement (figure 25).

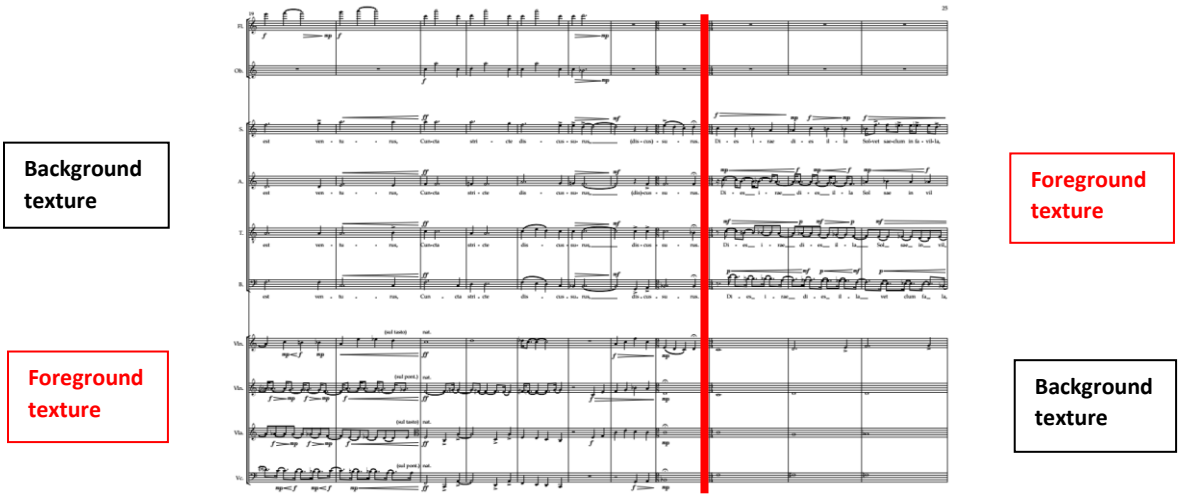

Figure 25: Change of the textural roles of the strings and choir during the Dies Irae movement.

In addition, the spatial placement of the musicians also changes drastically, indicating the new use of space. In this movement, space is no longer used to clarify the differences between the textures. On the contrary, it is used to merge them and enhance the directionality of the musical material. For that reason, the choir and strings are divided into new sound groups; the sopranos are paired with violin I, the altos with violin II, the tenors with the viola, and the basses with the cello. These pairings are distributed around the audience, similar to the *Life* piece. The foreground texture (either when it is in the choir or the strings) moves continuously around the audience, while the background texture sounds dispersed from the four directions (figures 26 and 27).

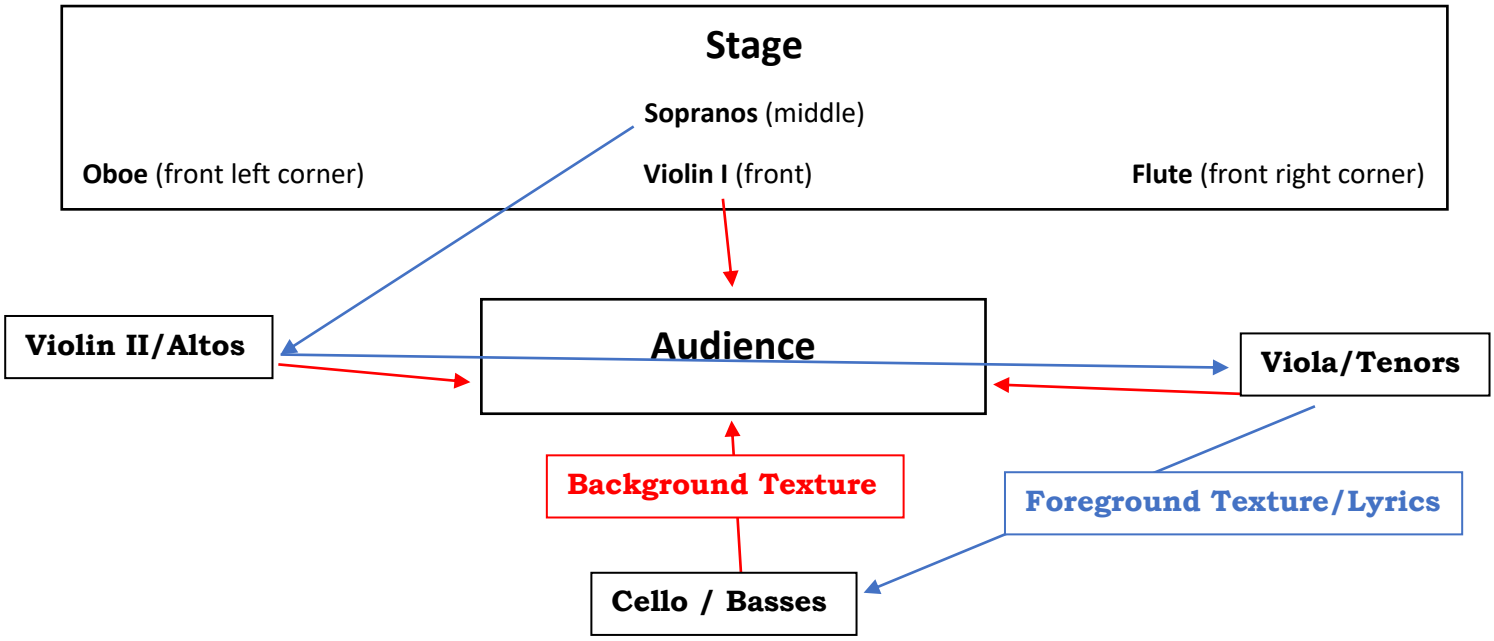

Figure 26: The motion of the musical material and text around the audience when the choir has the foreground texture in the Dies Irae section.

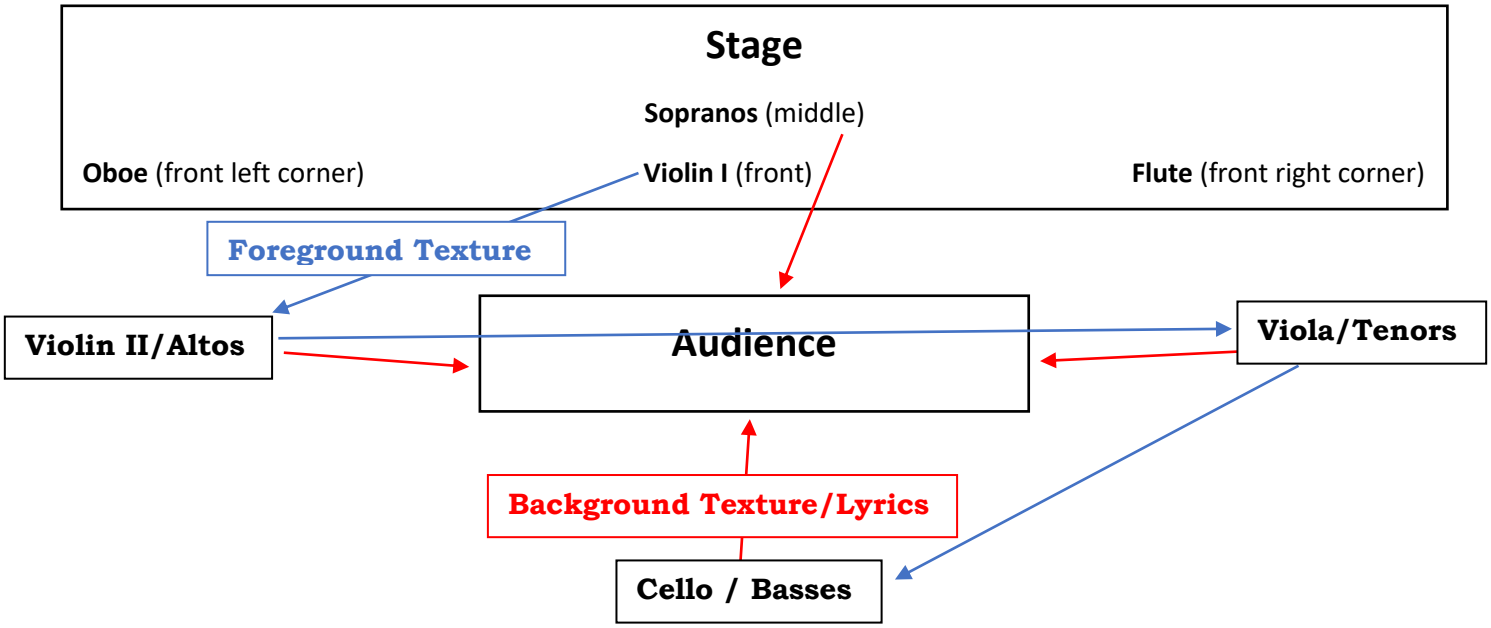

Figure 27: The motion of the musical material around the audience when the strings have the foreground texture in the Dies Irae section.

At the beginning of *Dies Irae*, the alteration in spatial utilisation is distinctly evident with the creation of an echoing sensation. The first phrase of the text, "Dies Irae dies illa", initiates from the sopranos, subsequently progressing to the altos with a slight delay, and then advancing to the tenors and basses. (figure 28).

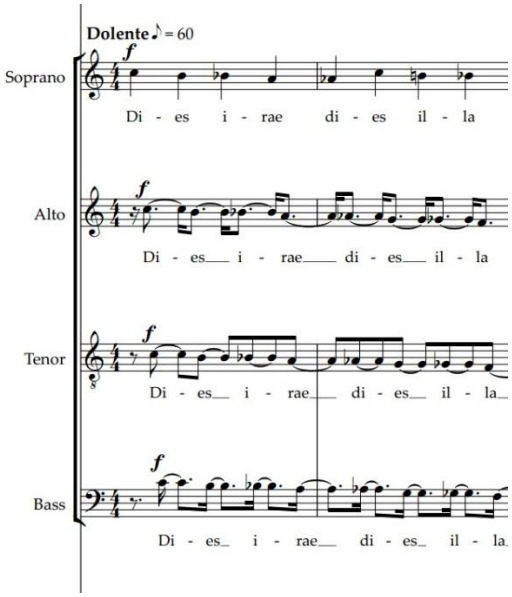

Figure 28: Echoing sequence starting from the sopranos.

This echoing effect becomes more evident in the following phrase, “Solvet saeclum in favilla, Teste David cum Sibylla” as each word is heard only by the sopranos. This is because the altos sing only the first syllable of each word simultaneously with the sopranos but hold to it until the next first syllable. The tenors do the same but with a slight delay to end with the basses who sing the word’s following syllable (figure 29).

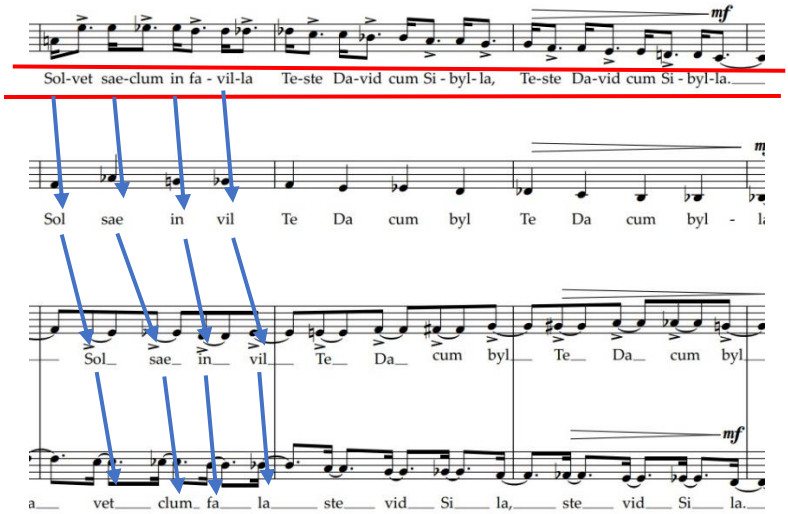

Figure 29: Echoing sequence enhanced with the division of the text.

When the strings have the foreground texture, a combination of contrasting dynamics and bow techniques is used to highlight the motion of the musical material in space (figure 30).

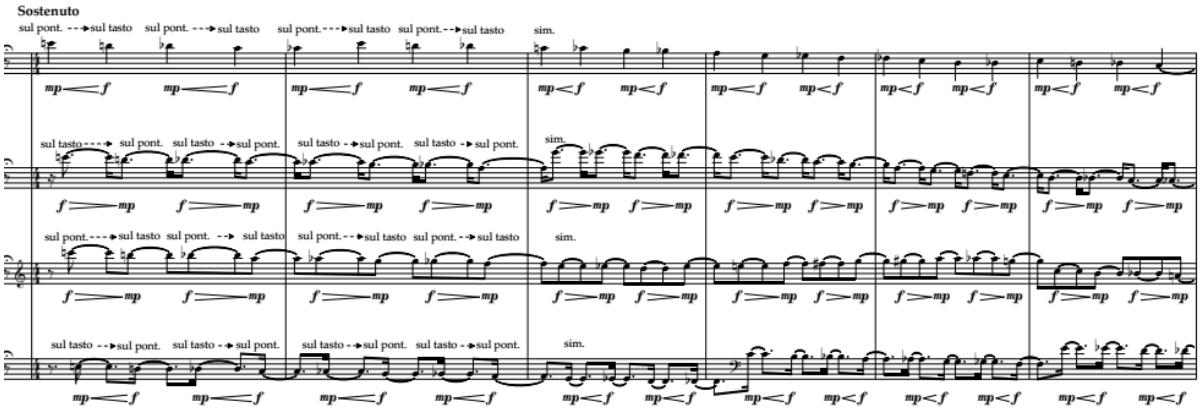

Figure 30: Bowing techniques change throughout the delaying repetitions initiated by violin I, giving a contrasting tone during the directional emphasis; violin I and cello also play contrasting dynamics, making the directional movement smoother.

When the strings play the background texture, they return to the standard bow technique playing stable dynamics. This helps the clarification of the change between foreground and background textures.

Finally, the *In Paradisum* movement is characterised by two distinct textures: musical and non-musical. The non-musical texture is conveyed through the *In Paradisum* text, recited by the solo soprano, while the musical texture is produced by the remaining ensemble, incorporating the *Requiem Aeternam* text.

The musical structure is based on a call-and-response pattern. The call is presented by the reciter, who uses forte dynamic, placed at the front of the stage, and the solo soprano, also at the front, who sings in the background using piano dynamic. The response comes in forte dynamic by everyone, excluding the soprano reciter. The direction is utilised in this movement to amplify the call and response roles. The call is projected towards the audience from the front while the response is delivered from all directions (figures 31 & 32).

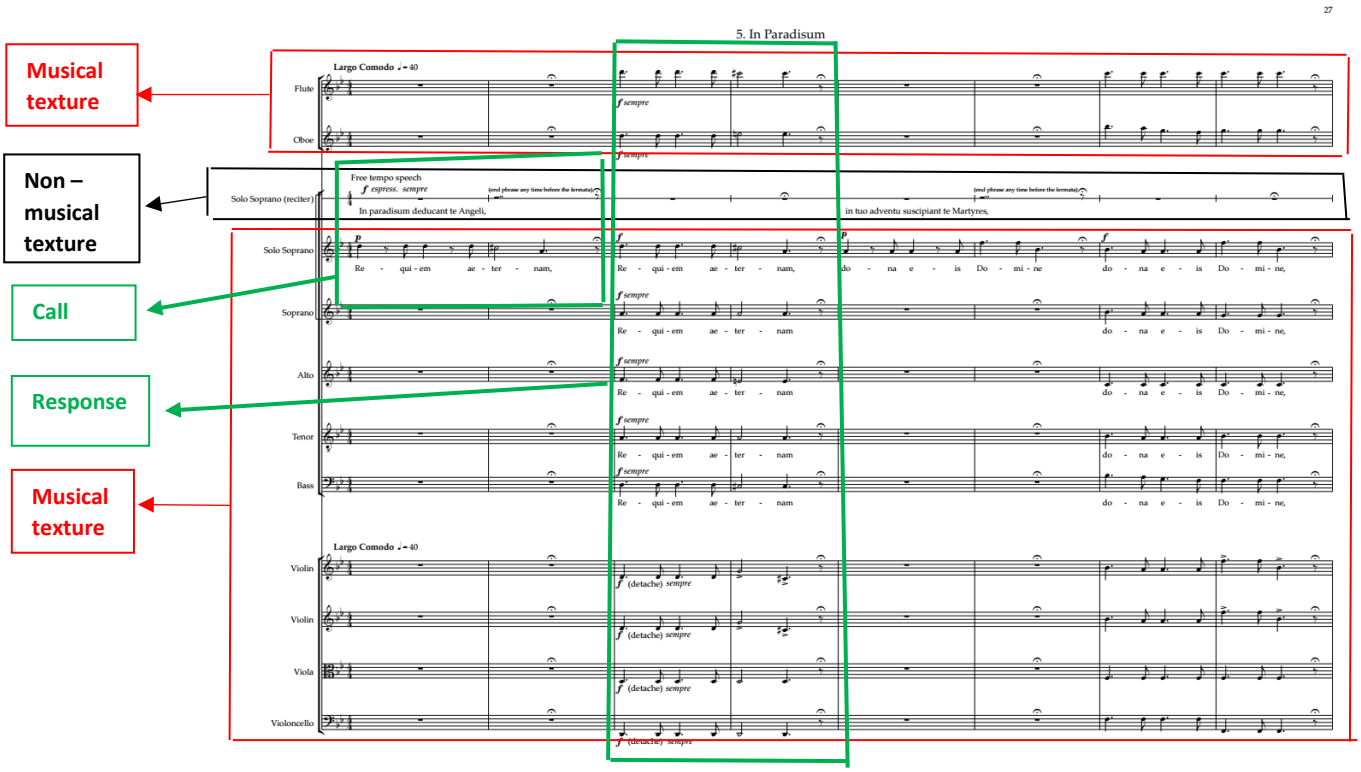

Figure 31: In Paradisum's musical structure.

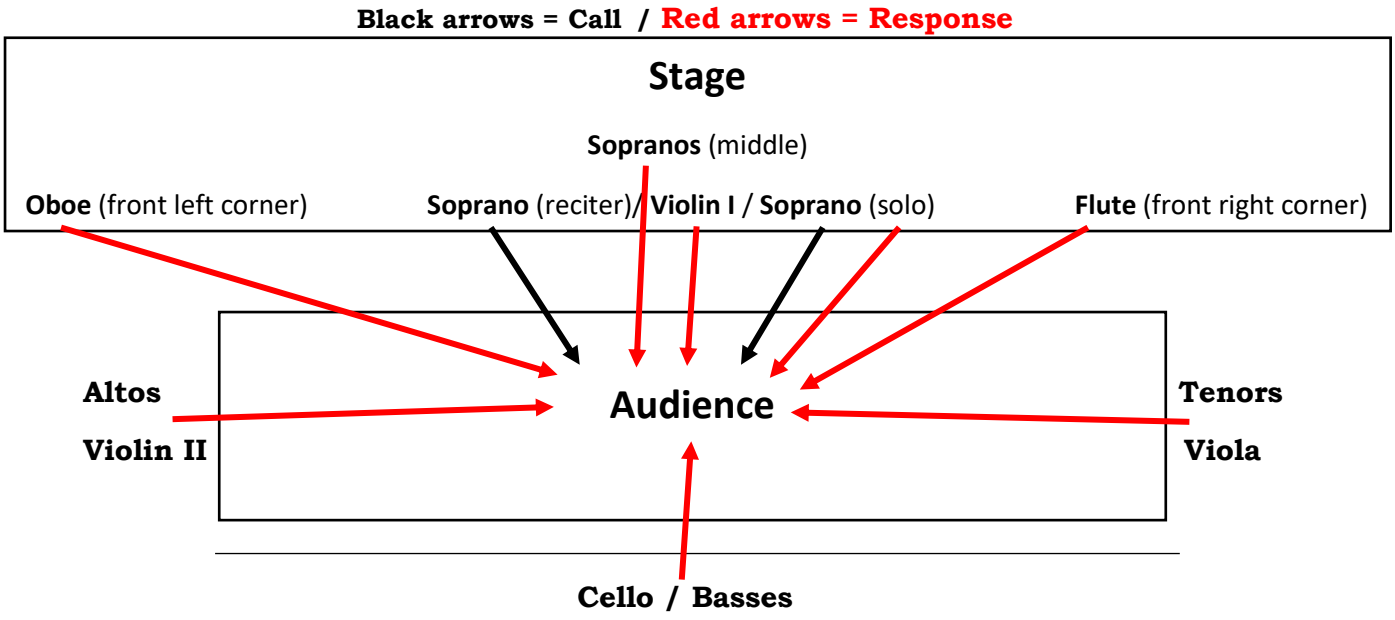

Figure 32: In Paradisum's spatial structure.

In conclusion, while space is often used to clarify the simultaneous juxtaposition of independent textures and layers, in *Requiem*, space is also used to enhance the individual character of each texture or layer. The direction of sound sources is used to prioritise foreground textures and make background textures seem intimidating or hidden. In the *In Paradisum* movement, *Requiem* employs spatial manipulation to emphasise the difference between the musical call and response, with direction used to strengthen this characteristic.

The influence of Ives's *The Unanswered Question*, referenced earlier in this section, is reflected in the spatial division of ensembles and their association with distinct textural roles. As in Ives's work, *Requiem* assigns separate musical functions to different sound sources placed in distinct physical locations: the woodwinds at the front represent the foreground, the strings and choir at the back represent background layers. However, in *Requiem*, these roles are not static. From the *Kyrie* movement onward, the spatial and textural functions of each group change gradually, with performers moving positions or exchanging musical material. This becomes more pronounced in the *Dies Irae*, where the ensembles are redistributed and paired to form mixed sound groups that rotate around the audience. In contrast to Ives's model, where ensemble layers remain fixed and independent, *Requiem* uses spatial change as part of the compositional structure. The piece employs space both to differentiate textures and, at other times, to merge them. These techniques align with the spatial strategies outlined in the methodology chapter, particularly the use of directionality to shape structural transitions, echo to emphasise distributed motion, and distance to define or shift textural roles across movements.

6.4 Spin, for one live clarinet in Bb and a recorded ensemble of 5 clarinets and 3 bass clarinets in Bb / 8 loudspeakers

Spin utilises a spatial approach designed to create a circular motion of sound around the audience. This was implemented through a symmetrical configuration of eight loudspeakers placed around the audience, alongside a live clarinet performed on stage. In this piece, as in the others submitted, spatialisation is treated as a primary compositional parameter; however, *Spin* differs in that the spatial trajectories are fully integrated into the structural logic of the score through explicit notation and timed speaker allocation from the outset.

The compositional methodology of *Spin* also differs significantly from the other works in the portfolio. While it was initially drafted using conventional notation for eight clarinets and one live performer, the score was later restructured to realise precise spatial trajectories. Each recorded part was systematically assigned to a fixed speaker location, and the notation was reformatted to ensure that the point of spatial origin shifted bar by bar. The intention behind this was to create a perceptible circular motion of the musical material around the audience. This regular rotation functions as a structural pointer: it stabilises metric expectation, clarifies polyphonic layers, and when counter-rotations appear in sections C–D, creates perceptual tension that thickens the texture. In the A section, this motion progresses in a clockwise direction, with the entry point of the material rotating to the next speaker every bar. In the B section, the same rotational logic is preserved, but the direction is reversed, producing an anticlockwise motion.

In section C, the same anticlockwise movement continues for all clarinets except Clarinet 5, which intentionally moves in the opposite direction, clockwise, at the rate of half a bar. This countermotion introduces a second layer of rotational behaviour, designed to increase spatial

complexity and disrupt the uniformity established earlier. In section D, this motion comes to a temporary halt. Each speaker maintains its assigned part without rotation until bar 58, at which point the music resumes its spatial movement. From that point onward, the live clarinet part, previously fixed on stage, is now gradually distributed to the speakers as well, changing location at every crotchet. The intention here was to generate two concurrent clockwise motions, each unfolding at a different speed and spatial scale, thereby increasing both the density and the rhythmic ambiguity of the texture.

The circular motion slows down in section E, with the transitions between speaker locations occurring every two bars instead of every one. This deceleration was designed to gradually dissolve the sense of motion and prepare the listener for the conclusion of the piece, which occurs when the material comes to rest at bar 76.

Spin shares several structural and spatial characteristics with Steve Reich's *New York Counterpoint*, as presented in the McGill University research project performance discussed in section 4.2.1. Both pieces use a solo clarinet accompanied by pre-recorded parts distributed across a multi-speaker system. In the McGill performance, the ten recorded parts were diffused dynamically across speakers placed around the audience, behind the performer, and elevated above the stage. This created a three-dimensional spatial field in which motifs could move freely and be perceived from multiple directions and depths. By contrast, *Spin* uses a fixed, symmetrical ring of eight speakers surrounding the audience, with each recorded part assigned to one speaker. The motion in *Spin* is not dynamic in the same way; instead, it is explicitly composed into the score through measured and systematic changes in speaker activation. For example, the piece uses clockwise and anticlockwise rotations, alternating patterns, and layered melodic material to structure the spatial motion.

Unlike the McGill version of *New York Counterpoint*, where spatialisation was shaped in post-production based on the musical texture, the spatial behaviour of *Spin* is fully integrated into the compositional process through notation. In both cases, spatialisation serves to clarify rhythmic structures and enhance the perception of polyphony, but the methods and degrees of compositional control differ significantly.

Spin is a piece in which spatial motion functions not as an added effect but as a fundamental structural device. The entire score was conceived to articulate these movements precisely, with each section governed by different rotational schemes and speeds. The result is a listening experience in which directionality, rhythm, and form are all interlinked through the physical placement and behaviour of sound in space. This approach corresponds directly to the spatial strategies outlined in the methodology chapter, particularly the use of directionality to generate structured motion, and the use of spatial rotation as a formal parameter that defines transitions, texture, and temporal proportion.

6.5 Greek Étude, for bass clarinet in Bb and tuba

The *Greek Étude* is a piece that employs a variety of musical elements from Greek folklore music, creating a distinctive sound that blends different cultural influences. One notable aspect of this composition is the use of space, which creates a directional interplay between the left and right sides of the audience when performed acoustically.

Another performance option involves using three speakers to play six pre-recorded music parts, created by the performers, alongside live parts performed during the piece. This option represents a further development of the ideas explored in the piece Spin. In this piece, the combination of live performance and recorded parts is designed to produce specific,

measured, and timed motions of sound around the audience, with the sound shifting in a clockwise pattern at every bar. Unlike Spin, which featured a single soloist, this piece includes two soloists with different timbres, making it easier for listeners to localise the sound. Additionally, the performers' parts integrate smoothly with the circular motion of the speakers, whereas in Spin, the soloist's role often stood apart, initiating musical patterns or functioning separately from the speaker-generated music. This results in a more cohesive sound texture within the circle. Since the musicians' parts start at different times, two distinct circular music patterns are created, further enriching the spatial texture of the piece.

The instrumentation of the piece plays a crucial role in its spatial aspect. The clarinet, a prevalent instrument in Greek music, is used here in a different way by employing the bass clarinet's tone. This creates a distinctive East-Mediterranean inflection, differing from the timbral palette commonly associated with Greek music. Furthermore, the tuba, usually associated with Balkan influences in Greek music, is also used to add a distinct sound to the composition.

The melody is a blend of Eastern and Balkan influences. For instance, the distinctive bass motif consisting of three quavers that is repeated throughout the piece is influenced by Balkan music. On the other hand, the remaining melody in the first bar is derived from Eastern influences (figure 33). This melodic mixture is prevalent throughout the piece.

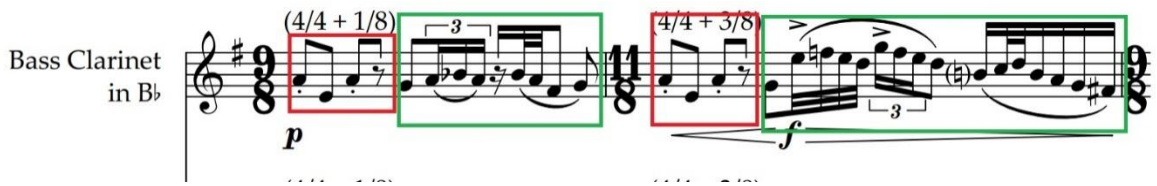

Figure 33: The first bar of the piece. The Balkan motif is in red, and the Eastern melodies are in green.

Regarding the rhythm, both 9/8 and 11/8 time signatures are frequently used in Greek dance music. However, in this piece, they are combined and alternate with each other. Furthermore, their pulse is altered, emphasising the commonly used 4/4 signature. Thus, the 9/8 is musically interpreted as 4/4 and one quaver, while the 11/8 is treated as 4/4 and three quavers, as evidenced in the first bar of the score. This is also apparent in the note groupings.

The spatial aspect of the composition is most evident in the directional interplay between the left and right sides of the audience. The melody starts with the bass clarinet and then merges with the tuba's part, with the roles of melody and accompaniment alternating between them. The frequent and sudden changes in contrasting dynamics between the two instruments also enhance the directional changes, further accentuating the spatial aspect of the composition.

In conclusion, the *Greek Étude* builds upon the ideas first explored in the *Spin* piece, continuing to experiment with spatial and auditory elements in performance. While *Spin* introduced the concept of a soloist interacting with directional sound movement, the *Greek Étude* develops this further by incorporating two soloists with distinct timbres and a closer integration between live performance and pre-recorded elements. This approach allows for a subtle sound environment, where the music moves around the audience in a carefully timed pattern, creating overlapping circular patterns that contribute to the spatial texture. By using traditional Greek musical elements, such as the bass clarinet's tone and the tuba's Balkan influences, the piece aims to blend cultural references with acoustic experimentation, expanding on the spatial concepts introduced in *Spin* with a focus on duality and integration. The spatial techniques employed in *Greek Étude* correspond directly to the methodological strategies outlined in Chapter 5, particularly the use of directionality to construct spatial dialogue, and dynamic contrast to highlight positional shifts.

6.6 Deadline, for quadruple clarinet, cello, and double bass trio & four Speakers

This composition takes a different approach from the *Spin* piece by combining the spatial elements from *Syria* and *Greek Étude*. Instead of having one group of musicians split into four directions, as in *Syria*, this piece uses four trios placed in the four main directions around the audience: front, back, right, and left. Additionally, instead of the two performers used in *Greek Étude*, there are now twelve. Four speakers are placed between the trios, creating a circle around the audience, similar to the setup in *Spin*. However, in this case, the musicians are included within the circle.

For most of the piece, the music is played without the use of speakers or pre-recorded parts. During this time, the music moves between the scattered trios in different patterns around the audience, similar to the previous works.

The inclusion of more musicians enriches the acoustic motion within the spatial texture of the piece. With twelve live performers divided into four trios, each positioned around the audience, the sound becomes more dynamic and multilayered. Unlike previous compositions, where fewer performers meant more focused and singular sound movements, the presence of additional musicians allows for a more complex interplay of sound waves. As these trios interact, their melodies and rhythms overlap and conflict, creating a web of sound that moves in various directions simultaneously. This multi-layered motion results in a more immersive auditory experience, as the audience is enveloped by the interplay of sounds that shift and rotate around them. The additional musicians enable more varied acoustic patterns, such as echoes, counterpoints, and harmonic layering, all of which contribute to a richer spatial texture. This expanded setup allows the composition to explore new dimensions of spatial

interaction, where the directionality and movement of sound are not only enhanced but also multiplied.

In the final section of the piece, the speakers join in, playing 19 recorded parts along with the 12 live parts. These speakers either move the music in circular patterns, enhancing the live ensembles' motion by adding different sounds in various directions, or they play in unison with parts of the live ensemble, which deepens the complexity of the sound. By adding different sounds in various directions, the speakers create contrasts and interactions with the live music, making the overall sound texture more intricate. These interactions can cause the music to feel more dynamic and constantly shifting, keeping the audience engaged as the sounds seem to move and change around them.

When the speakers play in unison with parts of the live ensemble, they reinforce and amplify those musical elements, creating a fuller and more powerful sound. This can heighten the emotional impact of the music and make certain passages stand out more. The combination of live and recorded parts adds to the complexity of the sound, as the audience experiences both the synchronised elements and the contrasting ones, all blending together to create a rich and layered auditory experience.

In conclusion, this composition represents a development in the exploration of spatial sound and musical interaction. By expanding the ensemble to twelve musicians and integrating them within a circular speaker setup, the piece achieves a more dynamic and complex soundscape than my previous works. The intricate interplay between the trios and the added layers from the speakers creates a multi-dimensional auditory experience, where sound moves fluidly around the audience. This blending of live and recorded elements, along with the strategic

use of spatial patterns, enhances the depth and richness of the composition, offering listeners an immersive experience that continually shifts and evolves. The piece reflects all three spatial strategies outlined in the methodology chapter: the use of echo to generate movement between performers, the use of directionality to define and rotate musical roles, and the spatial separation of textures to clarify complex musical interactions within a shared acoustic space.

6.7 Sahara, for symphony orchestra

Sahara represents the final and most expansive realisation of the spatial strategies explored in this portfolio. It combines a live orchestral ensemble with three pre-recorded speaker groups (SP1, SP2, SP3), positioned to the right, left, and rear of the audience. These fixed-media groups function as spatially distributed virtual ensembles, rendered using digital sampling and spatialisation techniques. Each speaker carries a unique instrumental mix, allowing for directional contrast, echo layering, and spatial interplay with the live ensemble.

Rather than treating electronics as an external layer, *Sahara* integrates fixed-media material into the compositional structure from the outset. The three speaker ensembles act as ghost orchestras, independent yet intertwined with the live group. Their musical content is rendered in advance and notated in the score via cue staves, grouped by family (winds/brass, strings, percussion), to support conductor orientation. The live performers synchronise to a conductor who hears a click track via in-ear monitoring, allowing alignment without enforcing mechanical precision. The speakers form a symbiotic extension of the live orchestra, actively reinforcing and highlighting key musical elements by aligning fixed-media content with live performances, thus blurring the lines between acoustic and electronic sounds. For instance,

speakers can isolate an oboe phrase from SP3 to enhance clarity and create spatial movement, echo or sustain a brass chord via SP1 for added depth, or layer a strings fast passage through SP2 or SP3 to clarify complexity and generate rhythmic propulsion. This intentional approach, with pre-recorded material notated in cue staves to mirror the orchestra, aim to enrich my expressive palette and magnifying musical gestures.

Throughout the piece, spatial motion is treated as a compositional parameter. The three speaker ensembles interact with the live orchestra through antiphonal echo, dynamic divergence, timbral reinforcement, and layered simultaneity. Directionality becomes a means of articulation, clarifying formal transitions and emphasising musical tension. The use of three spatially distinct speaker identities enables contrapuntal layering and spatial ambiguity, continuing ideas from *Spin* and *Deadline*, but scaled to a full orchestral environment.

Sahara also reinterprets the rotational and fragmentary logic explored in earlier works. Whereas *Spin* relied on pre-composed circular motion and *Deadline* on live ensemble placement, *Sahara* maintains fixed spatial positions while varying the temporal, timbral, and structural function of each source. This includes moments where speakers lead, echo, or conflict with the orchestra, creating textural overlaps and delayed synchronisation. The result is a multi-dimensional sound world in which space is no longer background but an active part of musical form.

In conclusion, *Sahara* extends the portfolio's spatial research to a larger compositional scale. It applies the three strategies outlined in Chapter 5: (i) echo and delay to generate motion, (ii) directional placement to articulate structure and contrast, and (iii) texture separation for spatial clarity. The piece also draws on Stockhausen's spatial thinking in *Gruppen* and *Carré*,

where segregated groups surrounding the audience yield layered material and dramatic motion through overlapping dynamics. Here, the three fixed-media streams function as virtual groups against the live orchestra, adapting Stockhausen's group composition to a hybrid format that foregrounds directional handovers and textural clarification, consistent with the portfolio's methods of echo and multi-layered juxtaposition. By combining live ensemble with multi-speaker fixed media, *Sahara* creates a dense, immersive spatial texture that foregrounds interactions between ensemble, electronics, and listener position.

7 Conclusion

Through a portfolio of instrumental and vocal compositions, this PhD study has investigated how allocating fragmented musical material to different musicians positioned around an auditorium can alter the listener's overall experience. This portfolio illustrates that, in the contexts studied, manipulating distance and direction can influence listeners' understanding of instrumental or vocal music.

Furthermore, by viewing space from the perspectives of distance and direction, the research showed how this approach could allow for more precise manipulation of musical material and emphasis on directional elements. It has also been discussed how contrasting dynamics can be used to smooth directional changes and how adding extra layers of sound movement in space can create even more intricate spatial perceptions. However, these perceptual effects are seat (and room) dependent since strong reverberation or occlusion can blur lateral cues, extreme source distances reduce DRR contrast, and listener hearing profiles vary. Overuse of spatial motion can also distract from structural focus. In practice, mitigation involves venue-

specific balance and placement, dynamic calibration in rehearsal, and (where used) carefully diffused electronics.

However, this exploration is only the beginning, and there are several practical pathways for advancing this work.

1. Audience Feedback through Interviews and Questionnaires: Future live performances could incorporate structured interviews or questionnaires to gather direct feedback from audiences. These tools would help assess how listeners perceive the spatial elements within the music. Insights gained from this feedback could be invaluable for refining spatial techniques, understanding audience preferences, and improving the overall effectiveness of spatialisation in music.

2. Application to Virtual Reality (VR) and Gaming Environments: Another avenue for future work involves adapting the fragmentation of music to VR environments, such as games and movies. In these contexts, spatialised sound can significantly enhance immersion by dynamically responding to user interactions. Research could focus on how to best integrate these techniques into VR development, ensuring that the spatial elements of the music contribute to a more engaging and interactive experience.

3. Development of Music Software for Automated Spatialisation: There is significant potential in creating music software that can automatically split musical materials from a score and generate spatial scores. This software could use algorithms to analyse a score, identify key elements for spatial distribution, and create a spatial map that composers and performers can use to design their pieces. Such a tool would make spatial music composition more accessible to a broader range of musicians, encouraging further experimentation and innovation.

4. Automated Command Systems Using MAX/MSP: A crucial next step in this research is the development of automated command systems using MAX/MSP (Max Signal Processing) to control the spatial distribution of live music during performances. This system would allow performers to allocate live-performed music to different speakers in real-time, without the need for pre-recorded parts. By integrating microphones and a Digital Audio Workstation (DAW), the system could be programmed to trigger the automatic routing of audio outputs to different speakers based on predefined parameters. This would enable a more dynamic and flexible live performance, where spatial elements can be manipulated on-the-fly, creating an immersive experience.

5. Live Performance through DAW and Automated Spatial Audio: Building on the MAX/MSP system, future performances could involve using DAW software during live shows to manage the real-time spatial distribution of sound. Performers could trigger devices that automatically send audio outputs from the DAW to different speakers, creating a live, spatialised soundscape that evolves with the performance. This approach can enhance the live listening experience and offers practical ways to integrate spatialisation into real-time music production.

In summary, the future possibilities for this research are vast and exciting. By incorporating audience feedback, applying spatial techniques to VR environments, developing automated spatialisation software, and leveraging MAX/MSP and DAW systems for live performances, the field of spatial music can continue to evolve and expand. These practical advancements will contribute to making spatialised music more accessible, dynamic, and immersive, both for performers and audiences alike.

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