A Symphony of Sound Images: Spatial composition strategies in Zhang Xiaofu's *Yarlung Zangbo*

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Yarlung Zangbo is a multimedia symphony combining orchestra, visual images and electroacoustic music by one of China's most internationally influential electroacoustic music composers, Zhang Xiaofu. This article focuses on the spatial aspects of *Yarlung Zangbo*. First, we discuss two different spatial composition preferences in electroacoustic music: image delivery and creation. We then divide the development of electroacoustic orchestral music into three different periods and examine the general spatial intention of the works in these periods. Finally, we analyse and identify four spatial composition strategies of *Yarlung Zangbo*: equity, virtuosity, diversity and unity. The successful utilisation of these strategies has not only made the piece a milestone in Chinese electroacoustic music, but also a unique and meaningful contribution to the electroacoustic music repertoire worldwide. We believe this article will provide valuable knowledge and insight for future research and practice of spatial composition.

1. INTRODUCTION

In 1977, Zhang Xiaofu (张小夫) left his hometown in northeastern China to become a member of the most internationally recognised class since the founding of the Central Conservatory of Music (CCOM) in Beijing: Composition Class 77.[1] Despite being the top music school in China, the CCOM did not have any course on electroacoustic music in the 1980s (Battier 2020). As a consequence, Zhang, passionate about electroacoustic music, went to study in France in 1988. After six years of study there, he returned to China and founded the Musicacoustica-Beijing Festival in 1994, regardless of difficulties including lack of funds, staff, equipment and venues. The Musicacoustica is not only the most long-standing and influential electroacoustic music festival in China to date, but also the first international festival of contemporary music in the country. For more than

20 years, the festival has developed under the tireless persistence of Zhang, receiving growing attention and enthusiastic support from professionals in China and all over the world. Until now, artists and engineers from almost every major electroacoustic music centre and institution across the world have given concerts or lectures at Musicacoustica. Consequently, this enhanced Chinese scholars' and students' experience, knowledge and understanding of electroacoustic music in an unprecedented manner. During the founding of the festival in the 1990s, Zhang was also very visionary in electroacoustic music education. He combined his experience of studying in France with conditions of Chinese music education, and gradually established curriculums for undergraduate and graduate programmes in electroacoustic music. He became the first doctoral supervisor in electroacoustic composition in China, recognised by the Chinese Ministry of Education in 2009. In recognition of his contribution to the development of electroacoustic music both nationwide and worldwide, Zhang received an Honorary Doctorate of Music by De Montfort University in Leicester, England in 2019, the first Chinese electroacoustic music composer to receive an honorary doctorate overseas.

Yarlung Zangbo is a large piece by Zhang that combines orchestra, visual images and electroacoustic music, which the composer himself describes as a *multimedia symphony*. It is not only the composer's most complex and ambitious work in terms of sound combination to date, but also the largest mixed electroacoustic music work ever performed in China. The work consists of six movements with identical pronunciations in Chinese, each entitled '原' – Origin, '源' – Source, '园' – Home, '愿' – Hope, '缘' – Fate, and '元' – Meta. The total duration of the performance is approximately 40 minutes. The world premiere of the piece was at the Tianjin Concert Hall on 6 November 2020. The second performance of the work was at Beijing Tianqiao Performing Arts Center on 8 June 2021

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[1]In China, composition Class 77 is also known as Class 78. The class was originally scheduled to enrol in 1977, but the Central Conservatory of Music postponed the opening of the class until 1978 due to a lack of the dormitory and classrooms, so Class 77 was actually enrolled in 1978, but is still known to many as Class 77.

(Video Example 1[2]) and was also live-streamed online. According to official figures from the CCOM, the performance was attended by over 120,000 viewers, setting a record for the number of audiences to a symphony concert at the conservatory in recent years.

As a composer heavily influenced by French electroacoustic music, Zhang has long regarded space as a central aspect of his artistic expression and the essence of his work. Before analysing the spatial composition strategies in *Yarlung Zangbo*, it is necessary to contextualise the work in spatial composition and the electroacoustic orchestral music genre. First, we make a distinction between two different spatial composition preferences: image delivery and creation. We then divide the development of electroacoustic orchestral music into three different periods and examine the general spatial intention of the works in these periods. After that, we analyse and identify four spatial composition strategies of *Yarlung Zangbo*: equity, virtuosity, diversity and unity. Finally, we summarise its implications and contribution to the development of electroacoustic music in China and around the world.

2. COMPOSING SOUND IMAGES IN ELECTROACOUSTIC MUSIC

Researchers, theorists and composers worldwide have investigated in great detail the importance of space in electroacoustic music and the irreplaceable role that spatial expression plays among compositional techniques from different perspectives. Spatial composition is of considerable significance and has witnessed invaluable achievements in many areas, thanks to the efforts of academics over the years. The field, however, still faces many challenges, including weak historical accumulation (Roads 2015), lack of consensus (Danieli, Witek and Haworth 2021), limitations in spatial notation (Carpentier, Barrett, Gottfried and Noisternig 2016) and disconnection between creative intent and spatialisation system (Kendall and Cabrera 2011). Before analysing the spatial composition in *Yarlung Zangbo*, it is necessary to define and discuss two important trends in spatial composition: image delivery and image creation.

2.1. Complexity of spatial parameters

We often simply juxtapose sound space with more 'solid' parameters such as pitch, amplitude and timbre, but this may not be a fair approach. The reason is that the pitch and timbre of the sound can be accurately

represented with the mere combination of frequency and amplitude, and rhythm be represented with only changes in amplitude. As a result, in most cases, although the music in the concert and studio is not identical, it is rarely the case that a fixed media has a significantly different melody or rhythm during the concert from that in the studio. The spatial parameters of sound are another story, as they require a mixture of three-dimensional Cartesian coordinates, width, reverberation, spectrum, intensity, state of motion, the acoustic response of the environment, and many other factors to relatively accurately convey the spatial concept of sound in a physical sense. This difference leads to one of the most common characteristics and challenges facing the composition of space nowadays: complexity. At the same time, what lurks behind this complexity is the fragility of the artist's intention of spatial composition, the high likelihood of contradiction, and the disconnection between the intention of musical spatial expression and the spatial delivery.

The first representation of the complexity of spatial composition is that it is significantly influenced by the specific sound spatialisation system. These systems can be divided into two main typologies: acousmonium and sound-field (Carpentier et al. 2016). The distinction between the two types stems mainly from the different acoustic reproduction mechanisms behind them. The acousmonium system is based on a more traditional, channel-based, amplitude-based manipulation mechanism. The system's advantages include more mature support for relevant hardware and software, a relatively low level of complexity in system construction, and importantly, the spatial manipulation in the acousmonium mode being easily understood and known by artists. A survey showed that ease of use of the system significantly outweighed even the quality of the system's spatial delivery as a decisive factor in artists' choice of a system (Peters, Marentakis and McAdams 2011). The sound-field type is relatively young and is a system developed under the support of modern computer advancements. Higher-order Ambisonics (HOA) and wave field synthesis (WFS) are among the representative spatial audio codecs utilised in sound-field systems. An important attraction of this typology for composers is their ability to physically achieve holographic sound (Carpentier et al. 2016). However, the trade-offs for its higher localisation accuracy and holographic sound are as follows: its hardware and software structures are more complex, hundreds of speakers are needed to achieve a desirable effect, the current availability for artists is relatively low, and the acoustic requirements of the venue are higher than those of acousmonium typology.

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[2]The limited recording quality and stereo audio format of the video are incapable of representing the spatial diffusion at the concert, but still, it may offer some reference. The timing for the movements are as follows: Movement 1, 0:00–7:33; Movement 2, 7:33–15:31; Movement 3, 15:31–21:30; Movement 4, 21:30–29:09; Movement 5, 29:09–35:36; and Movement 6, 35:36–41:35.

2.2. Image delivery and creation at concerts

In light of such complexity and vulnerability, two important and different preferences can be observed in the historical practice of electroacoustic music. One of them is to conduct spatial organisation in a specific concert venue during the performance, which can be summarised as *image creation*. The other is to reproduce as faithfully as possible the organisation or scheduling of the space in the studio during the concert, which we might call *image delivery* or *image reproduction*. Both preferences can exist in the acousmonium model as well as in different sound-field models.

For electroacoustic music, *image creation* during concerts has a longer history. As early as 1951, Schaeffer's practice of controlling sound movement through space using potentiometers revealed a potential for a 'live space show' in concert. Survey data showed that the majority of electroacoustic music artists considered the loudspeaker arrangement in the performance situation as different from their studio environment (Peters et al. 2011). This means that due to aesthetic choices or technical constraints, a significant proportion of artists are inclined to create and compose new musical spaces in specific concert scenes. Concrete music, acousmatic music and German electronic music are the genres that contribute most to this inclination. Despite major differences in specific technical paths, many famous spatialisation systems were created with the important purpose of creating new spaces at concerts. Such examples include GRM acousmonium, Gembaphone & Cybernephone in Bourges (Clozier 2001) and BEAST in Birmingham (Wilson and Harrison 2010). In many electroacoustic music practices, the musical space is 're-composed' at the concert, and this re-composition can be done not by the composer himself, but by a sound diffuser as a 'second spatial composer'. For instance, Philippe Dao performed Bernard Parmegiani's *Dedans-Dehors* as a sound distributor at the GRM concert during the 2015 Musicacoustica-Beijing, where a large number of new sound images were created live in the concert. Together with Parmegiani's brilliant musical colours, it formed a perfect musical spatial experience. The preference for image creation also exists in today's sophisticated sound-field systems, enabling a variety of interactive spatial sonification (Barrett 2016).

Computer music, born in the United States, has contributed greatly to *image delivery*. One of the earliest and most famous examples of this approach was John Chowning's *Turenas*, where frequency modulation, reverberation, volume, Doppler shift and many other psychoacoustic parameters were coded by the composer into a computer (Chowning 2011). Moreover, the automated spatial programmes were reproduced as accurately as possible at the concert, thus creating a new realm of spatial expression. Curtis Roads's preference for image delivery was also evident in his concert *Sculptor* at Musicacoustica 2012. The composer kept the multichannel configuration at the concert venue as consistent as possible with the system in the studio and tried not to 'modify' the intention of the spatial expression in the digital medium. Although based on the same acousmonium typology as Parmegiani's work, Daniel Teruggi's *Transmutations* and *Springtime* at the Musicacoustica showed clear different preferences towards image delivery. Through GRM Spaces software, both works achieved much of the sophisticated automatic spatial organisation, which needed to be reproduced in the concert venue. Meanwhile, Teruggi's reflected a combination of the two approaches. The single ring in the original multichannel files rendered by the software was diffused into two main inner and outer speaker rings at the concert site, creating a model where image delivery was primary, and image creation, an important supplement. In addition, the same piece can show different spatialisation preferences in different versions of the performance. For example, while the spatial organisation of the original *Turenas* was fully automated, Laurent Pottier came up with a version for four percussionists and live electroacoustic music in 2015. In this version, Pottier instructed in the score the performers to control the movement of the sound in space according to the trajectories generated in the programme, but the interactive, 'manual' manipulation of the performance significantly increased the spatial creation at the concert.

3. SPATIAL INTENTIONS IN THE ELECTROACOUSTIC ORCHESTRAL GENRE

It can be inferred that it is very difficult to handle both the symphonic and electroacoustic worlds at the same time. Owing to its interdisciplinary nature, the number of works combining electroacoustics and large symphonic orchestras is rather limited, so we expand our discussion here to involve more relevant pieces. In addition to symphony or orchestra, we also included pieces for electroacoustics and a relatively large ensemble. It is important to note that pieces were excluded where electronic devices were used only briefly as one member of the 'colour section', such as Richard Strauss's 1940 *Japanese Festival Music*, which used electronic instruments only to emulate the sound of a gong (Wierzbicki 2008). We also excluded concertos for different types of 'e-instruments' composed in a classical or romantic style, a famous example of which is Paul Hindemith's *Konzert für Trautonium in Begleitung des Streichorchesters* from the 1930s. Since electroacoustic orchestral music combines live instrumental

performance and electroacoustic music, it is a kind of mixed electroacoustic music (Lalitte 2006). Although in terms of amount, electroacoustic orchestral works occupy a small part of the history of art music since the twentieth century, their significant value cannot be simply evaluated by their quantity, as outstanding works in this area have exerted an important influence on musical innovation. In the following sections, we divide the development of the electroacoustic orchestral genre into three periods and provide an analysis and discussion of the spatial intentions of works in each period.

3.1. 1950s–1970s: The spatial distinction

Contrary to some literature, the world's first publicly performed electroacoustic orchestral work may be *Rhapsodic Variations*, a collaboration between American composer Luening and Ussachevsky, performed on 20 March1954 (Luening 1968). The piece combined delayed woodwinds, tape loops and electronic drones with orchestra, and contained passages of purely electroacoustic music. In contrast, Varese's *Déserts*, performed in December 1954, is better known, partly for its exploratory significance, and is considered a landmark work that had a great influence on the post-World War II generation of composers (Mattis 1992). Its fame is also attributable to the intense controversy raised after the premiere of the work. The reasons for the controversy are complex, one of which may be the extreme and radical approach adopted to construct the relationship between electroacoustic music and orchestra, where the two artistic domains are presented alternately throughout the piece without any vertical integration. In 1967, American composer Subotnick's *Laminations I* combined orchestra with electroacoustic sounds, especially synthetic sounds. Some of its musical materials were derived from the first part of Subotnick's *Silver Apples of the Moon* (Swift 1971). Xenakis's *Kraanerg* mixed chamber orchestra with pre-recorded sounds was completed in 1969. The tape part was made up entirely of orchestral recordings, but 'can never be mistaken for the live orchestral performance', even if it shared common score material (Harley 2012). The spatial presentation played an important role in 'separating' the tape from the orchestra: the loudspeakers were intended to surround the audience whereas the orchestra was seated together on stage or in the pit.

Although no direct information on the composition of spaces can be obtained from the documentation of many of the early electroacoustic orchestral works, it can be inferred from the content of these works that the creation of *distinct spaces* outside live orchestral space was an important feature of the period. The reason for this characteristic may lie in the electroacoustic 'experimental boom' set off by concrete music and

electronic music. Like some other art music of the 'avant-garde era', the electroacoustic orchestra pieces of this period have overall received polarised reviews.

Judging from the practical choices of the composers after the 1970s, the spatial distinction between orchestra and electroacoustics did not fully 'prove itself' in this period. Part of this may be due to the general challenges that exist in mixed music, as audiences were not encouraged to change their mode of listening from the visual instrumental to the invisible acousmatic (Austin 2000). Despite his preference for composing instruments with live electronics, Pierre Boulez considered the combination of fixed media and orchestra to be arbitrary, anticreative and 'one's concentration is focused entirely on keeping in time with the pre-recorded tape part' (Anderson 2015). Tristan Murail commented: 'I don't know whether people today realise how limited the electroacoustics was in the 1970s (and before)' (Smith 2000).

3.2. 1970s–2000s: The spatial fusion

In 1971, Karlheinz Stockhausen's *Trans* showed an imaginative spatial relationship between orchestral and electroacoustic music. The curtains parted to reveal only the strings of the RAI orchestra of Milan seated behind a red-lit scrim playing sustained harmonics (Campo 1982), and, to a certain extent, this transformed the live orchestra in the venue into an acousmatic space. In 1977, IRCAM was founded as a landmark influence in the development of the electroacoustic orchestral field. This place, which brings together a large number of distinguished composers, engineers and performers, has become the top centre for electroacoustic orchestral music in the world. From 1981 to 1985, Boulez composed his *Répons* for orchestra and IRCAM 4X processor at IRCAM, a milestone in the history of computer music and the development of IRCAM (Gerzso 1984). *Répons* was also considered the archetype of instrumental and electroacoustic interactive works (Croft 2007) and one of the first music pieces combining a chamber orchestra with soloists whose sounds were digitally transformed (d'Alessandro and Noisternig 2019). Tristan Murail's first electroacoustic music work *Désintégrations*, premiered in 1983, was written for 17 instruments with four voices, with Andrew Gerzso responsible for the electroacoustic part. According to the composer's notes, despite being spatialised in four-channel like *Kraanerg*, the electroacoustic music part of this work seemed to be motivated by the composer's intention for it 'to be mistaken for the live orchestral', and 'the electroacoustic part has a common unity which ensures that they maintain an audible organic unity' (Murail 1983). This showcases the very different spatial intentions in the works of Murail and Xenakis.

Kaija Saariaho's first orchestral work, *Verblendungen*, also for orchestra and tape, was written in 1984, in which the relationship between electroacoustic music and orchestra was evidently influenced by the spectral style, with the two mediums joining together to form a unified texture.

The successful practices of the 1980s created a very different approach from the earlier 'distinct era', and the influence of this spatial preference continues today. During this period, the construction of electroacoustic music forms based on the analysis of spectral data, and organising sound on the computer, became an important paradigm for electroacoustic orchestral works. For example, the electroacoustic part for *Répons* was mainly derived from the real-time audio organisation and processing of live solo instrumental sound. In this way, the electroacoustic music was no longer an 'alien' to the orchestra. Inevitably, space also played an important part in the process of achieving a 'new friendship' between the two media. This is either an attempt to bring the live orchestra into the acousmatic space, as in Stockhausen's *Trans*, or more generally, the practice of 'constraining' electroacoustic music to the live orchestral space, with the sound image of electroacoustic music being somewhat an extension in unity with the orchestral image.

3.3. 2000s until now: The spatial expansion and rediscovery

In the twenty-first century, electroacoustic and orchestral space continued to merge successfully. A famous example was British composer Jonathan Harvey's *Speakings*, premiered in Royal Albert Hall, where a large orchestra and electronics brilliantly 'spoke' together. According to notes from the composer, 'the orchestral discourse is electroacoustically shaped by the envelopes of speech taken from largely random recordings' (Harvey 2008). It was also one of the earliest pieces that adopted an advanced computer-aided orchestration system (Carpentier, Daubresse, Vitoria, Sakai. and Villanueva 2012). Oliver Schneller's *Wu Xing* was a cycle of five works for orchestra and electronics, and the first from the cycle, 'Wu Xing/Fire', was created in 2009. Like many other spectral-based electroacoustic orchestral works, the electroacoustic sound was an integral part, but the title of the piece merely adopted grand orchestra rhetoric, without any indication relating to electroacoustic music (Schneller 2013). This may reflect the composer's conception of the electroacoustic sounds as a part of the orchestra. During the performance of *Wu Xing/Water* at the opening concert of the 2017 Beijing Modern Music Festival, the speakers projecting electroacoustic sound were placed inside the orchestra on stage, enhancing the spatial fusion, in a very direct physical sense, of the electroacoustic sound with the orchestra.

Different from the 'mainstream' that emphasises 'spectral functions' of electroacoustic sounds, Murail's *Liber Fulguralis* in 2008 may represent another way of thinking, with the electroacoustic music part of the work mainly based on concrete sounds such as thunderbolts. Sounds were dissected into elementary components, and then reinserting this material and its multiple transmutations into the musical space-time of live instruments (Murail 2008). This change in the materials enhanced spatial independence, which was further reinforced by the purely electroacoustic section without any instrumental music for nearly two minutes at the beginning of the piece. Saariaho's *Circle Map*, created in 2012, was a more pronounced indication of a kind of 'renaissance' of spatial distinction. The electroacoustic music part of the work took some typical acousmatic approaches to compose, with a mysterious male voice reading ancient Persian texts, which were time-stretched, modulated, reverberated and spatialised. The piece also used a unique 6.2 sound diffusion system (Saariaho 2012), in which the main quadraphonic speakers were not arranged around the audience like the conventional setup, but distributed in the corners of the stage area. In addition to the quad-sound, there was a centred and narrowly spaced stereo cluster, as well as two subwoofers. This setup was characterised by enhanced depth changes in the sound space, rather than image localisation in the rear area of the audience. In addition, with the support of a computer spatialisation program, the piece could change different spatial organisation schemes according to the specifications of different performance venues and playback systems.

The incorporation of visual media has been a noteworthy new trend ever since the twenty-first century, bringing new spatial expansion and transmodal experiences to the electroacoustic orchestra, and allowing us to rethink the relationship and boundaries between virtual and real space with the help of new digital media technologies. *Liber Fulguralis* mentioned earlier was also a work that combines digital visuals with ensemble and electroacoustic sounds. One notable piece that may not be neglected was *Piano Concerto* for piano, sampler, orchestra and video, composed by Simon Andersen and finished in 2014. It was described by the composer as a *virtual double concerto* (Andersen 2014), in which a very creative spatial relation in the genre is explored. The pianist's video clips, presented in a holographic style at the concert, form a tight data linkage with the performance audio triggered and processed by the sampler. This audiovisual experience seemed to have a strong sense of both the virtual and the real. Together with the live pianist

and orchestra, the piece blurs the boundaries between the real and virtual space, as well as the past and present space.

4. SPATIAL COMPOSITION STRATEGIES IN YARLUNG ZANGBO

Throughout the decades of the development of electroacoustic orchestral music, advances in spatialisation techniques have profoundly changed composers' spatial composition strategies over time. The tendency towards more restricted spatial fusion, deeply influenced by the spectral school, is still quite inspiring for today's practice, but a more diverse spatial aesthetic is also developing in some of the new works of the twenty-first century. Overall, *Yarlung Zangbo* is a piece based on an acousmonium spatialisation typology with a clear spatial distinction preference. The composer takes a 'classic' live diffusion approach. By combining Western techniques with Eastern culture and personal creativity, the piece develops distinctive characteristics in terms of spatial composition.

4.1. The spatial equity

Zhang's compositional technique and style are strongly influenced by the birthplace of concrete music (Battier 2007): Ina-GRM. He focuses on exploring the powerful artistic expression of electroacoustic sound itself, and in so doing, electroacoustic music in his works is not considered as part of orchestral instrumentation. The same is true for space. In the various movements of *Yarlung Zangbo*, the space of electroacoustic music hardly seems to belong to the space of symphony orchestra, but rather, it creates another parallel space against the live orchestra, to achieve *spatial equity*. This 'orchestra-dual' model is achieved through the combination of 'a loudspeaker orchestra' and a live symphony orchestra.

Figure 1 shows the schematic layout of *Yarlung Zangbo*'s loudspeaker arrangement for the 2021 Beijing performance. The layout differs somewhat from the system in place at the Tianjin premiere due to changes in the performance venue, but they are all structured with three different speaker layers. The whole system consists of 38 speakers, including different models mainly from d&b, as well as a part of Meyer Sound speakers. All the speakers are arranged to three different height levels. A(udience)1 to A14 speakers and the main audience area of the concert hall are basically in the same horizontal position. Together with A(udience) S(tage) 1 to AS6, they form a ring around the audience area and are connected with solid lines. S1 and S2 speakers are arranged on either side of the orchestra at the back of the stage and create the furthest source distance

in the plane of the main audience area. The ring formed by L(ifted)1 to L8 speakers is arranged at the height of the 2nd floor of the concert hall, which constitutes the second loudspeaker height layer and adds a certain sense of lift to the sound image. These speakers are connected with a single dotted line in Figure 1. Finally, C(eiling)0 to C6 speakers are suspended in the highest region of the concert hall, which form the top third speaker plane and are connected with double dotted lines. Overall, this loudspeaker orchestra exhibits two important features: it can achieve a dynamic range that rivals that of a live symphony orchestra, and it can surpass the entire symphony orchestra in the spatial scale of image, especially in the movement domain. This serves as an important physical basis for the composer's pursuit of spatial equity.

Figure 2 is the score reduction of bars 76–8 of the first movement, where the different layers of Tong Qin (a kind of Tibetan Tuba) sounds in the electroacoustic music section form an intertwined and dialogical relationship with the live orchestra. First, the Tong Qin section is at the exact level of the orchestra in terms of sound pressure. Second, the different Tong Qin sounds are diffused to different locations in the space to achieve a grand spatial scale. Third, the Tong Qin sounds cut in at different beats, dominating the distinctive changes in the spatial rhythm. Another example in the first movement is the presence of passages, in which the orchestra acts as a direct accompaniment for the acousmatic sounds. The composed sounds of lamas (Tibetan Buddhist monks) chanting are diffused around the hall, especially at the level of ceiling speakers, as if some distant Buddhist sound is floating in the sky. This dialogue of 'heaven and earth' between electroacoustic music and orchestra significantly increases the spatial separation and equality. This is the most common relationship between electroacoustic music space and live orchestra space, present in every movement of the symphony.

4.2. The spatial virtuosity

Although today's advanced holographic sound systems are capable of a rather good performance, *Yarlung Zangbo* nevertheless takes the traditional approach of using a hardware console as the core for sound diffusion. The composer made this choice partly for technical reasons. The work needs to be performed in different concert halls in China, and these venues do not have acoustical design dedicated to electroacoustic music. This makes it difficult for them to provide an ideal acoustical environment for a soundfield type system. Meanwhile, if the venue is solely optimised for the delivery of electroacoustic sound,
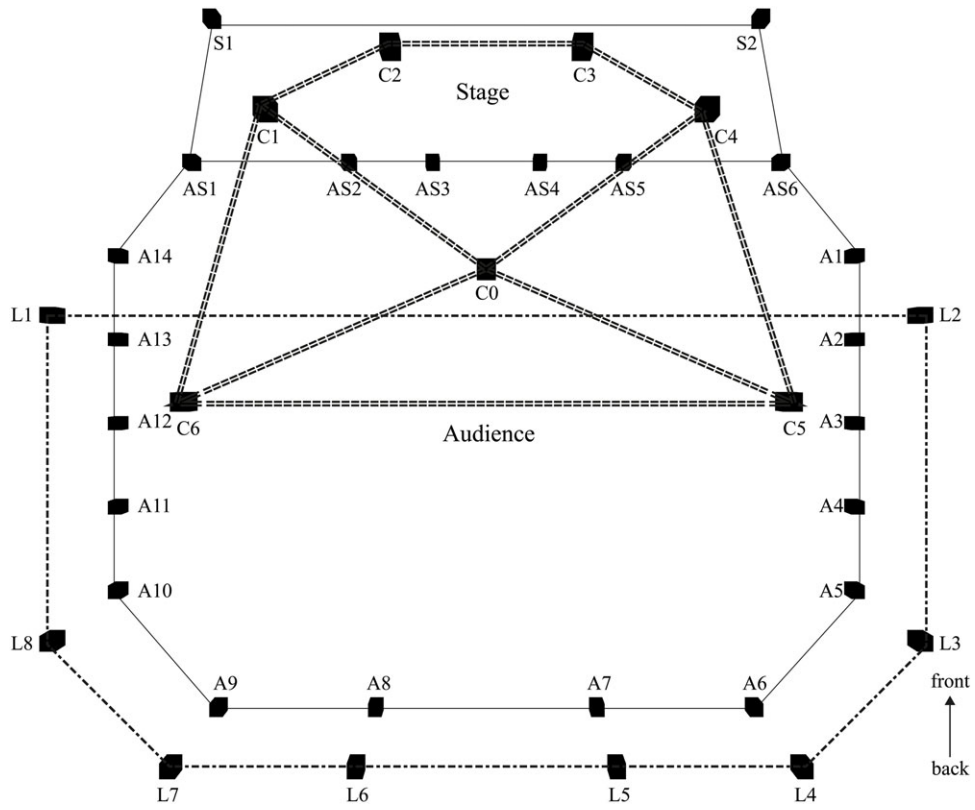
Figure 1. The layout of the speaker orchestra of *Yarlung Zangbo* for the 2021 Beijing performance, top view.

Figure 2. Score reduction of the first movement, bars 76–8. An equal dialogue formed between the electroacoustic section and the entire symphony orchestra.

it may negatively affect the sound performance of the live orchestra. This architectural acoustical dilemma is likely to be well mitigated by acoustical treatment and calibration of long-term installed high-density loudspeaker array (HDLA) systems, but it may be difficult to accommodate temporary concert events. In contrast, the acousmonium is more flexible in terms of installation and configuration, as well as adaptability to different shapes and layouts of the venue.

The most important reason for the composer to adopt the acousmonium typology is still an aesthetic one. Live sound diffusion through a mixer, or mixer assisted by some equipment, dates back to the time when concrete music originated and was formalised as a performing art in the 1970s in places such as Bourges and Paris. This artistic charm has profoundly influenced Zhang's spatial aesthetics. Zhang performs each of his electroacoustic works using live spatialisation with different loudspeaker systems, making him a 'console performer' with over 30 years of experience in sound diffusion. With this concept, the expression of space is ultimately about people. The composer enables the audience to experience a spatial virtuosity, through a deep understanding of the purpose of the spatial expression, through the spatial conception of the specific concert venue formed during intense rehearsals and through the flexible fingers in the course of the performance to convey spatial thoughts through the sound system. Just as piano music is no less artistically sophisticated because it is not a 'technological product', the art of spatial performance is no less valuable because it is not purely based on the worship or aesthetics of technology.

4.3. The spatial diversity

Yarlung Zangbo is the most important river system in Tibet. Meaning 'water flowing down from the summit' in Tibetan, it is the cradle of the birth and development of Tibetan civilisation. Thus, the work contains some symbolic sounds of Tibetan culture, which are called *sound themes* by the composer and become core acousmatic materials of electroacoustic music (Figure 3). The acousmatic materials are carefully selected iconic sounds from a large number of sounds recorded by the composer in his Tibetan travels, spanning over 20 years. From out of the Sangye Monastery in the Shannan region to the inside of Drepung Monastery in Lasa, from the home of a Tibetan grandmother in Gongka county to the riverside of the *Yarlung Zangbo*, these audio files record sound images in different locations, both indoor and outdoor sound fields in Tibet. The contents of the sound themes are also colourful, containing both secular Tibetan festivals, entertainment and solemn religious rituals. There are both song melodies and Tibetan vocal chants,

enacted images formed by the rhythmic dance steps of young Tibetan men, and natural images formed by the sound of continuous rivers and irregular water drips. These sounds are organised and processed electroacoustically to form an acousmatic artistic picture of Tibetan culture intertwined with modern music culture. What is more, the electroacoustic music based on Tibetan sounds further fuses with traditional Chinese pentatonic music, traditional Western symphonic music and the sound diffusion of the speaker orchestra to form highly diverse spatial combinations and expressions. These include the contrast between the space of the loudspeaker orchestra and the live orchestra as has been discussed, the contrast between the sound space symbols of different regions and eras in the East and the West, the contrast between the micro-tonal space in the Tibetan sound theme and equal temperament space of the Western orchestra. Thus, the composer describes the piece as a collection of sound symbols from three eras: agricultural, industrial and technological civilisation.

4.4. The spatial unity

Despite assembling a large number of diverse images in one work, the composer successfully ensures that the work does not appear disorganised or cluttered, and that spatial attributes do not create destructive contradictions. Moreover, he manages to strike a spatial balance between opposition and unity. In this piece, unity is manifested by the composer's success in making the apparent images, metaphorical images, and non-spatial attributes of the sound, such as timbre, work in concert as a whole entity. This serves the diverse spatial compositional and expressive purposes of the work. Such important strategies are used throughout all the movements.

In the passage of the first movement where the electroacoustic section of the lamas chanting is gradually introduced, the basic material is a call and response structure formed by the sound of two kinds of lamas chanting. This structure is looped and edited to form a continuous electroacoustic part. Against the quieter background of the orchestra, the apparent images are first diffused to the ceiling level in the speaker orchestra and the movement of the image is limited to a small area. With some amount of delay effect and a wide distant picture of Tibetan snow-capped mountains in the digital video, a faint, distant metaphorical image emerges. As the music progresses, the composer carefully and gradually changes the volume of the acousmatic sounds and the audio engineer adjusts the sending amount of reverb and delay effects, while the height of the apparent images begins to decrease. There is no apparent spatial movement within each of the different sound objects, but different sound objects

Movement		Acousmatic Material	Recorded Year	Recorded Place
Movement 1 - *Origin*		Tibetan lamas chants	2002	inside Shannan Samye Monastery
		Tong Qin long notes (Tibetan tuba)	2001	inside Lasa Drepung Monastery
Movement 2 - *Source*		Tibetan tenor melody	2001	near Shannan Samye Monastery
		river and water drip sounds	/	sample from CD recording
Movement 3 - *Home*		Tibetan girls singing	/	sample from CD recording
		Tibetan young men singing and dancing	/	sample from CD recording
Movement 4 - *Hope*		Tibetan grandma singing and reciting	2001	A Tibetan grandma's home in Gongka County
		Tibetan lamas chants	2002	inside Shannan Samye Monastery
Movement 5 - *Fate*		Tibetan grandpa singing cowhide boat song	2001	riverside of Yarlung Zangbo in Qushui
Movement 6 - *Meta*		Tibetan lamas chants	2002	inside Shannan Samye Monastery
		Tibetan tenor melody	2001	near Shannan Samye Monastery

Figure 3. Acousmatic materials in *Yarlung Zangbo*.

will begin to show in different static locations around the audience, evolving into a spatial call and response. This gives the work a sense of the supernatural and mysterious, while still maintaining a sense of religious solemnity. The overall spatial organisation of this section then forms a credible, multilayered expression varying in distance and height.

In the closing section of the second movement, the main material of the electroacoustic music comes from a melody sung by a Tibetan tenor. This melody is typical of the male voices of the southern Tibetan region, combining long-line melodies with euphonious, high-pitched vibrato. For the electroacoustic sound diffusion, the composer 'maps' the pitch motion to the trajectory speed of the sound movement (Figure 4). The solid line represents the pitch contour of the electroacoustic sound, while the dotted line represents the speed of trajectory roughly corresponding to the pitch contour. The composer correlates faster pitch curve changes with faster image trajectory movement. When the male voice arrives with long notes, the apparent images of the electroacoustic music are in a relatively static state. This correlation of sound parameters enhances the spatiality of the sound and, in turn, articulates the melodic curve of the sound.

The two main types of electroacoustic music material in the third movement are sunny and lively, the first being phrases sung in unison by Tibetan children and the second being samples of Tibetan young men dancing, 'rapping' and singing. Two different musical passages are composed based on the materials. In keeping with the temperament of the sound material, this movement also employs the most dynamic image motion. With smiling faces in the video, the voices of children and young men sometimes move through the concert hall with a playful air like a gust of wind at a festival gathering. At other times, the electroacoustic music moves into competitive left–right or back-and-forth duets. In the climax of the movement, the internal development of the electroacoustic part forms a canon-like polyphonic structure, while the composer also diffuses a canon-imitated spatial projection in the concert. All these are interwoven with the multiple layers of different sections in the symphony orchestra and the fast-changing visual images on the stage to reach an enthusiastic festival culmination.

Unlike the other movements, which show a more open and distant sense of space, the fourth movement shifts to a more intimate expression. One of the main electroacoustic materials is a close recording of a Tibetan grandmother's voice, which contains a combination of singing and recitation. The metaphorical images embedded in them are very personal and intimate. In terms of the organisation of the apparent image, the composer diffuses the electroacoustic sound to the location near the speaker A4 next to the audience, drawing near the physical distance between the sound object and the audience, as if the Tibetan grandmother approaches the audience of the concert and tells the ancient Tibetan mythological story. At the same time, the electroacoustic music and the contemplative texture of the orchestra on stage achieve a clear division and dialogue between two different spaces. The author observed in the live concert that when the grandmother's voice first emerged, some audience members even turned around to find out if someone
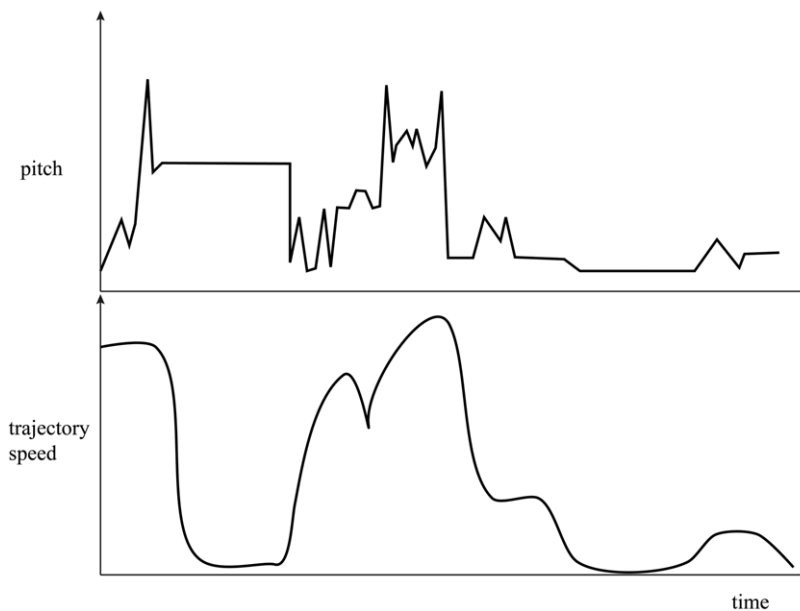
Figure 4. The movement speed of sound objects diffused in the space changed according to the pitch contour of the Tibetan tenor.

was actually speaking, reflecting the composer's success in finding an effective way to compose in space.

In the fifth movement, acousmatic material mainly comes from the *Cowhide Boat Song*. Apparent images move back and forth with the rhythm of the sound through the different height levels of the loudspeaker orchestra. This movement is a good demonstration of Zhang's preference for creating symbolic and imaginary space through concrete sounds (Zhang 2018). The spatial rhythm and manner of movement in the loudspeaker orchestra form a symbolic space, as if the body movements of an old Tibetan grandfather working on a river with a cowhide boat were magnified and projected into the concert hall. At the same time, multiple sections of the symphony orchestra mimic the melodic lines in the acousmatic sound in metaphorical pitch space. The spatial composition of the sixth movement is mainly retrospective. At the end of the whole piece, the electroacoustic part of the Tibetan tenor reappears again, at a lower volume, encompasses the far-field space at the back and top of the concert hall, and juxtaposes with the faint sound of water drops representing the source of the *Yarlung Zangbo,* which connotes the longevity of Tibetan culture through the space of the music.

5. CONCLUSION

Looked at from just a single, isolated perspective, *Yarlung Zangbo* may seem, at first glance, to be a relatively traditional, conservative work. In some of Zhang Xiaofu's acousmatic pieces, rather abstract,

drastic sonic transformation features can be observed. Yet for the electroacoustic music part of the *Yarlung Zangbo*, such extreme techniques as the deconstruction of sound, radical modulation and sound clustering are absent. Moreover, the composition of the symphony orchestra part is similarly 'mild', with no highly 'contemporary' compositional techniques common in Chinese orchestral pieces today. However, we should not be misled by these phenomena on the surface and ignore the creative value in this work. As a composer who has dedicated more than 30 years of his life to electroacoustic music, Zhang no longer needs to 'prove' any of his technical skills in his music, but instead, endeavours to deliver pure artistic expression and personal emotion. This is achieved through a multimedia system formed by a symphony orchestra, a loudspeaker orchestra, visual projections, as well as the effective combination of the traditions of Chinese music, classical and romantic orchestral music with modern electroacoustic music and digital video technology. *Yarlung Zangbo* has been received positively by Chinese music professionals and audiences alike. The spatial composition, in particular, sets it apart from other works. The piece is not only an important milestone in the composition of Chinese electroacoustic music, but also a unique and meaningful contribution to the electroacoustic music repertoire worldwide. Its research provides valuable knowledge and insight for future study and practice of spatial composition.

There is still plenty of room for exploration and investigation in terms of electroacoustic orchestral

music in the future. Interactive, adaptive and intelligent electroacoustic music may further liberate the orchestra's expressive power (Lengelé 2021). In a concert or exhibition scene, whether the intention of sound image delivery or creation is prominent or not, the combination of speaker orchestra and computational spatialisation programs can make the layout and movement of the apparent image more diverse and more sophisticated. Systems based on sound-field rather than acousmonium typology have the potential for more experiments in combination with orchestras. When it comes to the format of electroacoustic music, we now live in a very different era due to coronaviruses, when recording, transmission and playback of electroacoustic concerts are more pressing issues than ever before. In 2021, the metaverse became a hot topic and vision in the internet industry. In a virtual world that seeks to 'build everything' in the future, electroacoustic music could be an indispensable part. Moreover, many of the technical characteristics and aesthetic features of electroacoustic music naturally fit highly with the digital, virtualised nature of the metaverse. Electroacoustic concerts in the metaverse may not have to be limited to the immersive reproduction of a live concert in reality, but can be more imaginative and fulfilling than real concerts in terms of the expressiveness of the audiovisual media. Another possibility is the combination of network music performance with online virtual space, which results in a mixed reality electroacoustic concert. At the second performance of *Yarlung Zangbo*, more than 100,000 people participated in the concert through online channels, but the sound format of this broadcast is traditional stereo down-mixing. This means that the important essence of the work – the space – was is not well represented in the recorded signal. This may inspire composers of electroacoustic music to focus more on mixing and recording in 3D immersive audio formats in the future and to optimise specifically for headphone playback scenarios. Compared with speakers, the headphone-based format is deficient and compromised in several ways (Tarzan Alunno and Bientinesi 2019), but its advantages are also extremely clear: the format makes it easy for anyone to get a spatial experience that is much better than traditional stereo. Recently, the Key Laboratory of Intelligent Processing Technology for Digital Music, Chinese Ministry of Culture and Tourism plans to collaborate with Professor Zhang in the audiovisual 3D immersive recording of concerts and aspires to afford an experience of the unique charm of spatial distribution and expression in electroacoustic music for future audiences who cannot be at the concert venue.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/S1355771822000474

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