An original composition, Diamundo, and a historical survey of music spatialization

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AN ORIGINAL COMPOSITION, DIAMUNDO,
AND
A HISTORICAL SURVEY OF MUSIC SPATIALIZATION

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The School of Music

by

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B.M., Universidade Federal do Rio Grande do Sul, 1993
M.M., Universidade Federal da Bahia, 1996
May 2007
Aconteceu há mil anos?
Continua acontecendo.
Nos mais desbotados panos
estou me lendo e relendo.
Carlos Drummond de Andrade¹

¹ Did it happen one thousand years ago? It’s still happening. In the most washed-out clothes I am reading and rereading myself. (Translated to English by the author.)
DEDICATION

I would like to dedicate this dissertation to all Brazilian citizens who, paying their taxes, allowed the Brazilian government, via CAPES and UFSM, to be my sponsor during these doctoral studies.
ACKNOWLEDGMENTS

I wish to thank my advisor, Dr. Stephen D. Beck, for his guidance and advice during my years here at LSU. I would like to thank the other members of my doctoral committee, Dr. Robert Peck, Dr. Dinos Constantinides, Dr. Griffin M. Campbell, Dr. Jan Herlinger, and Dr. Laura M. Martins.

A special thanks goes to my sponsors, the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Universidade Federal de Santa Maria (UFSM), whose financial support made possible my doctoral studies.

I wish to thank the LSU Writing Center, especially Dr. Joe Abraham, for their help with my English writing skills. I am thankful for the productive discussions with Brian Willkie, Barret Johnson, Ronaldo Cadeu, and José Maurício Brandão, and for the support and friendship of the Brazilian colleagues Francisco Silva, Vladimir Silva, Luciana Rosa, and Rafael Andrade. I also would like to thank my parents, Amaro and Alice, and my brothers, Luis Alberto, Pérsio, and Marcelo.

I am especially grateful to my wife, Jussara, and my son, Pedro. Nothing would be possible without their support and care.
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INSTRUMENTATION

1 Flute (doubles on Alto Flute)
1 Alto Saxophone in Eb
1 Trumpet in C
1 Tenor Trombone

4 sound projectionists

4 Timpani (32”, 28”, 25”, 23”)
3 Percussion (repeated instruments never play at the same time)
   1. Snare drum, Tam-tam, Suspended cymbal, Crash cymbal, Gongs, Triangle
   2. Xylophone, Vibraphone, Temple Blocks (5), Crash Cymbal
   3. Marimba, Crash cymbal, Tam-tam,

1 Electric Jazz Guitar (or amplified Classical Guitar)
1 Piano

Strings (a minimum of 4 First Violins, 4 Second Violins, 4 Violas, 5 Cellos, 2 Double Basses)

Electroacoustic installation
   1 Kyma²
   Three computers
   8 loudspeakers, or eight groups of loudspeakers with independent amplification
   4 microphones
   1 Mixing console

Duration: ca. 30 minutes

Score in C

---

² The Kyma system is a visual sound design language with an associated Capybara multiprocessor hardware accelerator. Kyma is manufactured by Symbolic Sound Corporation.
PERFORMANCE NOTES

Non Standard Notation

PLAY file: start playing the file at the beginning of the bar indicated by the arrow.

CB = Circed capital letters are guides for loudspeaker's spatialization, according to the list bellow:
CB  = center back
LB  = left back
RB  = right back
B   = all three back loudspeakers
LM  = left middle
RM  = right middle
M   = all middle loudspeakers
MB  = all middle and back loudspeakers
CF  = center front
LF  = left front loudspeakers
RF  = right front loudspeaker
F   = all front loudspeakers
FM  = all front and middle loudspeakers
T   = tutti loudspeakers

OFF  = no sound processing

= the following location is being added to the previous one

= the instrument sound is being processed and moving from the starting location to the pointed one.

= beamed accelerando and ritardando, according to specified durations.

= beamed accelerando, according to specified durations

= slow wide glissando vibrato

= for winds, pitched key slaps

= for winds, normal playing starting with a key slap
Notation for the “speakers” in score is only an approximation. The exception is the accents over the staff. Those accents indicate percussion sounds and are tempo clues for the conductor.

The choral notations for the “speakers” in the second and fifth movements are only guides for the granular synthesis frequencies and harmony.

**Playback instructions**

All of the four projectionists need to know how to read a musical score, which must be provided to them.

The distribution of the eight channels in space is the following (according to the General Seating Plan):

- Channel 1 goes to front-left loudspeaker
- Channel 2 goes to front-center loudspeaker
- Channel 3 goes to front-right loudspeaker
- Channel 4 goes to side-left loudspeaker
- Channel 5 goes to side-right loudspeaker
- Channel 6 goes to rear-left loudspeaker
- Channel 7 goes to rear-center loudspeaker
- Channel 8 goes to rear-right loudspeaker

The mixing console has to have a minimum of 28 input channels and eight output channels. It has to be able to submix 3x8 inputs through the same correspondent 8 channel outputs.

Each one of the four off-stage instruments (flute, sax, trumpet, and trombone) is connected to a microphone. Each microphone is pre-amplified by the soundboard and sent to Kyma input channels 1 to 4, according to the following order:

- Flute to Kyma’s input 1
- Saxophone to Kyma’s input 2
- Trumpet to Kyma’s input 3
- Trombone to Kyma’s input 4

A simple way to play back Diamundo’s electroacoustic procedures is using four sound projectionists working with a mixing desk and three computers.

Computer 1 runs Kyma. Other two (Computer 2 and Computer 3) run any multi-track sound-file software able to playback several eight-channel files in one section, like Logic Pro, Ardour, etc. The software has to be able, after the previous file has finished, to jump the cursor and be ready to play the next eight-channel file during the performance.

The first projectionist performs the diffusion of the electroacoustic sounds in order to obtain equal amplitude balance among the eight loudspeakers and for the general balance between the speakers and the ensemble sounds. Projectionists I also control the four wind’s microphones gain. If available, one can add reverb to each channel according to the size of the hall. The first projectionist is also responsible for controlling speaker’s dynamic indications specified in the score.
The second projectionist is responsible for Computer 1. Projectionist II has to be familiar with the Kyma system in order to play back Kyma’s Timeline, named Diamundo, which includes:

1. The pre-recorded electroacoustic eight-channel sound-files for the First and Sixth movements.
2. The real-time processes for the Third and Fourth movements.

The sound-files and processes appear in the same order they are called in the score. The sound projectionist is advised to stop the cursor after a sound is played, and jump immediately to the next mark to be ready for the next sound.

The third and the fourth projectionists are responsible for Computer 2 and 3, respectively. They play back all the eight-channel sound files sections as they are called throughout the score. The section has to include all the electroacoustic sounds for the second and fifth movements. For the best synchronization with the ensemble and because the succeeding eight-channel sound-files overlap each other, the eight-channel sound files have to be distributed in the following order:

Computer 2: second 1, second 3, second 5, second 7, second 9, fifth 2, fifth 4, fifth 6, fifth 8, fifth 10, fifth 12, and fifth 14.

Computer 3: second 2, second 4, second 6, second 8, fifth 1, fifth 3, fifth 5, fifth 7, fifth 9, fifth 11, and fifth 13.

The projectionists are advised to place marks in each eight-channel sound-file and put a small space between them. This procedure will allow the jumping to the next file and be ready to play it back after stopping the previous one.
ABSTRACT

This dissertation is divided in two parts. Part one is an original composition, Diamundo, for percussion, winds, strings, and loudspeakers, based on the poem of the same name by the Brazilian poet Carlos Drummond de Andrade. It is scored for a chamber orchestra with a main ensemble formed by strings, piano, percussion, and guitar, plus electroacoustic sounds, and four solo wind instruments: flute, saxophone, trumpet, and trombone. The ensemble and the eight-channel loudspeakers are spatialized.

The piece is divided in six movements without interruption. The first five movements are separated by 4 cadenzas for the solo instruments. Most of the motives, rhythms, and harmonies were generated having the all-interval tetrachords (0146) and (0137) as the background structure. For the first and sixth movements, pre-recorded electroacoustic sounds are synchronized with the ensemble. During the second and fifth movements, a granular synthesis is used as background for the chamber orchestra. During the third and fourth movements, sounds of the instrument soloists are recorded and processed in real-time. Tools for the electroacoustic techniques include the Kyma system, Csound, and sound editing software.

Part two is an historical survey of music spatialization, divided into seven chapters. The first chapter is an introduction. The second chapter is concerned with musical space in antiquity and the medieval ages. The third chapter deals with the polychoral music, at the time of Gabrieli in Venice, and its legacy. The fourth chapter focuses on the dramatic space effects in opera and in orchestral music of the 18th and 19th centuries. The fifth chapter explores spatialization from the beginning of the 20th century through the end of World War II. The sixth chapter discusses music spatialization from the middle through the end of the last century. The final chapter outlines some conclusions based on the preceding chapters.
PART 1. AN ORIGINAL COMPOSITION, DIAMUNDO

Diamundo

for Strings, Winds, Percussion, and Loudspeakers

based on a poem by Carlos Drummond de Andrade

I. Allegro no molto
II. Rallentando
III. Lento, quasi senza tempo
IV. Adagio, quasi senza tempo
V. Accelerando
VI. Allegro
G Fl.

A. Sax.

Tpt.

Trb.

Spk.

Timp.

Perc.

Vln I

Vln II

Vla

Vc

DB
II. Rallentando
G Fl.
A. Sax.
Tpt.
Trb.
Spk.
Perc.
Pno
Vln I
Vln II
Vla
Vc
DB

2.
3.
4.
2.
3.
4.
2.
3.
4.
2.
3.
4.
2.
3.
4.
III. Lento, quasi senza tempo
V. Accelerando

Tempo giusto

Flute

Alto Sax

Trumpet

Trombone

Speakers

Timpani

Percussion

Guitar

Piano

Violino I

Violino II

Viola

Violoncello

Double Bass

Still G Flute

PLAY HH 1

\textit{Tempo giusto} 
Fl.
A. Sax.
Tpt.
Trb.

Spk.
Timp.
Gtr

Perc.

Gtr

Pno

Vln I
Vln II
Vla
Vc

DB
VI. Allegro
Fl.

A. Sax.

Tpt.

Ttb.

Spk.

Timp.

Perc.

Gtr

Pno

Vln I

Vln II

Vla

Vc

DB
\textbf{Score Page: 148}

\textbf{Fl.}

\textbf{A. Sax.}

\textbf{Tpt.}

\textbf{Trb.}

\textbf{Spk.}

\textbf{Timp.}

\textbf{Perc.}

\textbf{Gtr}

\textbf{Pno}

\textbf{Vln I}

\textbf{Vln II}

\textbf{Vla}

\textbf{Vc}

\textbf{DB}
PART 2. A HISTORICAL SURVEY OF MUSIC SPATIALIZATION
Chapter 1. Introduction

Since my arrival at LSU in 2003, I have been watching and participating in several concerts of electroacoustic music at the LSU School of Music, in New Orleans, and in Texas and Alabama. I became very impressed and interested in the techniques of sound diffusion used during these concerts, known by the general term “spatialization.”

This term has been used in music in relation to different aspects than the issue of this research. Joseph McDermott, for example, wrote about a type of musical space.\footnote{McDermott, “The Articulation of Musical Space in the Twentieth Century.”} However, the notion of space that concerns him is not what we will be dealing with here. His thesis is, generally speaking, about the spatial image caused by the structural relationships of pitches in a musical work. It is a metaphor of space. Rather, our topic is connected with the real or physical aspect of sound in space.

Before any attempt to define music spatialization, it is important to go through basic acoustical principles involved in how one perceives sound in space. Sound is, simply said, a physical process. As many others physical processes (like electricity, light, heat), sound can be described by the interaction of three main systems: the source, the medium, and the reception.

The sound source system normally is formed by an excitation mechanism that drives a vibrating element (mechanical oscillations) coupled to a resonator that converts vibrations in air pressure oscillations (sound waves). The resonator connects the source with the medium, which propagates these sound waves, suffering during their journey with the interference of the environment, which can cause their reflection, absorption, and reverberation. As the sound travels in three spatial dimensions, the interaction between the source and the medium can provoke a specific sound radiation pattern.\footnote{Moore, Elements of Computer Music, 18.} Finally, in the third interactive system, those original

\begin{footnotesize}
\begin{enumerate}
\item McDermott, “The Articulation of Musical Space in the Twentieth Century.”
\item Moore, Elements of Computer Music, 18.
\end{enumerate}
\end{footnotesize}
vibrations reach the auditory capacity of human beings. Inside the middle ear, the timpanic membrane converts the sound waves into mechanical waves again. The inner ear, on the other hand, converts the sound frequencies into nervous impulses that are transmitted through the nervous system to the brain. Here, a psychological reaction reveals one of the most marvelous and mysterious wonders of life: the cognitive process—the brain recognizes the nervous impulses as “sound.”

In recognizing sound, the mind can recognize the main attributes that normally are related to sound’s physical parameters: it can sense frequency as pitch, amplitude as loudness, dynamic spectral envelope as timbre, and duration as itself. Besides these traditionally cited physical parameters of sound and their corresponding human discrimination, there is one more parameter that has to be cited here, since it is one of the fundamental aspects of this work: the spatial location of the sound.

Human perception of the placement of a sound source is called by Charles Dodge “auditory localization.” Curtis Roads, taking it from the area of psychoacoustics, describes how human beings hear a sound’s direction as “sound localization.” David Malham described it as “spatial perception of sound.” Certainly there will be many others terms, but, for the purpose of this research, the physical placement of the sound source will be called sound location, and the perception of this sound location will be called spatial localization. When dealing with the relationship of both concepts, it will be referred to by the generic term sound spatialization, as Christopher Morgan defines it:

---

3 Roederer, *Introdução à Física e Psicofísica da Música* [Introduction to the Physics and Psicophysics of Music], 17-25.


6 Malham, “Approaches to spatialization,” 169.
The term “spatialization” refers to the process of adding a spatial component to sound events. This involves either providing the listener with localization cues or physically placing the source of the sound events in different locations.7

An important aspect of sound spatialization is how listeners accomplish spatial localization. This accomplishment is commonly said to be dependent on clear cues for the perception of direction and distance for stationary sources. For a moving sound source, or listener, or both, distance is substituted by velocity.8 Direction has two dimensions, or angles: the horizontal plane, measured by the azimuth or horizontal angle (φ); and the vertical plane, measured by the zenith or vertical angle (θ).

Two more concepts are worth citing here before going to the use of sound spatialization in music. The first one is sound radiation, defined by Roads as a three-dimensional pattern that describes the amplitude of sound projected by the sound source in all directions.9 The second, termed by Dodge as the apparent source width of a sound, is resultant of multiple sound sources distributed over a region to be perceived as a unit (a symphony orchestra, for example).10

After those technical considerations above, entering the discussion about the artistic manipulation of sound spatialization in music would be more understandable. An attempt to define music spatialization must be launched as a departing point in this research, even if a definition at this point can be amplified and improved during the following chapters.

Roads related music spatialization to “a similar position today as the art of orchestration had in the nineteenth century,”11 pointing out that, like with orchestration in that period, spatialization is an important and new addition to the composer’s technical palette. According to

---

7 Morgan, “Circumfusion.”
9 Ibid, 469.
10 Dodge, Computer Music, 311.
Maria Harley, this technique “can be recognized in every situation in which the position (direction and distance) of the sound sources and the acoustic quality of the performance space are given compositional importance,”\textsuperscript{12} relating spatialization in music as an interaction of various concepts. Hence, putting together these notions with the previous sound definitions above, one can define \textit{music spatialization} as the role that sound spatialization has in composition or performance. When music spatialization is \textit{present}, it implies the composer’s imagining or expecting some type of relationship between the music and sound spatialization. When there is not a composer, like in most of folk music, for example, music spatialization can be present if the same relationship still exists.

Otherwise, by adapting Maria Harley’s terminology, one can say that music spatialization is \textit{latent} when the sound spatialization is standard and unspecified by the composer.\textsuperscript{13} The traditional arrangements of performers in chamber music, symphony concerts, or operas are examples of latent music spatialization. It is assumed that performers and audience will have traditional placements inside expected acoustical environments.

Only standard solo music has no latent or present musical spatialization, and “seems to be neutral from the spatial point of view.”\textsuperscript{14} In nonstandard solo music, the performer or the audience could be said to move in space. The aspect of mobility in music space was classified by Maja Trochimczyk (formerly Maria Harley) in four different categories: (1) static performers and

---


\textsuperscript{12} Harley, Maria, “From Point to Sphere,” 128. Maria Harley or Maria Anna Harley changed her name to Maja Trochimczyk in 2000.

\textsuperscript{13} Ibid., 126.

\textsuperscript{14} Ibid., 125.
audience; (2) mobile performers with static audience; (3) static performers with mobile audience; (4) mobile performers and mobile audience.\textsuperscript{15}

The historical aspect of this survey is divided into five chapters. Chapter 2 is concerned with the musical space in antiquity and medieval ages. Chapter 3 will be dealing mainly with \textit{cori spezzati} in Venice in the Renaissance and the polychoral legacy throughout the Baroque. In Chapter 4 the focus will be music spatialization in opera and orchestral music of 18\textsuperscript{th} and 19\textsuperscript{th} centuries. Because of the importance that musical space has in the second half of the twentieth century, I divided the last century in its two halves, forming respectively Chapter 5 and 6.

\textsuperscript{15} Trochimczyk, “From Circles to Net”, 39.
Chapter 2. Music Space in Antiquity and in Medieval Ages

The spatialization practice in Western music begins not on a specific date, but with a performance practice that goes back to Jewish liturgy, which was common since the Middle Ages in the Catholic Church: the antiphonal and the responsorial singing of psalms, or psalmody.

The poetry structure of the psalms has each verse divided into two parallel halves: “The Lord is my shepherd, I shall not be in want.”

This characteristic enabled both the antiphonal performance (the division of the choirs in two alternated groups) and the responsorial performance (the congregation responding to a soloist). Both types presume different placements for the performers, an incipient form of music spatialization.

There is a possibility that these singing practices were present in civilizations even more ancient than the Israelites. Alfred Sendrey affirms that during the Egyptian festivals, antiphonal singing was “performed by choral groups of dancing men and women.” According to the same author, the responsorial and antiphonal performances “were employed by the Babylonians and Assyrians long before their use was historically recorded by the Israelites.” Unfortunately, Sendrey do not present clear evidence for these conclusions. One of the main bibliographic Sendrey’s sources is Curt Sachs’s writings on ancient music. Sachs has the same point of view of Sendrey about antiphonal and responsorial singing between ancient Egyptians and Assyrians. However, according to Sachs, there is no irrefutable evidence of this: “despite an almost

16 Psalm 23.


19 Ibid., 46.

complete lack of direct information, conclusions by analogy and other indirect inference allow us to draw the vague outlines of how music was in the ancient Western Orient.”21

2.1. Samples of Music Spatialization Present in the Old Testament

There are several mentions of music in the Bible’s Old Testament. Some of them refer or imply some kind of latent music spatialization. One could call the following passages as quasi-latent music spatialization, because it seems that the treatment of space is not a consequence of a conscious musical thought or even it follows a traditional spatial localization in performance. However, they are worth citing since they are historical predecessors of events that will be viewed through the next chapters.

The curses from Mount Ebal describe a very interesting early stage of responsorial performance.22 A group of soloists, represented by the Levites, should recite curse verses (V) in alternation with all the people that should response the refrain “Amen” (R). The form of this response is:

\[ V_1 \ R \ V_2 \ R \ldots \ V_n \ R \]

We do not know for sure; however, two different locations can be implied: one for the Levites near the altar and other for the people surrounding them. If that was the case, the spatialization would be driven by liturgy and geography. At the same time, the locations would emphasize the response form shown above. Even if in this case there were not a clear distinction between performers and audience, the first mobility categorization—static performers and audience—could be assumed.

---

21 Ibid., 101. This research could not find any up to date source endorsing or refuting these conclusions by Sender and Sachs about antiphonal and responsorial singing before the Israelites. However vague these statements are, they form an interesting hypothesis that is worth citing here.

After the time of Moses, the Bible also describes one of the most ancient forms of mobility in music location, a small orchestra, moving in space:

A procession of prophets coming down from the high place with lyres, tambourines, flutes and harps being played before them.23

An observation of mobility categorization can also be made here. If one imagines that in a procession there were, as traditionally until today there are, audience members engaged in the procession and watching it, Trochimczyk’s categories 2 and 4 were already present at that time.

According to Sendrey, the Bible describes, during the celebrations of the first victories of David, an early stage of antiphonal performance, with two groups of women singing the following text one to another while playing and dancing:

“Saul hath slain thousands, and David his ten thousands.”24

One can see here a prototype of the antiphonal singing of the psalms. In terms of spatialization, one can infer two moving locations, as they were dancing. These localities would be driven by the choreography of the dance, and in this case there were movement in the performer’s space localities, forming the category number 2.

In a later passage, one can find another brief description of musical spatialization during King Solomon’s celebrations for having accomplished the construction of the First Temple.25 The Levites stood on one side of the altar playing cymbals, harps, and lyres. In the opposite side, priests sounded trumpets. There is a mention of trumpets playing in unison with singers; although no specific location is mentioned for the voices. However, in an early passage, during King David’s time, it was said that some of the Levites were responsible for the singing. There

23 1 Samuel 10:5.

24 Sendrey, *Music in Ancient Israel*, 75. The author is citing 1 Samuel 18:7; 29:5.

25 The description here is a possible visualization based in 1 Chronicles 15:22; 2 Chronicles 5:12-13; and 2 Chronicles 7:6.
were also all the Israelites standing in the courtyard, but no mention of a possible part of the people in the performance is made. Sadly, we do not have here a text of the singing that could allow us to form conclusions. What can be said is that we have at least two different locations for the performers, and the spatialization was driven by architecture and liturgy.

2.2. Early Music Spatialization Present in the Rabbinical Tradition

The sacrifice was known to be the most important moment in the Temple Liturgy. To each sacrifice, a specific performance of the psalms was set. Sendrey states that some rabbinic sources make it possible to conclude that there were at least two probable sound sources: Levite instrumentalist and singers. It is not clear if the general public present at the ceremony participated actively during the singing.26

A. Z. Idelsohn, based on a description found through a passage of the Mishnah,27 made a possible structure of a musical performance at the Second Temple service. According to Jewish sages of the first century, there were three forms of responsorial psalmody in the temple at that time (A, B, and C in Table 2.1). These three different forms were based on what part of the verse the congregation or the leader was supposed to sing.28 The singing procedures are described in Table 2.1.29

<table>
<thead>
<tr>
<th>Form</th>
<th>leader</th>
<th>congregation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>first half verse</td>
<td>repeats the leader singing of the first half verse</td>
</tr>
<tr>
<td></td>
<td>the succeeding half verses</td>
<td>interpolate with the same first half verse</td>
</tr>
<tr>
<td>B</td>
<td>a half of each verse at a time</td>
<td>repeats what the leader had last sung</td>
</tr>
<tr>
<td>C (responsive strictu sensu)</td>
<td>first half of each verse</td>
<td>second half of each verse</td>
</tr>
</tbody>
</table>


29 Idelsohn, *Jewish Music*, 20-1; Reese, *Music In the Middle Ages*, 10.
Unfortunately, there was no description in the rabbinic sources of specific locations for the leader and the congregation, whether they were static or moving in some way. One could only deduce a spatial separation and imply a category of performance number 1.

2.3. The Transition and the Middle Ages

Christian worship emerged based on a Jewish background. Hence, it would be hard to deny the influence of Jewish music upon the early Christians, since they were seen in the beginning as followers of a sect within Judaism. As for the whole religious content, there was also a period of transition between these two traditions during the two first centuries A.D.

J. A. Smith argues that Temple or synagogue music was not a primary influence on Christian assemblies of that time. Rather, private Jewish religious gatherings and the remembrances of the Last Supper—being itself traditionally Jewish and significantly Christian—were the main vehicles to deliver aspects of the music from the former religion through the new one. This tradition of antiphonal and responsorial singing was incorporated from the beginning of the early Christianity and with it a sensibility toward physical separation of groups and voices.

The first accounts for this kind of performances (as it was expected since the new religion was born there) came from the eastern Christian regions. Socrates (c. 380-450) reported a legend about the Bishop Ignatius of Antioch (martyred c. 107), who would have introduced this manner of singing to the church of Antioch after having a vision of Angels “hymning the Holy Trinity with antiphonal hymns.” Another source of an early example of antiphonal singing in

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31Ibid., 1-16.

32Ibid., 16.

33McKinnon, Music in the Early Christian Literature, 102. Also Hiley, Western Plainchant, 490.
Christianity is a letter written by Pliny the Younger in c. 112 to the Emperor Trajan, providing information that Christians, assembling in the province of Bithynia, “chant verses alternately among themselves.”

According to Augustine (354-430), the eastern manner of singing hymns and psalms was introduced into western Christianity in Milan, during the Arian threat in 386-7. Some writers connected the term referring to the eastern manner of singing as antiphonal. However, there is no precise evidence for that conclusion. Isidore of Seville (c. 560-633) mentioned that “antiphons are chanted by two choirs alternately.”

Beside some indications cited above of antiphonal and responsorial singing, David Hiley observed that the forms for the plainchant music before the eighth century are not clear in detail. Based on a description by Amalarius of Metz’s Liber officialis (c. 823), he gives a probable performance procedure for psalm verses and their added antiphons, where responsorial and antiphonal singing are integrated:

Psalm verse: soloist
Antiphon: first choir
Psalm verse: soloist
Antiphon: second choir
Psalm verse: soloist
Antiphon: first choir
Psalm verse: soloist
Antiphon: second choir
(and so on)

36 Hiley, Western Plainchant, 490.
37 Ibid.
38 Ibid., 492.
39 Ibid., 490.
Even if it is not possible to know exactly how the choirs and the soloist were placed in space, one can infer that they were separated in some way, implying a category 1 of performance. The music spatialization here is used to underline the form in which the texts were set up. In fact, a musical spatialization of that structure seemed to be encouraged, since it was a common physical layout of both monastic and secular medieval churches to have “the choir stalls divided into two sections facing each other across the chancel or altar area.”\(^{40}\) The soloist should be placed in the center of the altar area, spatially distanced from the choir or the divided choir.\(^{41}\)

Medieval plainchant was transmitted through generations fundamentally by an oral tradition. Even so, it was this tradition that brought about the most ancient forms of music notation of Western culture, generally dated to the ninth century.\(^{42}\) It was a matter of time until the first attempts to put on notation antiphonal and responsorial performances started to appear. In fact, the Antiphoner of Lucca,\(^{43}\) a manuscript from the beginning of the twelfth century, presented in several of its chants in what could be described as an incipient form of spatial music notation. In this source, according to Helmut Hucke, “the beginning of the repetenda in the responsories is marked by a cross, and it seems that the melody up to the cross was sung by the cantor and at that point the schola began.”\(^{44}\) Example 2.1 shows the usage of a cross in the responsory \textit{Lapidabant Stephanum} before the word \textit{Domine}.\(^{45}\)

\(^{40}\) Yudkin, \textit{Music in Medieval Europe}, 160.

\(^{41}\) Herlinger, interview by author.

\(^{42}\) Hiley, \textit{Western Plainchant}, 362

\(^{43}\) Catholic Church. \textit{Antiphonaire Monastique}.

\(^{44}\) Hucke, “Toward a New Historical View of Gregorian Chant,” 452.
Example 2.1. The cross symbol in *Lapidabant Stephanum* responsory

Hence, from this rudimentary type of notation, a link between a tradition of a quasi-latent music spatialization performance and a codification of these procedures was made—the basic fundamentals for music spatialization to evolve were present. However, plainchant singing is not “an end in itself but part of a religious ritual,” and so, performances similar to those described above do not appear to change too much throughout the Middle Ages. The antiphonal and responsorial placement was then dependent on liturgy, architecture, and the musical intentions used to emphasize the form of the texts. Even so, the technique evolved from an early quasi-latent form through a latent type of music spatialization in the last centuries of the Middle Ages. It seems that a significant improvement would have to wait until music notation and the polyphonic compositional processes were developed during the later Middle Ages and consolidated in the Renascence. Besides the antiphonal and responsorial possibilities, polyphony, with its multiply layered texture, contains in itself the germ of another kind of spatial relationship, since “space is linked to texture, a tactile, and again, spatial entity.”

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47 Harley, “From Point to Sphere,” 127.
Chapter 3. Polychoral Music at the Time of Gabrieli in Venice and Its Legacy

In the Renaissance, antiphonal and responsorial singing traditions were increasingly explored and exploited by composers for musical effect. Since polyphony had been firmly established, it was a only matter of time before composers began to realize the possibilities of mixing polyphony with the tradition of dividing a choir in space, what we now call coro spezzato⁴⁸, its plural cori spezzati, or polychoral music. This mixing of techniques developed at first in both directions: polyphony was applied to antiphonal performances of psalmody, and antiphonal singing was applied to polyphony to “split multi-voice textures into distinct voice groups.”⁴⁹

According to Giovanni d’Alessi, the early 16th century usage of polychoral music (double-choirs, in this case) occurred in three different forms: (1) one choir sings the Gregorian chant, while the other uses polyphonic verses; (2) two choirs using non-related polyphonic verses alternately; (3) two choirs with their own material, but in dialogue with each other, some times uniting both choirs, mainly near the end, forming a single composition. For d’Alessi, the last type forms the true coro spezzato.⁵⁰

3.1. The Polychoral Music in Venice

The first steps of cori spezzati polychoral practice occurred in the final years of the fifteenth century in northern Italy.⁵¹ It was a practice mainly for dignifying specific occasions, like weddings and celebrations, when “large music was almost a necessity.”⁵² It seems that these

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⁴⁹ Arnold, “Cori Spezzati,” 467.


⁵² Ibid., 5.
ceremonial events, with its social, religious, and economic environment, were important aspects to drive the usage of two or more choirs for more than a century.\textsuperscript{53}

Francesco Santacroce and Father Ruffino can be cited as examples of composers who were already working with double choir in the first decades of the 16\textsuperscript{th} century. However, polychoral golden age started around the middle of the century, mainly as a result of the music of three composers who succeeded each other at St. Mark’s cathedral in Venice: Adrian Willaert, Andrea Gabrieli, and his nephew Giovanni Gabrieli. In fact, the publication of Willaert’s well known \textit{salmi spezzati} for double-choirs in 1550, and the presence of \textit{cori spezzati} teachings in treatises (like Zarlino’s \textit{Istitutioni harmoniche}) were important backgrounds for the increasing popularity of polychoral music from about the middle of the 16\textsuperscript{th} century.\textsuperscript{54} Andrea Gabrieli continued the Venetian tradition. His polychoral work was collected by his nephew Giovanni Gabrieli and published posthumously in 1587 in a large volume called \textit{Concerti}.\textsuperscript{55} Giovanni followed his uncle and composed a large amount of music with \textit{cori spezzati}, including works for two, three, and four choirs. Many of them were published in his well known \textit{Sacrae Symphniae}.

In dealing with the challenge of writing for two or more choirs separated by space, these St. Mark’s composers had to make some adjustments in that style period. They started to use homophonic textures for those settings. According to Dennis Arnold, “it makes performances easier when choirs are distant from one another, certainly because imitative counterpoint would

\textsuperscript{53} Ibid., 5.

\textsuperscript{54} Ibid., 6.

\textsuperscript{55} Ibid., 8.
be less effective in such a mass of sound."\textsuperscript{56} For him, that was even emphasized by a slower harmonic rhythm probably as a consequence of the “acoustical necessities of separated choirs.”\textsuperscript{57}

A difficult technical problem faced by these first polychoralists is that the greater the distance between the groups, the harder it would be to keep them together, with a more obscure presence of the bass part. This later aspect can make the harmony sounds strange for some members of the audience not near to the bass voice. A highly effective solution for these difficulties was found by Willaert’s double choir music: he united the choirs by using essentially the same bass part for both groups.\textsuperscript{58} This necessity to adjust balance is viewed by Arnold as “to contain the beginnings of the modern idea of orchestration.”\textsuperscript{59}

Some of those achievements and another interesting aspect of the music spatialization technique of the northern renaissance Italian composers can be exemplified by the music of Giovanni Gabrieli. In Willaert’s single choir chanson, \textit{Irons-nous Toujours Couchers} (Example. 3.1), one can see the dialogue between the upper voices (soprano and alto) and the low voices (tenor and bass).

![Example 3.1. Beginning of Willaert’s \textit{Irons-nous Toujours Couchers}](image)

It seems that this colorful effect was simply amplified by the polychoralists by applying the rule that each of these sections of music sung by a single choir is now performed by a completely

\textsuperscript{56} Ibid., 8.

\textsuperscript{57} Ibid., 8.

\textsuperscript{58} Arnold, \textit{Giovanni Gabrieli}, 80.

\textsuperscript{59} Ibid., 80-81.
new group of singers separated by space. Those dialogues were made by long phrases in Willaert’s music. However, in the later Gabrieli’s music, the dialogue phrases, and consequently the choirs, can interchange much faster. After all, according to Arnold, “the whole basis of the separated choirs is that they provided contrasts in colour at a time when such contrasts were diminished by imitative counterpoint.” One can see the dialogue spatialization technique described in the double-choir outlined in Example 3.2.

Example 3.2. Excerpt of G. Gabrieli’s Magnificat from Sacrae Simphoniae

The repetition of the words Fecit potentiam in this excerpt is also a good example of another technique: the use of echo as a compositional procedure that imitates the acoustical phenomenon. The Renaissance was a period characterized by an intense influence of Greek and Roman cultures. Ovid’s story about the nymph Echo—who was able only to repeat the last few syllables of sentences spoken to her—had a “lasting influence on vocal and instrumental music from the Renaissance to the 20th century.” The musical echo effect was widely diffused, and Renaissance sacred works used it mainly in the form of repetitions of longer phrases and


sentences, underscoring the importance of the text, and eventually leading to antiphonal polyphonic writing for two or more choirs as in *cori spezzati*.\(^{63}\)

A more polyphonic texture had its place in polychoral music. However, multiple layers of music can be a problem if clarity is desired. The realization of a great number of polyphonic voices singing in the same place of performance can result in confusion and in many cases will sound like a unified mass of sound. The spatialization of choirs is a great tool to clarify multiple-voice textures. That seemed to be the option of a non-Venetian composer—Orlando di Lasso. His *cori spezzati* ignores the simpler texture of the Venetian composers, and uses a very complex imitative counterpoint and rhythm.\(^{64}\) There is also an extraordinary example of *cori spezzati* polyphony in Thomas Tallis’s 40-voice motet *Spem in alium* (1578), for eight five-part choirs.

According to Paul Doe, there are several controversies in respect to the origin of this outstanding English work: (1) motets for many voices were not common in Tudor England; (2) apparently, there is a total lack of precedent of similar large scale multi-choral music in Tallis’s production; (3) one can speculate whether this piece was written to be performed or just to show the composer’s skill; (4) facts regarding the date of its composition, the dedicatee, and when and where it was premiered have been discussed by musicologists; (5) no conclusive evidence exists to assure even Tallis’s authorship.\(^{65}\)

On the other hand, Denis Stevens does not challenge Tallis’s authorship. Moreover, he suggests that the work was premiered in 1571 at the Nonsuch Palace—owned by Henry Fitzalan, 12\(^{th}\) Earl of Arundel—in the region of Surrey south of London.\(^{66}\) In Stevens’s words, “the Long

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\(^{63}\) Ibid.

\(^{64}\) Arnold, “The Significance of ‘Cori Spezzati’,” 7.

\(^{65}\) Doe, “Tallis’s ‘Spem in Alium’ and the Elizabethan Respond-Motet.”

\(^{66}\) Stevens, “A Songe of Fortie Partes, Made by Mr. Tallys,” 171.
Gallery of Arundel House, which could easily accommodate a large choir, its supporting instrumentalists, and an audience of ample size, could well have witnessed the first performance of *Spem in alium*. The basis for Stevens’s argument comes from two main sources. The first source is a letter to the *Musical Times* in 1878 that reports an anecdote (written in 1611) stating that Tallis’s work “was songe in the longe gallery of Arundell house.” The second source is a copy of the catalogue of the library at Nonsuch brought to light and published in 1956: “one of its entries concerns a ‘songe of fortie partes, made by Mr. Tallys’.”

How was this music performed in terms of spatialization? We can not know for sure. However, notes in Philip Legge’s *Spem in alium* edition launch an interesting hypothesis for the performance. According to him, Nonsuch Palace possessed an octagonal banqueting hall that could accommodate a performance of the eight choirs arranged circularly and sequentially by number I to VIII (Example 3.3). With a set up like this, the piece’s opening points of imitation make the music rotate from choruses I to VIII. In the following imitative section, after a dramatic tutti, the music circulates in the opposite direction. Tallis is now making the choirs succeed themselves in groups of two choirs in stretto, with each group fading out after a new one enters: VIII and VII; after a while VI and V; then IV and III; finally II and I.

Example 3.3. Possible “circular” arrangement in Tallis’s *Spem in alium*.

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIII</td>
<td></td>
<td>III</td>
</tr>
<tr>
<td>VII</td>
<td></td>
<td>IV</td>
</tr>
<tr>
<td>VI</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

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67 Ibid., 175.
68 Ibid., 172.
69 Ibid., 175.
70 Legge, ed., “Spem in Alium.”
This circular set up also makes Tallis’s music create the possibility of antiphonal arrangements of these four groups of two choirs as they are geographical locations: north and south, east and west. Other interesting space-image combinations will result from the dialogue between two groups of massive 20-voice choirs, “which can be arranged in two different ways (north and west versus east and south, or north and east versus south and west).”

Music notation evolved considerably from the ninth century to Renaissance—staves and mensural rhythm were now common everywhere. However, the use of scores for vocal music was still not the norm during the 16th century. Most of the music publications were in choirbook and partbook formats. Even so, one could realize precisely which choir a specific part pertained by looking at the title of each single part. Seemingly, that was the whole evolution in music spatialization notation in this period. As far as this research could find, there were not any specific indications or clues for the position of the different choirs in St. Mark’s composers cori spezzati music publications, or elsewhere.

Because of this lack of information, we are not certain how and where these choral groups were placed in cathedrals. Hence, there is controversy on the development of the relationship between polychoral music and space in St. Mark. During the 1970s, Arnold articulated one of the prevailing myths as follows.

According to Arnold, the polychoral music in Venice at that time seems to have evolved as a consequence of various circumstances: the physical nature of the vast building of St. Mark’s church; the necessity to use music both for procession and masses; and the need to dispose effectively the grand musical forces available during festivals. The number of musicians involved on festivals could be thirty singers, two dozen instrumentalists, and two organists,

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71 Ibid.

frequently supplemented by a third player on a portable instrument. The most common procedure to adjust this large group was to divide both the music and space in two choirs and split them between the two galleries on either side of the altar. If a third or more choirs were required, they usually were put on the floor near the two choirs. It was not uncommon to perform from the pulpit or on a palco (stage), a platform specially erected for the occasion. Frequently, if not always, instruments were used to “swell the sound in the sung parts.” Hence, the polychoral performance in Venice included the seeds of “polyorchestral” music as well. With the exception of the usage of polychoral music during processions, one can classify those performances as mobility category number 1.

Since 1981, this traditional view of sound spatialization of choirs in St. Mark has been challenged by David Bryant. He states that double-choir Vespers psalm of Willaert and Giovanni Croce were not sung antiphonally, but rather responsorially, with four of the best singers in one of the musical groups and all the others in the second. In respect to the choirs’ placement inside the cathedral and based in his documentation, Bryant affirms that there is no evidence to believe that the choirs were positioned inside the organ lofts or divided into two parts. They were instead, for example, placed as one group sometimes on the floor near the high

73 Arnold, Giovanni Gabrieli, 30-31.
74 The instruments frequently doubled the choir parts or even had one voice singing one part while the instruments played the rest of the polyphony.
75 Ibid., 31.
76 Arnold, Giovanni Gabrieli and the Music, 166.
77 Ibid., 130.
78 Bryant, “The ‘Cori Spezzati’ of St Mark’s: Myth and Reality.”
79 Ibid., 169. One could question if this is a really responsorial singing, or whether it is still antiphonal.
altar, sometimes in one of the *pulpitum* located right and left in front of the altar and next to the audience. Bryant questions even the presence of the organists or the other instrumentalists performing. However, in case of the music of Andrea and Giovanni Gabrieli present in *Concerti* and *Sacrae Symphoniae*, “the participation of both organists and instrumentalists was definitely the norm.”

Moreover, Bryant admits that for both Gabrieli’s music, the groups of instrumentalists and singers were in fact divided in the manner described by Arnold above. He still reports the presence of three conductors during those performances. The leader conducted the ripieno singers positioned in the altar floor. It was his responsibility to indicate the beat in order for the loft conductors to relay it to their groups composed of soloists, instrumentalists and the two organists. One of the reasons for the main group of singers being placed at the floor level was the fact that they were also responsible for other liturgical and ceremonial functions. Here, as in the medieval period, the “combination of architectural and ceremonial considerations seems to offer the most plausible explanation for the particular lines along which the *cori spezzati* developed at St. Mark’s.” Hence, the main reason to write for spatialized groups still was not a musical one.

Christopher Robert Morgan theorizes that in the *cori spezzati* style “composers employed spatialization as a special effect rather than as a fundamental compositional practice. These effects augmented the dialog of the text but were not used as musical themes or motives intended for independent development.” Despite the controversy, what is clear is that, whether or not

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80 Ibid., 170-77.
81 Ibid., 180.
82 Ibid., 180-85.
83 Ibid., 186.
84 Morgan, “Circumfusion.”
Arnold’s view of *cori spezzati* is true, the mythology of St. Mark cathedral and its separated choir lofts was the inspiration for many modern composers and their interest in spatialization.

Interestingly, the presence of instrumentalists among singers in Giovanni Gabrieli’s music at St. Mark cathedral was seen by Adam Carse as “a link between vocal polyphony of the sixteenth century and the instrumental part-writing of the seventeenth century.”85 In fact, if one realizes that the distance separating those groups in St. Mark’s was not too much different from the distance that separates sections, or instrumental choirs, in modern orchestras, one can detect in the Venetian composers the roots of music spatialization of instruments in orchestras that started to become standard during the baroque era. After the polychoral music composed by the St. Mark’s musicians, almost every major composer in Italy was using the technique, and their influence can be traced in Germany, Spain, and England.86

### 3.2. Spatialization in the Baroque Era

From the beginning of the baroque, the new tendency was not to focus the dialogue contrasts between two or more split choirs, but by the opposition of soloist and *tutti*. Except for a brief development in Germany, that includes some works of Schütz, in general the golden age of *cori spezzati* was over by the third decade of the 17th century.87

In 1609, the German composer Heinrich Schütz (1585-1672) went to Venice where he stayed until 1613, a year after Giovanni Gabrieli’s death. Having studied with him, Schütz “was fond of polychoral devices and had much the same talent as his master for using space as part of the musical pattern.”88

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86 Arnold, “Cori Spezzati,” 468.

87 Arnold, “The Significance of ‘Cori Spezzati’,” 12.

88 Arnold, “Cori Spezzati,” 469.
Hence, inevitably, the influence of the Venetian *cori spezzati* can be traced in Schütz’s early compositions, like in the *Psalmen Davids* (1619)—a collection of twenty-six works that includes arrangements for multiple choirs, soloists, and instrumentalists. The fact that he worked in Dresden from 1617 until his death in 1672 as chapel master of the Elector of Saxony seems to be a second aspect that enabled him to compose first class polychoral music. Within the facilities found in the royal chapel environment, in some way similar to St. Mark, he had “ample space for the placing of separate choral and instrumental groups.” 89

Worries about possible poor performances in the hands of less experienced musicians led Schütz to a premonitory practice of writing prefaces90 with precise instructions that could include the size and nature of the performing forces and the best way to position them in the performance area. Important in these writings is Schütz’s distinction—similar to the baroque opposition concertino/ripieno—between the *Coro favorito*, smaller and formed of the best skilled voices, and the *Coro a capella*, larger and formed by relatively less skilled performers.91

Where pairs of each type of chorus are used, each Capella, he [Schütz] recommends, should normally be linked with one specific Favorito group, placed diagonally opposite it in a ‘cross-wise’ (Kreuzweiss) arrangement, so that the sound can emanate (‘stereophonically’) from all four corners of the performing area.92

Unfortunately, it seems that this aspect of Schütz’s commitment to performance is an isolated case in the early Baroque period and would stay unparalleled until Berlioz or the arrival of the avant-garde movement in the twentieth century. As an example, one can find music spatialization instructions in the text that prefaces one of Schütz’s most important

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89 Smallman, *Schütz*, 35.

90 Like the notes found in many avant-garde compositions.

91 Smallman, *Schütz*, 36.

92 Ibid.
compositions—the *Musikalische Exequien* (1636), for soloists, choruses in various set ups, instrumentalists and continuo. The notes for the third movement include these:

2. The First Choir should be close to the organ, while the Second is in the distance — or however it seems best on each occasion to arrange them.

3. Anyone who wishes to make one or two copies of this Second Choir and set up such groups at various places in the church would, the author hopes, increase the effect of the work not a little.93

Polychoral music persisted in Venice through Vivaldi in the 18th century, who wrote concertos and solo motets, having the orchestra placed in opposite sides in the church. In Germany, Bach’s masterpiece *St. Mathew Passion*, BWV 244 (1727-29), is an example of the longevity of *cori spezzati* practice. Even so, it seems that the most complex work for divided choirs is the *Missa Salisburgensis* for 53 voices grouped in eight different choirs, believed to have been composed in late 17th century by either Heinrich Biber or Andreas Hofer.94 In this piece, “the chordal structures are extremely simple, and the whole depends strongly on the element of surprise provided by the spatial separation.”95

The great novelty in terms of notation in the baroque era was that the score format became the norm for vocal and instrumental music. However, music spatialization is still latent, as the placement of singers and instrumentalists was implied, but not written specifically in those scores.

The Baroque usage of polychoral and polyorchestral echo was an example of a later development. When the *cori spezzati* started to be used also in secular music, echo effects gained attention. Croce and Donato wrote motets with echo techniques. Since echo effects were easily arrangeable by using solo voices, music with separated soloists was very popular in the

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93 Buelow, “German Requiem,” 21.

94 Arnold, “Cori Spezzati,” 469.

95 Ibid.
beginning of 17th century. Because of that, the usage of echo effects in this period, like in the concerto grosso genre—which was a much more important musical practice through the Baroque era—can be considered a related variation of the Renaissance polychoral musical spatialization.96 However, although it was used as an occasional novelty, the orchestral echo “never lost its appeal during the Baroque.”97 Besides this, the echo usage in Baroque music was predominantly a musical reference that was obtained mainly with contrasts of dynamics and instrumentation rather than splitting instruments in different locations out of the orchestral and choral group.

Another type of spatialization also appeared, and it is said to have been invented around 1612 by Ignatius Donati and his singers in the cathedral of Pesaro: the “distant singing,” where the soloists were placed in a distance that did not permit them to be seen in the church.98 This procedure seems to have provoked some “echoes” in 19th and 20th century music.

A similar procedure started to be used here and there in the baroque opera, announcing the later tradition to place singers or instrumentalists behind the scenes in stage works, mainly in music drama. However, it seems that composer’s instructions to place musicians in nontraditional locations did not start to appear in their opera scores until the first half of the 18th century.99 Before that, one probable hypothesis is that the librettos had the function to inform details of non standard sound locations, as we can see in a couple of Purcell’s excerpts.


97 Ibid., 155.


99 The only exception to this statement was found by this research at the beginning of the first Sinfonia of the prologue of Cavalli’s opera L’Egisto (1649), where an indication for the wind band to play behind the stage seems to have been written. However, the source for this information was a vocal score edited by Raymond Leppard in 1977. Hence, based on this source, it is hard to affirm surely that this instruction was written in Cavalli’s score or it was copied by the editor from the libretto. Francesco Cavalli, L’Egisto, 4.
In 1674, Henry Purcell wrote the music for Thomas Shadwell’s reworking of Shakespeare’s play *The Tempest*. In the Scene III of Act II, two play’s characters (first and second devils) are said to sing under the stage, according to Shadwell’s version.\(^{100}\) However, there are no written instructions in Purcell’s score for the placement of those singers. Similar procedure is seen in the Purcell’s opera *King Arthur* (1691). At the end of the first act, the libretto, written by John Dryden, gives instructions for a battle scene played behind the scenes.\(^{101}\) As in *The Tempest*, there are no instructions in score for any musician location.

This situation seemed to have changed during the end of baroque era. For example, one can see a composer’s concern for this kind of spatialization in Handel’s music. In the first *Coro* of the second Act of his opera *Giulio Cesare* (1724), Handel wrote above the character Durastanti’s part an instruction for the choir to sing back stage: “*Voci di congiurati di dentro.*”\(^{102}\) This procedure, associated with the “distant singing” cited above, seems to have provoked some “echoes” in the future, mainly in the 19\(^{th}\) century opera when they become ubiquitous.

Another spatial related issue that can be cited here is the development of the orchestra. The choice of specific instruments from an immense number to build up the four main choruses of the orchestra (strings, woodwinds, brasses, and percussion) was a process that took the whole 17\(^{th}\) century and first half of the 18\(^{th}\) century, with the appearance of the standard ensemble about 1750.\(^{103}\)

During the 16\(^{th}\) century and the beginning of the 17\(^{th}\) century, almost all “instrumental” music was part of compositions intended to be sung, with instruments being only used to

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\(^{100}\) Purcell, “The Tempest,” 10.

\(^{101}\) Purcell, “King Arthur,” lxiii.

\(^{102}\) Handel, *Giulio Cesare*.

\(^{103}\) Bekker, *The Orchestra*, 15.
underline the voices or to replace absent ones.\textsuperscript{104} With the rise of the violin family, at the last quarter of the 17\textsuperscript{th} century the four-part string chorus—the first standard group in orchestral history—was established.\textsuperscript{105} However, even with the presence of this standard group of strings, the non-standard group of winds and percussion, the number of instruments of each of these sections was not standard. More than that, the disposition of these groups in space was far from being standard. Apart this, composers from this period knew that these sections were available, and started to think them as layers of music, rather than sound locations. That gave birth to a latent form of onstage music spatialization related to both the implied separated orchestral sections and the implied texture linked to the “internal, microscopic differentiation in the orchestral sonorities.”\textsuperscript{106}

\textsuperscript{104} Ibid, 18.

\textsuperscript{105} Carse, \textit{The History of Orchestration}, 32.

\textsuperscript{106} Harley, “From Point to Sphere,” 127.
Chapter 4. Dramatic Space Effects in Opera and in Orchestral Music of 18th and 19th Centuries

The separation of instruments according to each section of the orchestra in purely instrumental music, the separation of the entire orchestra from choir and soloists in mixed pieces, and also the placement of the instrumentalists in the orchestra pit and the singers on stage in opera performances were already common procedures at Mozart’s time. Because of that, the placement of those different groups did not (and still does not) need to be specified by composers in the scores, making this entire repertoire representative of latent music spatialization. In spite of this, some forms of present music spatialization can be found during the classical and romantic periods, where the predominant form of spatialization was in opera, as a consequence of the need of reinforcement of dramatic effects. Composers started to notate instructions about instruments or singers that eventually had to perform in a different location than the standard.

Composers of the late 18th century, including Haydn and Mozart, worked with triple and quadruple echoing groups. Mozart’s Notturno No. 8 in D, K 286 (circa 1777) is an interesting manifestation of polyorchestral spatialization in the classical period. It was written for four six-voiced chamber orchestras, each with a quartet of string parts and two horns. The composer’s usage of echo orchestral techniques in the whole work is very simple, almost a literal echo—what the main orchestra plays is repeated literally in total or in part by, most of the time, each one of the other orchestras in sequence. In terms of notation, as in the polychoral score versions of the baroque period, Mozart just indicates in the first page the presence of four

\[\text{\textsuperscript{107}}\text{Herlinger, interview by author.}\]

\[\text{\textsuperscript{108}}\text{Térey-Smith, “Echo,” 861.}\]

\[\text{\textsuperscript{109}}\text{Mozart, “Notturno.”}\]
orchestras as separate sections of the score, and the inscription “l’Echo 1mo., l’Echo 2do., and l’Echo 3o.” for the first entrance of each of the echoes groups, with no specification of any locations. However, commenting about first performances, O. Lee Gibson states that the four orchestras “were separated by appreciable spaces.”\(^{110}\) Since Gibson does not present any evidence for his comment, it seems he is assuming that the four groups have to be widely separated. Otherwise the echo effects would not work, and the total effect would be compromised.

This literal use of echo is not the only echo composition procedure in this period. In Classical music, composers also use echo metaphorically, to try and denote space, as echo is an acoustical phenomenon that creates a perception of distance. One can see an example of this type of echo in the viola’s repetitions in Variation III of the last movement of Mozart’s *Clarinet Quintet*, K.-V. No. 581 (1789). A more emphatic example is the motivic treatment in Beethoven’s *Symphony No. 6*, Op. 68 (1808). In the beginning of the first movement (b. 16-28), Beethoven repeats thirteen times the same motivic cell with a long crescendo and decrescendo, in what seems to be an attempt to provoke in the audience a perception of a large open space in nature. However, this echo technique is used to imply space, not spatialization in music.

In the scene XIX of the first act of *Don Giovanni* (first performed in 1787), Mozart’s score indicates that a small orchestra formed by two oboes, two horns, and strings should be placed *sopra il teatro, da lontano* (“on stage, from a distance”) in order to play the famous minuet. In the subsequent scene, the composer adds two more small string orchestras on stage to play a new version of the same minuet. So, at that point the opera has the main orchestra in the pit, the three orchestras on stage, plus the seven soloists. Here, score placement of instruments and singers both in the orchestra pit and on stage is a good example of the use of spatialization

\(^{110}\) Gibson, “The Serenades and Divertimenti of Mozart,” 162.
techniques driven by drama in opera works.\(^{111}\) However, in *Don Giovanni*, Mozart announces a new musical procedure in dealing with spatialization, a procedure that would be used again by Charles Ives an entire century after.\(^{112}\) Beginning the minuet, Orchestra I enters playing in 3-4 time signature. Then, Orchestra II starts and, a few bars after, the time signature for only this orchestra and two characters, Don Giovanni and Zerlina, change to 2-4. Orchestra III and two other characters, Leporello and Masetto, repeat the same procedure, now changing their time signature to 3-8. Hence, the music is playing with three different time signatures at the same time. Example 4.1 shows an excerpt of this passage. That is a novelty in terms of music spatialization, because now—even if the main reason to use that effect is dramatic—the music spatialization is helping the perception of a *musical* invention: the polymeter. Otherwise, if the whole ensemble were placed at the same location, the perception of these rhythmic mixtures would not be so clear. It seems that this technique is an exception for Mozart’s music and also for other composers until the end of the Romantic Era.

Example 4.1. Mozart’s spatialization with polymeter in *D. Giovanni’s* Scene XX, Act I

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\(^{111}\) The most evident spatial contrast in opera is between the orchestra placed in the pit and the singers on stage.

\(^{112}\) See next chapter.
Another spatialization procedure during this period, and also still in use by opera composers, is the common practice of setting singers, instrumentalists, choirs, or any other group of musicians in a location not seen by the audience, most frequently behind the stage. This artifice can be traced back and related to the “distance singing” cited in the previous chapter. In Violetta’s solo aria in Verdi’s *La Traviata* I.5 (premiered in 1853), the character Alfredo suddenly interrupts her, singing in a distance. Verdi’s notated version for this off stage procedure is the inscription “sotto il balcone” above the Alfredo part in the score. Where is Alfredo exactly? Is he really there, or is it Violetta’s imagination? That will depend on the individual production. It seems that the composer’s intention is to provoke a sense of far from here, or from the present moment in time. The effect is yet more emphasized by a change in tempo: Alfredo’s intervention is marked *Andantino*, between an *Allegro brillante* and an *Allegro* in Violetta’s aria.

A similar procedure can be seen in the opening of Wagner’s *Tristan und Isolde*’s (first performed in 1865) first act. Here an unaccompanied tenor solo starts the action. Wagner notated in the score of Scene I: “Stimme eines jungen Seemannes (aus der Höhe, wie vom Maste her, vernehmbar).”

The type of music spatialization notation described above is the pattern for opera composers from late 18th through 19th centuries. Table 4.1 shows a sample of works of this period that use a parallel kind of notation; it also shows parameter changes that are linked compositionally with these “distant singing” procedures on each excerpt. One can see that, for this sample of works, changes in the parameter of tempo is the most used procedure connected with spatialization.

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113 Verdi, *La Traviata*, 96.

114 Wagner, *Tristan und Isolde*, 16.

Table 4.1. Music spatialization in some opera works of 18th (2nd half) and 19th century.

<table>
<thead>
<tr>
<th>Composer</th>
<th>Work</th>
<th>Where</th>
<th>Character(s), instrument(s)</th>
<th>Parameter(s) involved</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluck</td>
<td><em>Orphée et Euridice</em> (1762)</td>
<td>Beginning of Act II</td>
<td>Orchestra II</td>
<td>Tempo</td>
<td>Behind the scenes</td>
</tr>
<tr>
<td>Mozart</td>
<td><em>Don Giovanni</em> (1787)</td>
<td>First act, scene XIX</td>
<td>Orchestra I, II, III</td>
<td>Meter</td>
<td>On stage, from distance</td>
</tr>
<tr>
<td>Beethoven</td>
<td><em>Fidelio</em> (1805)</td>
<td>Act II, No. 14</td>
<td>Trumpet in B</td>
<td>Tempo, dynamic, texture</td>
<td>In the Theater</td>
</tr>
<tr>
<td>Rossini</td>
<td><em>The Barber of Seville</em> (1816)</td>
<td>First Act., no. 4, Cavatina</td>
<td>Figaro</td>
<td>Dynamic</td>
<td>From behind the scene</td>
</tr>
<tr>
<td>Weber</td>
<td><em>Der Freischütz</em> (1821)</td>
<td>Finale of Act II, No. 10</td>
<td>Spirits</td>
<td>Tempo, dynamic</td>
<td>Chorus of Invisible Spirits</td>
</tr>
<tr>
<td>Bellini</td>
<td><em>Norma</em> (1831)</td>
<td>Beginning of act I</td>
<td>Trumpets</td>
<td>Tempo, dynamic texture</td>
<td>Sound from the forest</td>
</tr>
<tr>
<td>Donizetti</td>
<td><em>L'Elisir D'Amore</em> (1832)</td>
<td>First Act, no. 3</td>
<td>Cornett in La</td>
<td>Texture</td>
<td>On stage</td>
</tr>
<tr>
<td>Meyerbeer</td>
<td><em>Les Huguenots</em> (1836)</td>
<td>Middle of Act V, no. 28</td>
<td>Coro di Donne</td>
<td>Tempo</td>
<td>In the inside of the church. (Nearly far away)</td>
</tr>
<tr>
<td>Berlioz</td>
<td><em>La Damnation de Faust</em> (1846)</td>
<td>Beginning of the Third Part</td>
<td>Corn I e II, Trumpet I e II</td>
<td>Dynamic</td>
<td>Behind the scenes</td>
</tr>
<tr>
<td>Verdi</td>
<td><em>La Traviata</em> (1853)</td>
<td>N. 3 of First Act</td>
<td>Alfredo</td>
<td>Tempo</td>
<td>Under the balcony</td>
</tr>
<tr>
<td>Wagner</td>
<td><em>Tristan und Isolde</em> (1865)</td>
<td>First Act, beginning</td>
<td>Young sailor</td>
<td>Texture</td>
<td>Voice of a young sailor. From aloft, as from the crow’s nest</td>
</tr>
<tr>
<td>Bizet</td>
<td><em>Carmen</em> (1875)</td>
<td>Second Act, No. 16</td>
<td>D. José</td>
<td>Tempo, texture</td>
<td>From the wings, distantly</td>
</tr>
<tr>
<td>Mascagni</td>
<td><em>Cavalleria Rusticana</em> (1890)</td>
<td>Beginning of the Opera</td>
<td>Turiddu and harps</td>
<td>Tempo</td>
<td>Behind the scenes</td>
</tr>
<tr>
<td>Puccini</td>
<td><em>La Bohème</em> (1896)</td>
<td>End of first Act</td>
<td>Schaunard, Colline, Marcello</td>
<td>Tempo, texture</td>
<td>From the courtyard</td>
</tr>
</tbody>
</table>

The distance element is present not only in the opera repertoire. Allusions to distance were a recurrent theme in the romantic composer’s mind, both in the form of a distant place or as a distant happening in the past. In most of the non-opera repertoire, the distance element is only suggested by the music. However, this theme had a real appearance in some 19th century orchestral works. The first music spatialization in a symphony seems to be the dialogue between the English horn on stage and the oboe behind the scene in the third movement of Berlioz’s *Symphonie Fantastique* (1830). It is a good example of a later development of both echo and distance singing in instrumental music. The composer uses here the same notation procedure

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116 Premiere dates.
used in the opera examples cited above: a small inscription above the Oboe I part informing that it must be “derrière la scene” (behind the scene).\textsuperscript{117}

What is important in Berlioz’s music is his passion for orchestration and spatialization. Apart for using the distant singing technique in his \textit{Symphonie Fantastique} described above, he also composed several pieces where groups of instrumentalists and singers are separated in space and dialoguing with each other in a similar technique to that used by the Venetians. The difference is that the musical groups are much larger than those in Giovanni Gabrieli’s time. Berlioz also emphasized the importance of writing more specific instructions in the score for the placement of these groups. Some of the Berlioz’s spatial ideas are stated in his orchestration treatise:

This is the moment to mention the importance of the different points of origin of sound. Different sections of the orchestra are sometimes meant by the composer to give questions and answers, and this idea can only be clear and effective if the dialoguing sections are far enough apart. The composer should indicate in the score the sort of arrangement he thinks appropriate.\textsuperscript{118}

His \textit{Requiem Mass} (1837), for example, asks for a huge orchestra composed of at least 108 string players, 32 woodwinds, a large percussion ensemble including 16 timpani, and a 210-voice double choir. The brass section is divided in four groups—Orchestras I, II, III, IV—and Berlioz added to the score specific instructions for their sound location: Orchestra I to the North, II to the East, III to the West, and IV to the south, surrounding the main orchestra. He also wrote in the score:

These four small brass-wind orchestras must be placed separately at the four corners of the grand group of choral singers and instrumentalists. Only the French horns remain in the grand orchestra.\textsuperscript{119}

\textsuperscript{117} Berlioz, \textit{Symphonie Fantastique}, 60.

\textsuperscript{118} Macdonald, \textit{Berlioz’s Orchestration Treatise: A Translation and Commentary}, 328.

\textsuperscript{119} Berlioz, \textit{Requiem Mass}, 27.
All that information was written by Berlioz at the first entrance of these four spatialized orchestras, which occurs in the second movement, “Dies Irae,” at rehearsal number 18. After a chord in fortissimo with the main orchestra horns, Orchestra I starts playing alone. The other three orchestras enter one at a time, imitating Orchestra I’s first gesture. As all the four groups have basically the same colour (brass), it would be very difficult for one to differentiate this echo—or polyphonic—procedure if all the brasses were in their normal place in the main orchestra. Hence, what could be heard as just a sound mass crescendo, if the instruments were playing at the same location, is perfectly heard as polyphony between four different groups of instruments because of the spatialization prescribed by Berlioz. Moreover, the point where the first of the spatialized orchestras enters is the beginning of a new section in the movement, with additional changes in others parameters like tempo, dynamic, timbre, and texture. The spatialization, as can be seen in the excerpts listed in Table 2, joins these parameters, helping to clarify the form of the movement.

The four orchestras are set in only two other of the ten Requiem Mass’s movements. In the fourth, “Rex tremendae,” the composer uses the four groups in a traditional way, reinforcing the orchestral tutti as they were the common brass section. However, in the sixth movement, “Lacrymosa,” at rehearsal number 52, Berlioz alternates chords in fortissimo, as they were sforzandi, with the four orchestras, almost making the sound circulate around (Example 4.2). This effect is not totally accomplished because of the rests in between each entrance. Another reason is the fact that those chords are also being played by the horns inside the main orchestra. It seems that the real Berlioz’s intention was to reinforce the upbeat position, causing a metric ambivalence. This can be seen as a germ of an orchestral spatial effect that only would be totally realized by Stockhausen in the middle of the 20th century.120

120 See Example 6.1.
Example 4.2. Berlioz’s quasi circulate sound in Requiem Mass No. 52

Berlioz’s *Te Deum* (1849) is another instance of the composer’s music spatialization usage. The work is set to two choruses, plus an optional extra children’s chorus, large orchestra, and organ. According to the instructions in the score, one can see reminiscences of Venetian’s composers:

The orchestra and choruses must be positioned at the end of the church opposite the end occupied by the great organ. If the conductor has no electric metronome with which to keep in immediate communication with the organist, then an assistant conductor must be positioned in the organ loft. There, watching the conductor’s movements, he will imitate them exactly, transmitting them to the organist who otherwise is likely to fall behind the beat.\(^\text{121}\)

Berlioz also suggests a conductor for each of the choirs. The most interesting effect here is the antiphonal usage by Berlioz of the opposition between the organ and the rest of the ensemble, a dialogue frequently underlined by changes in tempo.

One can see spatial instructions in others Berlioz’s works as well. In *Harold in Italy*, for example, the viola player “must stand in the fore-ground, near the public and isolated from the

\(^{121}\) Berlioz, *Requiem and Te Deum*, 134. His mention of an electric metronome anticipates a procedure very common nowadays in electroacoustic pieces using real time instrumentalists.
orchestra." Hence, with these much more specific directions for his untraditional instrument locations, Berlioz in fact planted the seeds of present music spatialization. One could call his spatial technique as quasi present music spatialization, as the relationship between his compositions and space is still not completely conscious, they happen only in few moments in relation with the whole of the pieces, and are essentially driven, as in theatre, by drama.

Besides Berlioz, very few important composers of orchestral music experimented with different placement of musicians during the 19th century. One can cite three: Franz Liszt, Giuseppe Verdi, and Gustav Mahler. From these, only Liszt had similar worries as Berlioz in writing instructions in more detail than the simple expressions used by opera composers to inform different musical locations they eventually imagined. Two of Liszt’s orchestral works use procedures of quasi present spatialization: Sinfonia Dante (1856), and the symphonic poem The Battle of the Huns (1861).

In the Magnificat of Sinfonia Dante’s second movement (Purgatory) score, Liszt uses a footnote to explain that the female or boys’ choir together with the harmonium are to be not only separated from the orchestra, but they have to be invisible as well. Certainly one can see here a variation of the “distance singing,” with the novelty being the presence of a much larger ensemble. However, most of the time in this Magnificat both the separated group and the main orchestra are playing as a whole, with no separated musical approach exploring the spatialization. Only for a short moment there is a musical contrast between these two groups, a kind of contrast the composer would present more developed in a later work: The Battle of the Huns.

\[122\] Berlioz, Symphonie Fantastique and Harold in Italy, 151.

\[123\] Walker, Franz Liszt, 312.
This symphonic poem is set to full orchestra with organ or harmonium. In bar 262, marked letter I - Maestoso assai (Andante), the orchestra is playing tutti, in fortississimo (fff), and in rhythmic unison. At this point, Liszt introduces also a similar location explanation in the organ part: “The Organ (or harmonium) to be in the rear of the orchestra, and when performed in a theatre, should the orchestra not to be upon the stage, then the organ must be placed behind the curtain.” Nevertheless, the organ only enters in bar 271, marked Lento - dolce religioso. The instrument is alone, playing a choral in piano (p). Five bars after, the orchestra abruptly overpass the organ, again in fortississimo, a tempo, and in rhythmic unison. Liszt repeats these huge antiphonic contrasts twice more, and the music spatialization reinforces them. According to Walker, if the location prescriptions are followed, the phrases of the choral Cruix Fidelis played by the organ “appear to float disembodied above the auditorium,” in a good metaphor for the technique called here “distance singing.” The organ part, with its spatialization, seems to be representing the distanced idealistic serene Christianity, and the orchestra the close barbarian’s fury and devastating forces.

Example 4.3. Liszt’s spatialization in an excerpt from The Battle of the Huns

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125 Walker, Franz Liszt, 312.

126 Liszt, “Hunnenschlacht,” 2.
Echo, distant singing, and the polyorchestral technique can be seen in the dialogue between orchestra, voices, and the two groups of on-stage and off-stage trumpets during the *Tuba mirum* part of the *Dies Irae* in Verdi’s *Requiem* (premiered in 1874). Although there are no specific indications of placement by the composer, Verdi followed the opera tradition and wrote at bar 91 above the two pairs of trumpets parts a small phrase which says that they have to be in a distance and invisible, with each pair in a different location.\textsuperscript{127} Clearly here, the spatialization is driven by the religious text, which mentions trumpets sounding at the “day of ire.”

For all the repertoire of symphonies up to the beginning of the twentieth century, Gustav Mahler used spatialization most frequently. He applied instructions for offstage instruments or voices in six of his nine symphonies. These instructions, however, are not so specific as in Berlioz or Liszt. Most of the time Mahler uses simple indications like “at a distance” in the list of instrumentation or above the instrument part in the score. In fact, Mahler’s spatial procedure basically underlines—as in most of the orchestral music of his time and before him—the important romantic allusion to the past or distance. These allusions are present in his orchestral works, emphasizing the drama of his programmatic symphonies. In order to accomplish that, Mahler uses techniques not different from the opera composers or from the orchestral works of Verdi, Liszt, or Berlioz described above.

Table 4.2 shows an outline of the usage of offstage instruments and voices in his symphonies. Interestingly, one can see that, even if it is for only two measures, Mahler uses spatialization involving polymeter in the fifth movement of his second symphony. Examining Tables 4.1 and 4.2, one can also notice the procedure used by most works that is to link the introduction of spatialized sound sources with important changes in some parameters. Of these, tempo is the most used. Also common are associations with changes in dynamic, meter, and

\textsuperscript{127} Verdi, *Messa da Requiem*, 38.
texture. Composers seem to prepare the entrance of these instruments “in a distance” with techniques similar to that used to prepare the first entrance of soloists in concertos.

Table 4.2. Music spatialization in Mahler’s symphonies

<table>
<thead>
<tr>
<th>Composer</th>
<th>Work</th>
<th>Where</th>
<th>VOICE(s), instrument(s)</th>
<th>Parameter(s) involved</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahler</td>
<td>1st Symphony</td>
<td>Bar 23</td>
<td>Trumpets 1,2</td>
<td>Tempo</td>
<td>In a very wide distance</td>
</tr>
<tr>
<td></td>
<td>(1888)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1st movement,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bar 22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trumpet 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bar 44</td>
<td></td>
<td>Trumpets 1,2,3</td>
<td></td>
<td>Take their place in the orchestra</td>
</tr>
<tr>
<td></td>
<td>2nd Symphony</td>
<td>5th movement, no.3, bar 43</td>
<td>4 horns</td>
<td>Tempo, texture</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>(1894)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. 6, bar 84</td>
<td></td>
<td>4 trumpets, 4 horns</td>
<td>Dynamic, density</td>
<td>From a distance</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>No. 22, bar 343</td>
<td></td>
<td>4 trumpets, triangle, cymbals, bass drum, timpano</td>
<td>Meter (Polarimeter)</td>
<td>In the farthest distance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. 27</td>
<td></td>
<td>Trumpets 3,4,5,6; 1 timpano (The instruments are not playing yet)</td>
<td></td>
<td>Take their place in “wide distance”</td>
</tr>
<tr>
<td></td>
<td>No. 29, bar 448</td>
<td></td>
<td>4 trumpets, one horn, one timpano</td>
<td>Tempo, meter, texture</td>
<td>In wide distance</td>
</tr>
<tr>
<td></td>
<td>Bar 471</td>
<td></td>
<td>Trumpets 3,4,5,6; 1 timpano</td>
<td></td>
<td>Take their place in the orchestra</td>
</tr>
<tr>
<td></td>
<td>3rd Symphony</td>
<td>1st movement, no. 51, bar 609 or 635</td>
<td>Several side drums</td>
<td>Tempo, dynamic, texture</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>(1896)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3rd movement, no. 14, bar 255</td>
<td></td>
<td>Flugelhorn (post horn)</td>
<td>Tempo, dynamic, meter</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>No. 15, bar 292</td>
<td></td>
<td>Flugelhorn (post horn)</td>
<td>Dynamic, density</td>
<td>Approaching itself a little bit</td>
</tr>
<tr>
<td></td>
<td>No. 16, bar 341</td>
<td></td>
<td>Flugelhorn (post horn)</td>
<td>Tempo, dynamic</td>
<td>Going away</td>
</tr>
<tr>
<td></td>
<td>5th movement, in the beginning</td>
<td></td>
<td>Tuned bells, boy’s choir</td>
<td>Tempo, dynamic</td>
<td>In a high gallery</td>
</tr>
<tr>
<td></td>
<td>6th Symphony</td>
<td>4th movement, no. 121, bar 239</td>
<td>Cow bells</td>
<td>Tempo, dynamic</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>(1904)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4th movement, no. 121, bar 254</td>
<td></td>
<td>Deep bells</td>
<td>Tempos, dynamic</td>
<td>Always in distant</td>
</tr>
<tr>
<td></td>
<td>4th movement, no. 144, bar 534</td>
<td></td>
<td>Deep bells</td>
<td>Tempos, dynamic</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>4th movement, no. 145 bar 539, 553</td>
<td></td>
<td>Cow bells</td>
<td>Tempos, dynamic</td>
<td>In the distance</td>
</tr>
<tr>
<td></td>
<td>7th Symphony</td>
<td>2nd movement, no. 84, bar 126</td>
<td>Cow bells</td>
<td>Tempo, texture, density</td>
<td>At a great distance</td>
</tr>
<tr>
<td></td>
<td>(1905)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8th Symphony</td>
<td>1st movement, no. 91</td>
<td>4 trumpets, 3 trombones</td>
<td></td>
<td>Offstage</td>
</tr>
<tr>
<td></td>
<td>(1907)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd movement, no. 218</td>
<td></td>
<td>4 trumpets, 3 trombones</td>
<td>Tempo, dynamic, density</td>
<td>Offstage</td>
</tr>
</tbody>
</table>

Noticeable is also the exclusive use of brasses or percussion as offstage sound sources. Two reasons can be cited for this usage. The first is technical: a group of brass and percussion instruments can project their sounds more loudly than strings and woodwinds. This characteristic makes them more easily heard in distant locations. The second reason seems to be esthetical: the
frequently associations of brasses and percussion with the drama present in these works, as the trumpets in Verdi’s *Requiem*.

In general, spatial arrangements were not common in the symphonic repertoire of the 19th century, and the music spatialization was still latent onstage. The most important acquisition of this period is the incorporation of “distant singing” by pure orchestral or non opera works. The use of this procedure transforms the latent spatialization in a *quasi* present one. However, as Christopher Morgan affirms when talking about Berlioz’s *Symphonie Fantastique*, there is a “lack of a paradigm for using sound spatialization as a musical motif.”¹²⁸ This statement could eventually be generalized for most of the spatial examples cited here so far. Even so, the seeds for the present spatialization are already in the works of this period. Those parameters composed to underline and justify the sounds “in a distance,” are now ready to be used to make raise the status of space as an independent musical parameter itself.

¹²⁸ Morgan, “Circumfusion.”
Chapter 5. Spatialization During the First Half of the 20th Century

The percentage of composers interested in the role of space in music did not significantly change through the first half of the twentieth century. This fact is in contrast with the attention aroused by musical spatialization after World War II. However, two major composers from this period had important contributions to the issue: Charles Ives and Béla Bartók.

One can see Charles Ives’s interest in music spatialization by looking at the on/off stage special seating arrangements documented in his scores. However, according to Robert Morgan, this is only a symptom of a fundamental aspect of Charles Ives’s music: its perception can provoke a non-temporal quality, a space quality. Robert Morgan points at least seven factors implicated in this spatial phenomena in Ives’s work: harmonic stasis, the circular motion of materials, the constant crosscutting from one idea to another, separate strands of continuity heard in isolated segments, the simultaneous combinations of independent/related musical continuities, motives relationships are essentially combinational rather than progressive, and passages of unprecedented textural density.129

Interestingly, as Charles Ives states in his article “Music and Its Future,” the main influence in his well known interest in space was not Western art music traditions: rather, it was impressions from his childhood of a music band in which “the players were arranged in two or three groups around the town square. The main group in the bandstand at the center usually played the main themes, while the others, from the neighboring roofs and verandas, played the variations, refrains and so forth.”130 Apart from these childhood recollections, Ives cites in the same article three other reasons that leaded him to use spatialization in his music: one cannot

129 Morgan, “Spatial Form in Ives.”

130 Ives, “Music and Its Future,” 192. This seems to be one of the first, if not the first, articles written by a composer in which music spatialization is one of the main subjects.
reproduce the timbre of distance sounds by simply playing them softly when nearby; distance sounds have a “quality” of feeling hard to take off; musical parameters can be clarified by placing instruments and singers off the stage.

Ives’s spatialization has two modes of expression: special seating arrangements and offstage placement. *Central Park in the Dark* (1906) is an example of the first mode; *The Unanswered Question* (1906) and the *Fourth Symphony* (1910-20) are examples of both. Even if there is a lack of a specific location instruction, Charles Ives’s *The Unanswered Question* is an example of his spatialization techniques.

In his note to performers for the second version (1930-35) of *The Unanswered Question* he wrote: “the string quartet or string orchestra (*con sordini*), if possible, should be “off stage,” or away from the trumpet and flutes.” By using this procedure, Ives guaranteed that the audience would perceive a timbre necessary for an environment for the winds that would be otherwise difficult to build if the strings were on stage. The choice to put the string group offstage, a familiar timbre to the listeners, is an important factor in the perception of distance. Moreover, some of the spatial qualities of Ives’s music present in this piece—the independent tempo, meter, dynamic, rhythm, counterpoint, harmony, and melody of the three groups (strings, flutes, trumpet)—are greatly clarified by their separation in space. Example 5.1 shows an excerpt of Ives’s work. Here, polyorchestral and echo spatialization procedures reach a new and interesting degree in sophistication, even if echo seems to never come out… Even if McDermott was not referring exactly to the same kind of space relationship that is being treated in this dissertation, one might quote his words in respect to Ives’s piece: “it is the spatial trenchancy of

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131 Morgan, “Spatial Form in Ives,” 147.


133 Morgan, “Circumfusion.”
examples such as *The Unanswered Question* which begins to make space a cogent reality for later composers as well as which retroactively insinuates a musical space for earlier music as well.”

Example 5.1. Ives’s multiple layers in *The Unanswered Question*

"The Unanswered Question" by Charles Ives (c) 1953 by Peer International Corporation Copyright Renewed. International Copyright Secured. Used by Permission. All Rights Reserved.

Ives’s *Fourth Symphony* contains among the simplest music and the most complex music ever written so far. It is scored for an immense orchestra, large percussion section and chorus. The first and fourth movements call for a “distant choir,” a small instrumental group placed onstage. There is a different instrumentation for each movement: two violins, solo viola (and/or clarinet), and harp during the first movement; five violins and two harps in the fourth. The rhythmic and metric complexity of this symphony made Ives explicitly recommend the use of a second conductor for the basses and bassoons in the second movement. Furthermore, the complexity of the multiple layers of the last movement made the composer divide the performing ensemble in three main groups: the percussion battery, the distant choir, and the main orchestra with chorus. However, specific spatial instructions were made only for the “distant choir.”

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135 Ives, *Symphony No. 4*. 
Before going through Bartók’s music, one can cite Edgar Varèse’s *Intégrales* (1924), for winds and percussion, as an example of onstage spatialization leading with the concept of “depth” in space. This is a concept that was present, even unconsciously, from the origin of polyphony, and stayed latent until the twentieth century. According to Flo Menezes, Varèse’s *Intégrales*, as a result of the instrumental writing, provokes some examples of a sensation of spatial depth which precedes and influences Ligeti’s similar procedures in his works from the 1960s.\(^{136}\) This understanding of sound depth, even if similar to subjects like sound radiation and apparent source width cited earlier in chapter one, seems to be more like the concept discussed by Victor Zuckerkandl.\(^{137}\)

Depth in auditory space, then, refers not to the distance between my ear and the location in space where a tone is produced, does not refer at all to the space in which I encounter tones; it refers to the space I encounter in tone, to the “from…” element of the encounter. Depth in auditory space is only another expression for this “coming from…” that we sense in every tone.\(^{138}\)

One could perceive a similar depth in space in the third movement of Schoenberg’s *Five Orchestral Pieces*, op. 16 (1909), and in some of the Webern’s output, like in his Symphony, op. 21 (1928), as well.

Another milestone in music spatialization during the first half of the twentieth century is Béla Bartók’s *Music for Strings, Percussion and Celesta* (1936). Even if there is not any offstage instruments in this masterwork, it does present what seems to be “the first detailed plan for performer placement”\(^ {139}\) ever used. Example 5.2 displays Bartók’s instructions in the score about the instrument localization on stage.

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\(^{137}\) Zuckerkandl, *Sound and Symbol*.

\(^{138}\) Ibid., 289.

Why does Bartók choose this layout? One possible answer would be that Bartók was trying to make a stereo image of his work. By using two string orchestras in both sides of the stage, he could produce sounds with similar timbres from the right, left, and center. A center image can be reached if the string groups are perfectly balanced from the center of the stage, if the audience is seated near the center, and if, for example, he uses the violas of both orchestras—or other similar combination of equal timbres, including the tutti, in unison and with the same dynamic. The first movement shows some of the stereo procedures used by the composer.

Example 5.2. Bartók’s onstage spatialization.\textsuperscript{140}

\begin{center}
\begin{tabular}{ccc}
\textbf{Violoncello I} & \textbf{Double Bass I} & \textbf{Double Bass II} \\
\textbf{Viola I} & \textbf{Timpani} & \textbf{Bass Drum} \\
\textbf{Violin II} & \textbf{Side Drums} & \textbf{Cymbals} \\
\textbf{Violin I} & \textbf{Celesta} & \textbf{Xylophone} \\
\textbf{Violin II} & \textbf{Pianoforte} & \textbf{Harp} \\
\end{tabular}
\end{center}

It starts exactly with the center image, by making Violas I and II play the first statement of the fugue subject. They are followed by Violin III and IV, changing the balance through the right, and creating tension in the audience which is now expecting the arrival of a left sound. Bartók, who certainly mastered harmonic techniques, prolongs the tension, making the next entrance for the Violoncellos I and II, and slowing resolving the expectation by setting first the Violin II and than completing the cycle with Violin I. This movement from right to left was seen by Erno Lendvai as an analogy of the movement from the “outer” world (right) through the “inner” one (left) found in both ancient philosophy and modern stereo stages (“sonic stages”).\textsuperscript{141}

Interestingly, at the climax of the movement (m. 56), with the arrival of percussion instruments

\textsuperscript{140} Bartók, \textit{Music for String Instruments}.

\textsuperscript{141} Lendvai, “The Quadrophonic Stage,” 72.
placed in the center of the stage, Bartók transforms the stereo counterpoint into a mono image, making both orchestras play the same material.\textsuperscript{142}

A similar procedure is accomplished in the second movement. In the first part of the movement, the two strings orchestras engage in a wild dialogue, antiphonally playing against one another, contrasting left. However, in the recapitulation (m. 374), Bartók unites again both groups with the same material in unison in order to dialogue with the timpani in the center. The whole piece is full of examples of this technique. In fact:

At its every step, the score of \textit{Music for Strings, Percussion and Celesta} betrays that the composer’s inner hearing was stereo. What is more, Bartók was acquainted with principles which the pioneers of modern stereo recordings did not begin to develop until the early sixties.\textsuperscript{143}

At this point it seems important to say a word about technology. Two major aspects of music related technology seem to be particularly worth citing here, as they started to develop during the first half of the last century: broadcasting and multichannel audio systems. These two technologies initiated the era of music being played by loudspeakers and started to get the music really far from its traditional stages, putting it in movie theatres and private locations.

In fact, the history of broadcasting begins with the invention of the telephone and, mainly, radio during the 19\textsuperscript{th} century. Broadcasting by telephone in 1901 by Thaddeus Cahill’s \textit{Telharmonium} playing Handel’s \textit{Largo} from Washington to Baltimore was an important achievement.\textsuperscript{144} The appearance of the first radio stations during and soon after the World War I, and the birth of television transmissions in the 1930s, completed the emergence of mass media. This made possible the broadcasting of music through a network of thousands, or even millions

\textsuperscript{142} Ibid., 77.

\textsuperscript{143} Ibid. In fact, research in stereo technology started much earlier than the 1960s, as we show later in this text.

\textsuperscript{144} Chadabe, \textit{Electric Sound}, 4.
of loudspeakers situated in the same amount of different locations. Hence, one can include music broadcasting as a latent or ultimate type of what Trochimczyk—speaking about some avant-garde compositions—classified as the spatial design of a “net, consisting of a potentially unlimited number of interconnected nodes, which stands for chaos and complexity, but also for equality and the lack of hierarchy and centralized focus.”

In terms of stereo sound systems, the steps to its development until the 1940s can be outlined as follows:

- 1879 – A. G. Bell’s basic binaural transmission arrangement.
- 1881 – In Paris, Clement Ader demonstrated the first stereophonic sound using earphones.
- 1919 – In San Francisco, P. Jensen and E. L. Pridham are responsible for the first reported example of stereophonic reproduction with speakers.
- 1933 – Bell Telephone Laboratories formal demonstration of the first successful reproduction of moving sound sources.
- 1940 – The Walt Disney’s movie Fantasia marks the first mass public exposure to stereo reproduction of the RCA Fantasound system. Ninety-six small speakers forming a primitive “surround” was used for the Los Angeles premiere.

However, during the first half of the 20th century, almost all the art music reproduced by those technologies was not composed for them. Both broadcasting and multichannel reproductions did not significantly reach art music composition until the end of the World War II, with the advent of concrete and electronic music in Europe, and the magnetic tape movement in the USA. In terms of music spatialization, there are two works by John Cage that are exceptions to that statement.

The first piece is his Imaginary Landscape No. 1 (1939), for records of constant and variable frequency, large Chinese cymbal, and string piano. There is a strong claim to proclaim

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145 Trochimczyk, From Circles to Nets, 50.

this work as the first electroacoustic composition, and it seems to be the first to contain specific instructions in relation to broadcasting. In the beginning of the score, Cage wrote the following:

“This piece is written to be performed in a radio studio. 2 microphones are required. One microphone picks up the performance of players 1+2. The other that of players 3 and 4. The relative dynamics are controlled by an assistant in the control room. The performance may then be broadcasted and/or recorded.”147

The second Cage’s work, *Imaginary Landscape No. 3* (1942), is for six percussion players. The first, fourth, fifth, and sixth players each need a loudspeaker. Even if Cage did not establish any space distribution for the audio equipment, he wrote instructions about where to put them: “place all speakers so that the orchestral sound is localized.”148

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147 Cage, *Imaginary Landscape No. 1*, 2.

148 Cage, John. *Imaginary Landscape No. 3*, ii.
Chapter 6. Spatialization in the Second Half of the 20th Century

After World War II, music spatialization started to occupy a more relevant presence in concert halls. From that point in history until today, the number of composers and performers who were involved with both the compositional and technological areas of sound spatialization grew exponentially. One can find at least four important, different yet interconnected factors that seem to have shaped this wave of interest: the development of multi-channel audio systems, the advent of electroacoustic music, the appearance of the avant-garde movement with its constant search for new and non-traditional musical approaches, and, contradictorily, the presence—as it was showed so far in this survey—of an ancient and not too popular art of musical spatial techniques ready to be developed.

6.1. Spatialization in Acoustic Music

A particular response to both the spatial ideas of *Unanswered* and to the American experimental tradition initiated by Charles Ives can be found in the work of Henry Brant, whom Maria Anna Harley nominated as “the pioneer of spatial music.”149 The spatial element of sound has a great importance in the work of this composer, since spatial compositions occupy more than half of his whole catalog.

His first spatial piece, *Antiphony One* (1953), the symphony orchestra is divided into five separated groups plus an optional voice group and, according to Brant’s notes, “each group situated in a different part of the hall, having its own distinct tempo, meter, and bar-line scheme.”150 Each group also has its own conductor. In this piece, Brant is sharing Ives’s belief that the space should be used to clarify the harmonic, rhythmic, and thematic material.151

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150 Brant, *Antiphony One For Symphony Orchestra*, v.

Moreover, as in Ives’s scores, he is thinking in terms of space separations or spatial layers rather than in specific locations. However, Brant’s score for *Millennium II* (1954) incorporates a diagram showing all performing locations: ten trumpets and ten trombones placed respectively along the right and left walls of the hall; an ensemble on stage; and a voice in the opposite side of the stage.\(^{152}\) Hence, direction and distance sound-space elements in *Millennium II* eventually have a degree of specification never found before in the instrumental-voice Western music tradition. Furthermore, the sound movement dimension is also inserted in this work. According to Brant, “during the various successions of accumulating entrances, the audience, situated inside the continuous walls of brass, experiences a physical sense of the sound traveling around and across the hall in various ways.”\(^{153}\)

In his writings about music spatialization, Brant point out some interesting aspects based in his experience in conducting and composing space related pieces. One can summarize his general theoretical achievements as follows:

1. Spatialization can clarify complex multiple layer textures.
2. Spatialization can clarify polymeter procedures.
3. Spatialization can clarify multiple-tempi procedures.
4. Spatialization can minimize or even eliminate harmonic relationships.
5. Spatialization can enhance contrapuntal distinctness.
6. There is no perfect distribution of ensembles in one ideal hall.
7. Spatialized groups are difficult to coordinate.
8. There is no optimum position for the listener in a spatialized environment.
9. Spatialization transforms the audience in a co-ordinating factor.
10. The effect of distance is not absolute: it is proportionate to the size of the hall.
11. The size of the hall affects more horizontal than vertical distances.
12. Vertical height can create an impression of higher pitch.\(^{154}\)

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\(^{152}\) Ibid., 75-76.

\(^{153}\) Ibid., 78.

\(^{154}\) This list is based on the following three articles: 1) Brant, “Uses of Antiphonal Distribution and Polyphony of Tempi in Composing;” 2) Brant, “Space as an Essential Aspect of Musical Composition;” 3) Harley, “An American in Space: Henry Brant’s ‘Spatial Music’.” One can see them for more details in Brant’s thoughts about music spatialization.
In terms of on-stage spatialization, Elliott Carter’s work follows the tradition started with Bartók and Ives in many of his works, like his *String Quartet No. 2* (1959). The complexity of this work’s textures seem to have made Carter partially endorse Brant’s spatial ideas, as he wrote in the quartet prefatory note: “to bring these differences [tempi and polyrhythmic textures] clearly to the listener’s attention, the performers may be more widely spaced than usual on the stage so that each is definitely separated from the others in space as well as in character, although this is not necessary.”\(^{155}\)

According to Maria Anna Harley, Brant’s ideas about spatialization may have been known also to John Cage and Karlheinz Stockhausen.\(^{156}\) As with any other parameter, space has a kind of philosophical approach in Cage’s conception. Most of his music seeks to put together non-related elements, and the placement of musicians in separated locations is very useful for the intended intentions of independent action for each performer. Coordination between performers is not necessary since the “new music does not need a common meter because it is based on the co-presence of dissimilarities.”\(^{157}\) Having those ideas in consideration, a radical and potentially absolute achievement of Cage’s space ideas can be seen in his piano piece 4′33″ (1952). In this work, since the performer never plays the piano, every sound eventually heard by the audience would come from a location other than the piano on stage. Hence, according to Trochimczyk, the

\(^{155}\) Carter, *String Quartet No. 2*, ii.

\(^{156}\) Harley, “An American in Space: Henry Brant’s ‘Spatial Music’,” 74. Maria Anna Harley does not present any evidence for this statement. Her main argument is that Brant’s 1955 article on music spatialization predates writings on the same issue by Cage and Stockhausen. However, her point of view is partially shared by Robin Maconie, who states that Stockhausen may have consulted Brant’s paper while orchestrating *Gruppen*. (Maconie, *Other Planets: The Music of Karlheinz Stockhausen*, 190.)

\(^{157}\) Maria Anna Harley, “Spatiality of Sound and Stream Segregation in Twentieth Century Instrumental Music,” 150.
composer is “creating a music in which all the environmental sounds are becoming a part of a performing space.”

There are many more examples of music spatialization in Cage’s compositions. For example, if the space is a good tool to clarify complex different layers sounding together, John Cage seems to have another radical approach in relation to this idea. During the second half of the 1960s, he started to experiment with what he called a “circus:” “a multi-media event of simultaneous and independent performances, often presented in non-traditional performance spaces, with a large number of participants, and lasting several hours.” In these multimedia performances Cage seems to have created a new type of music spatialization mobility—that one in which the performers are still and the audience are moving. This inverts the perspective, since now is not only the sound that is spatialized and it is eventually moving—the public is who is moving toward and from the sound sources.

For the first of this pieces or “events” he composed, *Musicircus* (1967), “the spectators are free to wander around and experience various aspects of the whole event, or perceive one of its elements from different aural and visual perspectives.” Moreover, any instructions or scores were given to the performers, making possible for them to play their own music or whatever they like. And that was in fact what happened in the premiere: David Tudor and Gordon Mumma performed their own compositions. One could argue that it would be hard to find potentially more contrasted layers than in this manner. In another of his “musicircus” pieces, *Renga with Apartment House 1776* (1976), Cage put together again two different compositions, now of his

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158 Trochimczyk, interview by author.

159 Fetterman, *John’s Cage’s Theatre Pieces*, 125.

160 Trochimczyk, “From Circles to Nets,” 50.

own. However, besides the fact that Cage used chance to compose both pieces, the instrumental part of *Apartment House 1776* was built based on excerpts of early American composers. The composer also uses “four vocalists representing the Protestant, Sephardic, Native American, and Negro song traditions.”\(^{162}\) Differently from *Musicircus*, and probably because of so contrasting and different cultural backgrounds presented in this musicircus piece, *Renga with Apartment House 1776* does have a specific spatial floorplan for each group of performers: 78 parts for *Renga*; four string quartets, four instrumental soloists, and four vocalists for *Apartment House 1776*.\(^{163}\)

The “avant-garde” scenario did not bring spatial movement only to the audience—performers started moving as well, opening western instrumental music to a tradition common in religion processions. Iannis Xenakis’s sextet *Eonta* (1963), for piano and brass quintet (two trumpets and three trombones), is an example of on-stage music spatialization with mobile performers and static audience. At the beginning of the performance, brass players are put at the bottom of the stage, and then they go near the piano, on the left side of the stage. After that, they are said to walk to the right side and then to come back to the left. Then, they have to go the “zone de promenade” (procession zone) placed at the stage center. Finally they are commanded to walk to the right side and stay there through the end of piece. Xenakis explains all these movements graphically in the instruction page that precedes the score, and he reinforces those commands with written prescriptions through the score as well.\(^{164}\) These changes in location underline the major subdivisions of *Eonta*’s form.

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\(^{162}\) Fetterman, *John’s Cage’s Theatre Pieces*, 143.

\(^{163}\) Ibid., 143-5.

\(^{164}\) Xenakis, Iannis. *Eonta*. 

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A similar spatial approach can be found in George Crumb’s *Echoes of Time and the River: Four Processionals for Orchestra*. However, in this composition mobile performers are greatly intensified, as its title lets us anticipate. The four processionals refer to each set of mobile performers for each of the piece’s four movements. Only percussionists and wind players (brass and woodwinds) are said to move, and Crumb asks wind instrumentalists involved in spatialization, aside from playing their own instruments, to shout some words and also play detached antique cymbals. A “general seating plan” displays detailed graphics and instructions for processionals in each of the four movements. There are spatial directions inside the score as well. Most of spatial instructions refer to where performers have to be on-stage, off-stage (if visible or not), the processional direction (from off-stage to on-stage, or vice-versa), and, of course, the designation of performers involved.165 An arrow attached to the word “processional” is the notation used in the score to inform the performers the beginning of their movement. Some of Crumb’s reasons to his music spatialization are, in a certain way, revealed in the score program notes: “The ‘river of time’ is an ancient metaphor which interprets time as a continuum without beginning or end. I have further implied the concept of continuum by structuring a number of ‘processionals’ into the score.”166

According to James Harley, while making some considerations about those stage directions in *Eonta* mentioned above, in earlier Xenakis’s works “the distribution of glissandi and clouds of sounds across the orchestral strings certainly enhances the ‘spatial’ character of the music.”167 Harley is probably referring to Xenakis’s orchestral works like *Metastaseis* (1954) and *Pithoprakta* (1955-56), whose intricate textures can provoke that on-stage depth sound

165 Crumb, *Echoes of Time and the River*.

166 Ibid. Back of front cover.

spatial perception mentioned earlier here. Talking about the same kind of spatialization in an orchestral work using similar procedures—György Ligeti’s *Lontano* (1967)—Flo Menezes said that Ligeti was trying to build an imaginary space where

the spatiality was suggested by the musical notation capability itself (with no appeal to sound physical mobility or to sound sources differentiated placement/dislocation), here through simple rigorous control of intensities and spectral differences over the same frequency emission by distinct orchestral instruments, factors that could drive the hearing to the assimilation of a kind of spatiality, or at least to perception of depth—acoustical concept inseparable of the spatial factor—in a tridimensional perspective.  

An interesting approach to this kind of on-stage music spatialization was made by Pierre Boulez in his *Rituel* (1974-75). According to the composer’s notes in the score, the orchestra has to be divided in 8 orchestral groups, having the first (I) group one instrument/performer, the second two of them, and so one until the seventh group (VII). The exception in this order is the eighth group (VIII) which has fourteen instrument/performers. To each group from I to VII is added one percussionist playing several percussion instruments; group VIII has two percussionists added. Boulez provides also in his score note page a graphic showing the on-stage locations for each group and its added percussionist. These small ensembles (with its added percussionists) are also grouped throughout the score and identified by their numbers (I-VIII).  

With this spatial arrangements Boulez can make the metric and tempi differences between the ensembles more audible and understandable for both the audience and performers. Interestingly

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168 Menezes, *Atualidade Estética da Música Eletroacústica*, 24. “A espacialidade fosse sugerida por artifícios da própria escritura musical (sem o apelo à mobilidade física dos sons ou ao deslocamento/posicionamento diferenciado das fontes sonoras), aqui através do simples controle rigoroso das intensidades e da diferença espectral na emissão de uma mesma frequência por instrumentos distintos da orquestra, fatores que pudessem induzir a escuta à assimilação de uma certa espacialidade ou ao menos à sensação de profundidade – conceito acústico esse indissolúvel do fator espacial – em perspectiva tridimensional.” (Translated to English by the author.)

here the perception of the sound depth can be appreciated in two manners: for the whole orchestra and for the sophisticated differences in depth between each one of the groups.

Most of the music spatialization cited so far created only a discrete dimension of sound movement, i.e., a stepwise movement based in the exposition of a musical phrase successively through a group of performers distributed in a space. If a composer wanted a continuous form of sound movement, without moving performers or audience, another compositional procedure had to be accomplished. The orchestral technique to produce a continuous movement in sound was obtained for the first time in Stockhausen’s *Gruppen für Drei Orchester* (1955-7).\(^{170}\)

Stockhausen’s score for *Gruppen* indicates three stationary instrumental groups that have to be placed around the audience, each one with its own conductor: Orchestra I on the left, Orchestra II on the center stage, and Orchestra III on the right.\(^{171}\) With this polyorchestral dispersion the composer reaches in some points of the score—like the session starting in the rehearsal no. 119—a real continuous sound movement. At that point of the piece the effect is accomplished because *Gruppen*’s three ensembles are sharing the same pitches, texture, register and timbre (trumpets, horns, and trombones), similar dynamic envelopes, and the orchestras are overlapping each other. The result is a sound that seems to continually rotate in space. Hence, this piece leads with three dimensions in spatialization: distance, direction, and movement. However, Stockhausen uses this effect for just this few measures during the whole piece.

However, that simulation in *Gruppen* was not completely successful. Surrounding the audience with four groups would be a better option, and the next step was achieved by

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\(^{171}\) At the same time Luciano Berio was working in *Allelujah*, a similar piece using six groups of instruments to be put on stage as far apart as possible. After the premiere in Cologne in 1957, Berio withdrew the work and recomposed it as *Allelujah II* (1958), now as five groups of instruments to be arranged around the concert hall. Osmond-Smith, *Berio*, 19. Also in Menezes, *Atualidade Estética da Música Eletroacústica*, 23-4.
Stockhausen in *Carré* (1959-60), for four orchestras and choirs with four conductors.\(^{172}\) In *Gruppen* and *Carré* the composer was doing with instruments what now is a common effect with speakers.\(^{173}\) As Stockhausen had been working in both Paris and Cologne studios in the fifties, he probably had learned during his electroacoustic experiments there the acoustical laws that make possible the illusion of continuous sound movement with stationary sound sources. Luciano Berio was to employ the same sound movement procedure in his *Tempi Concertati* (1958-9), for flute, violin, piano and four chamber groups spatialized on-stage.\(^{174}\)

With Brant’s *Millennium II* and Stockhausen’s *Gruppen* and *Carré*, the most effective spatial techniques used in pure instrumental and vocal music for the three basic dimensions of sound—distance, direction, and movement—were accomplished. The efforts of music creators since biblical times have arrived a great historical moment in which it seems that acoustic music spatialization has finally conquered all the dimensions of sound available from the physical realities of nature. The next step should be a human abstraction: geometry.

The Stockhausen’s placement of four groups surrounding the audience in *Carré* and the music techniques applied to them can make arouse a perception of a geometric pattern: a square. In fact, “a survey of the repertory of spatialized music reveals the continuous hold of geometry on the imaginations of composers.”\(^{175}\) Postwar avant-garde composers started to imagine musical spatial designs from geometric abstraction.\(^{176}\)

\(^{172}\) Harley, “From Point to Sphere,” 135.


\(^{175}\) Maja Trochimczyk, “From Circles to Nets,” 41.

\(^{176}\) Ibid., 40.
The basic topology of musical-spatial designs reflects the straightforward growth of the number of dimensions from zero to three—from point to sphere—from music without spatial characteristics, perceived as if it resounded from a point (i.e., as if it were purely temporal, with a spatial dimension of zero), to the full three-dimensionality of sounds surrounding the listeners from all sides.  

Table 6.1. From point to sphere

<table>
<thead>
<tr>
<th>Geometric pattern</th>
<th>Music examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
<td>Any stationary soloist</td>
</tr>
<tr>
<td>Line segment</td>
<td>Traditional string quartet stage placement</td>
</tr>
<tr>
<td>Two line segments</td>
<td>Antiphonic medieval performances in cathedrals</td>
</tr>
<tr>
<td>Triangle</td>
<td>Stockhausen’s <em>Gruppen</em></td>
</tr>
<tr>
<td>Square</td>
<td>Stockhausen’s <em>Carré</em></td>
</tr>
<tr>
<td>Hexagon</td>
<td>Six percussionists in Xenakis’s <em>Persephassa</em> (1969)</td>
</tr>
<tr>
<td>Circle</td>
<td>Xenakis’s <em>Terretektorth</em> (1965-1966), for orchestra dispersed among the audience</td>
</tr>
<tr>
<td>Cube</td>
<td>Julio Estrada’s <em>Canto Naciente</em> (1975-1978), for eight brass instruments</td>
</tr>
<tr>
<td>Sphere</td>
<td>Stockhausen’s <em>Spiral</em> (1970)*</td>
</tr>
</tbody>
</table>

One could argue that those geometric figures are hardly really heard by the audience, and can be only visually imagined. Its perception could be a pure idealization, a geometric metaphor, depending on a correct disposition of performers, on a correct performance of the music, on the dimensions of the music hall (if one is implied), on the correct positioning of the listeners, etc. Table 6.1 reproduces, with some modifications, Trochimczyk’s table presenting representative musical examples for dimensional geometric patterns. She points out that music pieces containing spatial designs can be motivated by composer’s intention to create or evoke secular mythical, ritual symbolic connotations.  

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177 Ibid., 41.

178 Ibid., 41.

179 *Spiral* is an electroacoustic piece composed by Stockhausen for the spherical pavilion in Osaka World Fair (1970). The inclusion of non pure instrumental/vocal music in this table is a result that, so far, any spherical musical geometric design was accomplished using only performers.

180 Maja Trochimczyk, “From Circles to Nets,” 42.
6.2. Spatialization in Electroacoustic Music

Before going to art electroacoustic music spatialization, let us say a word again about mass media sound technology. A new milestone for audio systems came with the movie *This is Cinerama*, premiered in 1952 in New York City.

Much of the impact came from “point-source” sound: a source traveling across the screen, such as the famous roller coaster, would be heard across all five of the speakers behind the screen; the sound of something occurring in the left panel would issue from the left speaker, at right from the right speaker, etc.; of-screen sound came from “surround” speakers on the left, right, and rear that enveloped the audience. This was the first true stereo in accordance with the famous demonstrations of “auditory perspective” by Bell telephone in the 1930s. 181

In fact, for a variety of reasons, movie theatres sound declined in quality until the arrival of Dolby Stereo releases in the second half of the 1970s, like *Star Wars* (1977). The success of the Dolby-encoded films forced the exhibitors to use better equipment and new speakers, like the “sub-woofers” used to reinforce low frequencies. 182 However, even with the advent of the digital revolution in mass media starting in the 1980s, and in terms of sound space conception, things did not change too much in movie theatres since those achievements in *Fantasia* and *This is Cinerama*. In fact, it seems that the major improvements were in terms of sound quality and technological means to produce sound images of distance, direction, and movement similar to what had already been done during the 1950’s.

All the spatial sound effects in movies, as in opera, are thought as tools to reinforce the drama, and are driven by it. According to David Bordwell and Kristin Thompson, sound in movies can be classified by the space it occupies in two main types: *diegetic* and *nondiegetic*. “The voices of the characters, sounds made by objects in the story, or music coming from instruments in the story space are all diegetic sound. On the other hand there is nondiegetic

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181 Handzo, “Appendix: A Narrative Glossary of Film Sound Technology,” 419.

182 Ibid., 421-424.
sound, which does not come from a source in the story space.”\textsuperscript{183} Examples of the former are the omniscient narrator and the music incorporated to enhance the film’s action. If the diegetic sound comes from within the frame it can be called \textit{on-screen}. Otherwise, if the sound is outside the frame, it can be called \textit{off-screen}.\textsuperscript{184}

Apart from the broadcasting net concept cited earlier in this work, spatial effects reproduced by audio systems started to be present in private homes much later then in the movies. Even with the explosion of public interest for hi-fi equipment in the USA after World War II, a real stereo image did not reach homes nearly universally until the end of the 1950s, when RCA introduced LP and 45 stereo discs in 1958.\textsuperscript{185} The invention of the Quadruphonic Sound (Quad) at the end of the 1960s and early 1970s made surround systems part of the general public living rooms. “The Quadruphonic format consisted of matrix encoding of four channels of information imbedded in a two channel recording that could be retrieved by a normal phono stylus and passed through to a receiver or amplifier with a Quadruphonic decoder.”\textsuperscript{186} The rock band Pink Floyd’s album \textit{Dark Side of the Moon} (1972-3) is an example of a huge phonographic success that used quadruphonic format. With the movie sound decline during this time, “by the early 1970 there was a better sound system in the average American teen-ager’s bedroom than in the neighborhood theater.”\textsuperscript{187}

The outcome of digital technology has consisted of provoking new developments in mass media since the 1980s. One of these developments ended up in the now common spatial multi-

\textsuperscript{183} Bordwell, “Fundamental Aesthetics of Sound in the Cinema,” 192.

\textsuperscript{184} Ibid. This typology can make an interesting parallel with onstage and offstage spatialization.

\textsuperscript{185} Mortin Jr., \textit{Sound Recording}, 139.

\textsuperscript{186} Silva, “The History and Basics of Surround Sound.”

\textsuperscript{187} Handzo, “Appendix: A Narrative Glossary of Film Sound Technology,” 421.
channel “home theatre” systems, in a varied type of surround formats (5.1, 6.1, 7.1, etc.). Hence, spatialized audio systems have reached private homes and other new music stages, like nightclubs, restaurants, and even vehicles. However, in these “non traditional” stages equipped with audio systems, most of the music played was not created to use spatialization as part of the composition process. It seems that the real potential of music spatialization using audio technology was taken by another community: scientists, technicians, and, mainly, instrumentalists and composers engaged in the development of the electroacoustic music.

The principles of spatialization in electroacoustic music emerged in conjunction with the first studios and their attached composers and aesthetics that appeared worldwide after World War II. The Paris studio at the Radiodiffusion Télévision Française (RTF), named initially as Club d’Essai in 1946 by its pioneer Pierre Schaeffer (1910-1995), was responsible for developing an aesthetic known as musique concrète. Its basic principle was the music development of exclusive “concrete” recorded sounds of the “real” environment: instruments, machine noises, nature, etc. In 5 October 1948 RTF transmitted the historic Concert à bruits, a broadcast of Schaeffer’s early electroacoustic works named Cinq études de bruits (Five Noise Studies). This event is considered the first public presentation of an electroacoustic concert.

Public radio broadcasting is intended to be heard by thousands or even millions of personal radio receivers, with their respective loudspeakers. Hence, in a sense, radio, television, or Internet broadcastings can be considered a monumental net sound spatialization. Having this concept in mind, the RTF transmission of Schaeffer’s pieces can be thought as landmark in the history of electroacoustic music spatialization.

In 1951 the RTF provided Schaeffer with a new studio with tape recorders and other facilities. One of these facilities was a special version of a tape recorder named the Morphophone, which was able to create a type of reverberation. Consequently, the Paris studio was able to manipulate the distance aspect of sound space.
With the new tape recorders, Schaeffer and his co-researcher and composer Pierre Henry were able to record in four or five sound tracks. Concerned with problems of sound distribution, the studio engineer, Jacques Poullin, developed the *potentiomètre d’espace*, a sound projector aid that allowed the Paris group to experiment with performance diffusion of recorded sounds through four loudspeakers.\(^{188}\) According to Peter Manning, a frequent set up had two of these four loudspeakers positioned at the front in either sides of the stage, the third in the center of the ceiling and a fourth in the back wall.\(^{189}\) This array with a ceiling loudspeaker “made it possible to create illusions of vertical as well as horizontal movements, adding an extra spatial dimension to the diffusion of sound.”\(^{190}\) Hence, in 1951, the RTF studio was able to control, albeit crudely, the recording and projecting of the three main aspects of spatialization systems: direction (azimuth and zenith), distance, and velocity. The usage of the *potentiomètre d’espace* was also making possible the birth of a new performance practice: the diffusion of sounds through loudspeakers in real time.

A great number of composers worked in the Paris studio in the early fifties and an even larger number of works were created using the RTF facilities. Apart from Schaeffer and Henry’s pieces, electroacoustic works of, for example, Pierre Boulez, Olivier Messiaen, Karlheinz Stockhausen, Darius Milhaud, and Edgard Varèse emerged in the Paris studio during that time. Varèse’s landmark *Déserts* was one of these works.

*Déserts* was the first piece by the now many call “the father of electronic music” to use recorded sounds. It was the piece that broke with Varèse’s almost twenty years of silence. Intended initially to be a multimedia work, with a presence of film, lights, and chorus, the piece


\(^{189}\) Ibid., 26  
\(^{190}\) Ibid.
ended up for 14 winds, piano, five percussionists, with three interpolations of tape music. After completing the first tape interpolation and starting the second in New York, the composer finished the second and third interpolations with the assistance of Pierre Schaeffer’s studio in Paris. \(^{191}\) The composition was premiered in Paris on 2 December 1954. The performance, transmitted live, was part of the “first stereophonic broadcast in French radio history.” \(^{192}\) In terms of spatialization, there is only one general instruction given by Varèse’s score inside the instrumentation page: “2 Magnetic Tapes of electronically organized sounds transmitted on 2 channels by means of a stereophonic system.” \(^{193}\)

Almost at the same time, starting in late 1951 in Germany, a group formed initially by the phoneticist and linguist Werner Meyer-Eppler, the scientist Robert Beyer, the composer Herbert Eimert, and soon later incorporating Bruno Maderna and Stockhausen, formed the Cologne studio of the Westdeutscher Rundfunk (WDR). The aesthetic of this group was, at that moment, in total opposition to the concrete music of Paris. The so-called *elektronische Musik* (electronic music) basically used only synthesized sounds and a composition thought structured in the Second Viennese School.

The studio pursued a multi-channel loudspeaker system, using in its early years a three-channel sound projection setup with two speakers in the front corners of the studio and a third at the middle point of the back wall. \(^{194}\) For reverberation, the Cologne studio used initially an acoustic chamber: a room with a loudspeaker to project the sounds and a microphone to capture


\(^{192}\) Ibid., 557.

\(^{193}\) Varèse, *Déserts*, ii.

the resultant response. For technical and esthetical reasons, the diffusion was not centered in a performance device like the potentiomètre d’espace. Consequently, spatialization at the Cologne studio used only azimuth, distance, and velocity dimensions of spatialization.

In 1951, in New York, a group was gathered around John Cage in order to investigate the new music possibilities brought by electronic technology. Cage, the engineers Louis and Bebe Baron, the composers David Tudor (also a virtuoso pianist), Earle Brown, Morton Feldman, and Christian Wolf developed an avant-garde movement known as “Music for Magnetic Tape.” The new movement explored techniques of the Paris school an also, in some extent, from Cologne. In spite of their friendly commitment, their musical aims were rather different and the whole project was over in 1953. However, it was during the existence of this movement that John Cage created the first octophonic surround-sound composition: Williams Mix, the title referring to the architect Paul Williams who funded the New York tape project.

Based on musique concrète techniques, Williams Mix material included six hundred sound recordings. Cage used his “I Ching” chance operations in several decisions during the composition process, including where among any of eight tracks the recordings were to be placed. This process resulted in an eight layer graphic “score,” consisting of same-sized images of the tape on paper. In the explanatory text of what seems to be the first manuscript representing a multi-channel work, Cage wrote:

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195 Ibid., 57.

196 Manning, Electronic and Computer Music, 74-5.

197 Austin, “John Cage’s Williams Mix,” 189.

198 Chadabe, Electric Sound, 56.

199 Fetterman, John’s Cage’s Theatre Pieces, 29.
This is a score for the making of music for magnetic tape. Each page has 2 ‘systems’ comprising 8 lines each. These 8 lines are 8 tracks of tape and they are pictured full-size, so that the score constitutes a pattern for the cutting of tape and its splicing.200

Since at the time of the premiere—at the University of Illinois School of Music in March 22, 1953—there was no mixing desk available or even an eight-channel tape recorder, the piece was diffused, as Earle Brown reported, using eight mono tape recorders on stage feeding “eight loudspeakers equidistantly spaced around the auditorium.”201 One can imagine the difficulties of sound synchronization with this now rudimentary equipment.

Ernst Krenek’s *Pfingstoratorium: Spiritus Intelligentiae Sanctus* (1955) is a work produced at the WDR’s studios in Cologne mixing concrete sounds, electronic elements, and two vocal soloists (soprano and tenor). According to Menezes, this composition broke with the purism of the German *elektronische Musik* movement, and also inaugurated stereophony in the German electroacoustic production.202 However, it was in the WDR’s studios that Stockhausen composed a work that has been recognized as the first masterpiece of electroacoustic spatialization technique and its initial milestone: *Gesang der Jünglinge* (1955-56).

The piece was first presented on May 30 1956 in the large broadcasting studio of the WDR. It was composed for a group of five loudspeakers (or five groups of loudspeakers) that were to be spatialized around the audience. In *Gesang der Jünglinge*, Stockhausen “attempted to form the direction and movement of sound in space, and to make them accessible as a new dimension for musical experience.” 203 Commenting about the first performance, he wrote:

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200 Austin, “John Cage’s Williams Mix,” 197. According to Austin, the manuscript is housed in a branch of the New York City Public Library. One can see excerpts of the manuscript in this Austin article and also in Pritchett, *The Music of John Cage*, 91.

201 Chadabe, *Electric Sound*, 57.


203 Stockhausen, “Music in Space.” 68.
The 5th channel was played back on a mono recorder which was started synchronously (by hand) with a 4-track tape recorder. Originally, this 5th channel should have been played back above the listeners over a loudspeaker hung at the [center] of the ceiling. However, even at the world premiere this was not possible, and the loudspeaker for the 5th track stood at the front, in the middle of the stage. The [synchronization] of the two tape recorders was unsatisfactory, so I decided after the word premiere to [synchronize] the 5th track onto the 4th track. Since then, GESANG DER JÜNGLINGE has been projected 4-track.” 204

According to him, the spatial projection of this piece is a necessary correspondence of its polyphonic structural conception.205 In his article Music in Space, speaking about his imagined circle of locations surrounding an audience, Stockhausen argues that “one would thus obtain the scale of localities corresponding to the scales of pitch, duration, timbre and tone-loudness.”206 Space was no more only a performance tradition in a medieval or renascence cathedral liturgy, or even an allusion of distance in an opera or in a romantic orchestral piece. Space now acquires, for him and for music, a status of a musical parameter that plays a role in the composition process. As a parameter, it could be treated equally in a serial structure.

In spite of the existence of a very good book of sketches,207 the composer did not provide any score for this work, as this is the tradition for tape alone pieces. If Stockhausen was using in Gesang der Jünglinge a strict serialization of space, it is a conclusion that only a closer analysis of the piece could verify. “Exactly how Stockhausen applied serial techniques to the music’s distribution among the loudspeakers is an extremely complicated matter that scholars have only recently begun to unravel.”208 However, the fact that he gave up the vertical dimension proposed during his own compositional process during the world premiere of his piece, gives reasons to

205 Ibid., 146.
206 Stockhausen, “Music in Space,” 82.
207 Stockhausen, Gesang der Jünglinge.
208 Smalley, Gesang der Jünglinge, 10.
speculate that he was perhaps thinking here more in space layers than in specific locations in a space hall.

Since Gesang used spatialized electroacoustic material derived from both pure electronic sounds and a recorded voice performance, it seems natural that Stockhausen’s next step should be an experiment with a mix of spatialized electroacoustic and live performance sounds. That was accomplished in Kontakte (1960).

In fact, Stockhausen’s Kontakte can be presented in two different manners, each one with its own score. For the first version—tape alone—Stockhausen wrote the “realization score,” where the production of the 4-track tape is meticulously described. For the second version—tape and two live performers (piano and percussion)—exists the “performance score.” 209 According to instructions at the beginning of the performance score, the tape part can be played both in 2-or 4-track, and the playback of the 4-track tape should be done “over four groups of loudspeakers (at left, front, right and behind).” 210 Stockhausen does not specify here if left and right mean front or side locations. Any way, this information contradicts the spatial design provided by him in the booklet of his compact discs complete edition. In this source the composer prescribes a quad circle disposition of loudspeakers: rear left, front left, front right, rear right. 211 This discrepancy could be another argument in favor of a Stockhausen’s layer thinking instead of specific locations. Nevertheless, the spatial notation used in the performance score can be seen in Table 6.2.

In terms of distribution on each channel (track), Cage’s Williams Mix score is more complete and clear. However, Cage did not employ sound movement between the speakers, he

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209 Both versions are found in Stockhausen, Nr. 12 Kontake. Realisationpartitur.

210 Stockhausen, Nr. 12 Kontake. Aufführungspartitur, III.

was not notating the sounds but a guide to cut and splicing, and he did not have to synchronize electroacoustic sounds with a live performers score. These arguments make Stockhausen’s Kontakte signs for moving electroacoustic sounds a new and important achievement for music spatialization notation. A sample of Stockhausen’s spatial writing in Kontakte score is shown in Example 6.1.

Table 6.2. Kontakte spatial notation

<table>
<thead>
<tr>
<th>Notation signs</th>
<th>Sounds location</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>From left speaker</td>
</tr>
<tr>
<td>II</td>
<td>From front speaker</td>
</tr>
<tr>
<td>III</td>
<td>From right speaker</td>
</tr>
<tr>
<td>IV</td>
<td>Speaker from behind</td>
</tr>
<tr>
<td>I/III</td>
<td>From left and right speakers</td>
</tr>
<tr>
<td>Alternierend</td>
<td>Continuous alternation between the indicated speakers</td>
</tr>
<tr>
<td>Rotation</td>
<td>Rotate to the right or left with the indicated speed</td>
</tr>
<tr>
<td>Flutklang</td>
<td>From one loudspeaker, and then immediately from another</td>
</tr>
<tr>
<td></td>
<td>(like flooding through the hall)</td>
</tr>
<tr>
<td>Schleifen</td>
<td>Rotating movement in the form of a loop</td>
</tr>
</tbody>
</table>

Example 6.1. An excerpt of Stockhausen’s spatial notation in Kontakte

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212 Extracted from Stockhausen, Nr. 12 Kontakte. Aufführungspartitur, III.
In 1968, during the Darmstadt composition course directed by Stockhausen, the author of Gesang coordinated and planned a collective composition created by the participants of his studio. The result was called Musik für ein Haus (Music for a house), and was set up to a chamber orchestra distributed in four rooms of a two-floor lodge on the Darmstadt state. The performance event resembles Cage’s musicircus, with stationary performers and moving audience. It is well described by Wörner:

Their [instrumentalists’] improvisations were now picked up by microphones in each room, fed to a mixing desk, partly distorted by electronic means, then played back again on the loudspeakers of the other rooms, so that amongst the musicians themselves there was constantly an experience of reciprocal stimulation. The public had the opportunity to move around freely in the rooms. Listening was intuitive, freed from the pursuit of interrelations. A fifth chamber provided the opportunity of listening simultaneously to the musical processes occurring in all four rooms.213

During the 1970s Stockhausen composed what seems to be his most ambitious work to date. Intended to be part of the United States bicentennial commemorations in 1976, Sirius (1975-77) was premiered in Washington in July, 1977. For this long piece (96’), Stockhausen prescribes that the audience has to be seated in concentric circles facing the sound projectionist at the mixer in the center. Four soloists (representing four flying saucers) and eight loudspeakers, placed in platforms, surround the audience. The soloists, resembling Berlioz’s Requiem Mass, are asked to be located at the four compass of the external circle as being North (bass voice), East (trumpet), South (soprano voice), and West (bass clarinet). By electronic means, the composer uses in this work a technique of compressing and speeding up melodic samples in a manner that can result in new rhythms and timbres.214 In terms of spatialization—apart from the techniques already used already in former pieces with similar set up—by rotating sounds in some

213 Wörner, Stockhausen: Life and Work, 170-1.

214 Manion, “From Tape Loop to MIDI.”
places of the piece at “strobe-speeds” (in excess of ca. ten revolutions per-second),

Stockhausen seems to be trying to accomplish a similar effect as when altering the speed of samples: to alter the perception of timbre and rhythm by using fast sound space revolution.

Carter’s claim to spare the performers of his quartet further apart than usual, and the Romantic expressive usage of “distant singing” as well, were brought to a new and radical approach in Stockhausen’s *Helikopter-Streichquartett* (Helicopter String Quartet) of 1993. The piece was composed as the Scene III of *Mittwoch aus Licht* (Wednesday from Light), one of the operas of his seven-day *Licht* cycle. The four members of a string quartet are each put inside a particular helicopter. The helicopters have to fly around and above the theater where the audience faces the stage with a line of four columns of speakers and TV monitors showing sound and image that are transmitted from each one of the helicopters. Hence, the music heard inside the theatre is via a just stereo image. The novelty seems to be Stockhausen’s irony in dealing with performer’s separation and distance.

As Robin Maconie points out, one can find two interesting links uniting Stockhausen’s *Carré, Kontakte, Sirius*, and *Helikopter-Streichquartett*. The first is the number of four locations, partly limited by technology: “four helicopters, four flying saucers in *Sirius*, four channels in *Kontakte*, four orchestras in *Carré*.” The second is the composer’s experiments with rotating sound in these pieces.

After those first accomplishments by Cologne and Paris Studios symbolized by the compositional achievements in Stockhausen’s *Gesang*, the natural next step should be the search

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215 Ibid.


218 Ibid.
for special public rooms for electroacoustic music. A kind of “prepared hall,” with loudspeaker systems specially designed that could guarantee, support, and create a performance tradition for the new ideas in spatialization that were in the electroacoustic composers minds in the sixties, and even before.

New halls for listening must be built to meet with demands of spatial music. My idea would be to have a spherical chamber, fitted all round with loudspeakers. In the middle of this spherical chamber, a platform, transparent to both light and sound, would be hung for the listeners. They could hear music, composed for such adapted halls, coming from above, from below and from all directions. The platform could be reached by a gangway.219

Two years after Gesang was premiered, the World’s Fair in Brussels opened to the public on 2 May 1958 presenting between its attractions a particular one that would be the first answer to this claim. The electronic firm of Philips, one of the participants of the event, in 1956 hired the architect Le Corbusier to prepare the design of its pavilion. He and Xenakis modeled the building for the Philips Pavilion with a diffusion system that included 350 loudspeakers, and invited Edgard Varèse to provide the music. The resulting eight minute tape piece was Varèse’s *Poème Électronique*.220 It was projected in “a three channel tape system, distributed across eleven different groups of loudspeakers, positioned in the ceiling alcoves and the walls. Visual effects, associated with the movement of sounds, were created by means of a comprehensive lighting system, which produced changing patterns of colored images.”221 The technician assistants, who had worked with Varèse in the spatialization of his piece, named the sound system as “sound routes” (*routes de son*), because “the individual loudspeakers switched on and off successively in

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220 Xenakis’s *Concret P.H.* was also presented in the Philips Pavilion.

such a way that the sound-source would describe, as it were, set paths.”

With the exception of the loudspeakers, the entire electroacoustic control installation was duplicated to ensure some twenty continuous performances daily, totaling thousands of presentations for around two million people from all over the world over the course of the exhibition. In October of the same year the Brussels World Fair closed its doors and, unfortunately, soon after that the Phillips Pavilion was pulled down.

Stockhausen had the chance to realize the hall he imagined in the reference above in another World Fair: Osaka, 1970. The spherical hall constructed in the Western German section had 50 speakers “all around: seven circles from bottom to top, three below and four above the platform, arranged in ten vertical rows around the audience. A sound source, a singer, player or tape recording, could be sent to any point in this pattern of speakers.” With the spherical hall mixing desk, one could rotate the sound “by hand at speeds up to about five revolutions per second, in any direction.” The result could be an improvised or predetermined free spatial composition. *Spiral*, for soloist and short-wave receiver (1968), *Pole*, for two players and two short-wave receivers (1969-70), and *Expo*, for 3 players and 3 short-wave receivers (1969-70), were live electronic Stockhausen pieces that were presented every day for six and a half hours during 183 days in the Osaka World Fair. The spherical hall building was destroyed afterwards.

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225 Ibid.

226 Ibid., 104.
What Stockhausen and his assistants were doing with the mixing desk controls in Osaka was part of a spatial performance art that has been developed since the fifties in electroacoustic music: the diffusion of sound in concert. “Within the electroacoustic community, diffusion means more than simply utilizing multiple loudspeakers to distribute the audio around the hall; it also implies an active role in the performance by someone at the mixing board – that is, creating a dynamic multi-channel mix from a stereo source tape.”

The tradition of live diffusion and performance inspired the builders of one of the first permanent loudspeaker installations: the *Gmebaphone*, developed by Christian Clozier and Françoise Barrière at the Groupe de Musique Expérimental de Bourges (GMEB), in France. The Gmebaphone is a loudspeaker orchestra and other processing capabilities destined to process/simulate sonic electroacoustic space, as well as polyphonically synthesize the acoustic music space. The first version of the Gmebaphone premiered during the 3rd International Festival of Experimental Music in Bourges in June 1973. In spite of the permanence of the installation, the loudspeaker system is a “quasi-fixed installation,” since the diffusion performer has a certain freedom to set up the loudspeaker locations in the hall.

One year later another permanent quasi-fixed installation facility was available in Paris. In 1974, François Bayle and the Groupe de Recherches Musicales (GRM), direct successors of Pierre Schaeffer and the concrete music, created the *Acousmonium*: “a concert hall sound projection system allowing the diffusion of sound using up to forty-eight channels, distributed

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227 Pinkston, email message to author. Jon Nelson also shares this concept as diffusion being a performance practice. (Jon Nelson, email to author.)


across eighty loudspeakers.”\textsuperscript{231} The Acousmonium was intended to perform specifically tape music. Its name is a consequence of an electroacoustic aesthetic known as \textit{acousmatic music} in which the audience has to perceive “the music without seeing the sources or causes of the sounds.”\textsuperscript{232} Because of the lack of visual interest for the listeners, this Pythagorean\textsuperscript{233} musical thought that postulated the abolition of the interpreter did not evolve. In the Acousmonium, however, the audience is able to visualize the “diffusionist” and recognize a performer in the mixing desk. In Bayle’s view, spatialization was an opportunity to show the internal structure of sound, what he called the \textit{morpho-concept}.\textsuperscript{234}

As a consequence of these first “prepared halls” described above and the developments and researches in acoustic, electronic, computer music and digital audio since the fifties, other permanent quasi-fixed and non-fixed spatialization halls and systems started to appear worldwide. Some of the important halls created are the \textit{Espace de projection}, the concert hall of IRCAM (Institut de Recherche et Coordination Acoustique/Musique), directed by Pierre Boulez (Paris, 1978); and the BEAST (Birmingham ElectroAcoustic Sound Theatre), by Jonty Harrison (United Kingdom, 1982). The surround and the tri-dimensional B-format/Ambisonic systems are examples of important developments in spatialization after the seventies.

One masterwork that was born in one of these institutions cited above, IRCAM, was Boulez’s \textit{Répons} (1981-1988). The piece is scored for six soloists, a chamber instrumental ensemble, and electroacoustic devices diffusing sound through six loudspeakers. The spatial

\textsuperscript{231} Manning, \textit{Electronic and Computer Music}, 396.

\textsuperscript{232} Emmerson, “Electro-acoustic music,” 61.

\textsuperscript{233} “The word ‘acousmatic’ refers to the \textit{akusmatikoi}, pupils of Pythagoras who, so that they might better concentrate on his teachings, were required to sit in absolute silence while they listened to their master speak, hidden from view behind a screen.” (Emmerson and Smalley, “Electro-acoustic music,” 61).

\textsuperscript{234} Chadabe, \textit{Electric Sound}, 68.
layout for this work resembles Stockhausen’s *Sirius* and an earlier Boulez composition, *Poésie pour Pouvoir* (1958), for three orchestral groups and a five-track tape. From the former, one can find the similar notion of concentric circles (that could be squares in *Répons*) facing a center, with the audience between the center and the external circle. From the later, the parallel is based on the fact that *Répons* has also an ensemble in the center and loudspeakers on the hall walls. Besides that, there are two more parallels between the two Boulez works: in both pieces there are electroacoustically transformed soloist materials and synthetic electroacoustic sound. However, a fundamental difference exists—in *Répons*, the instrumental sounds from the six soloists in the external circle are processed digitally in real time and diffused through six loudspeakers (Example 6.2).\(^{235}\)

Example 6.2. Boulez’s spatialization in *Répons*.\(^{236}\)

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\(^{235}\) Häuser, “Pierre Boulez on *Répons*.”

\(^{236}\) Example based on graphics present in Häuser, “Pierre Boulez on *Répons*,” and Trochimczyk, “From Circles to Nets,” 54.
As a general compositional procedure in this work, microphones collect the soloist material (arpeggio chords) that are manipulated in terms of frequency, timbre and rhythm (mostly delays) by the electroacoustic devices at the center which then make the processed material travel from one loudspeaker to the other. The velocity of this travel depends on the dynamic of each instrument: the louder the instrument plays, the faster the sound travels.\footnote{Gerzo, “L’ordinateur et l’écriture musicale,” 76-8.}

The title Répons is a reference to the plainchant responsorial and antiphonal manner of singing dialogues. One can perceive all kinds of dialogues during Répons performance: between the soloists and the ensemble; between a soloist and the others; between transformed passages and non-transformed passages.\footnote{Ibid., 76.} In Boulez’s own words:

Thus one hears the chord very clear in the center by the chamber orchestra; and if the soloists step out in a certain way, the chord also sounds over the loudspeakers in the synthetic music from the periphery: as “Répons,” as in “Responsories,” a kind of antiphonal music with the chord in the center.\footnote{Häuser, “Pierre Boulez on Répons.”}
Chapter 7. Conclusion

Over the last two decades of the 20th century, music spatialization became a very common parameter in electroacoustical compositions and in some acoustic compositions as well. Its presence is so ubiquitous that searching for spatialized pieces in this late repertoire would be like searching for tonal compositions in the 19th century.

Today, electroacoustic composers are not only using spatialization in studio, but also in performance. In the electroacoustic field, Stephen D. Beck affirms “that there are as many diffusion strategies for the performance of electroacoustic music as there are composers of electroacoustic music.”240 As an example, I could cite my composition Diamundo, for Strings, Winds, Percussion, and Loudspeakers (the music spatialization of this piece is shown in the first part of this dissertation) as well as Ecoando, for Violoncello and Kyma (2006), an eight-channel surround composition of mine premiered by Dennis Parker at the LSU School of Music’s Recital Hall in February 24, 2007.

The later piece’s name is the Portuguese for “echoing.” As the title can suggest, the idea of Ecoando is to bring back the materials of what the cellist is playing, as if they are echoes. In order to accomplish that, the Kyma system241 records and processes live excerpts from the performance and sends the result through the speakers. In fact, the cellist is in a dialog with himself, since the musical procedure resembles points of imitations, which, in consequence, creates multiple polyphonic textures.

In terms of spatialization, I use two main procedures. The first resembles a technique used in Boulez’s Répons that links space with the instrument dynamics. The difference in Ecoando is that the louder the instrument plays, the farther from the violoncello the sound travels.

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241 See page ix, Instrumentation, for a brief definition of the Kyma system.
(the cellist is on stage, in the middle of the front speakers of an eight-channel surround array, in a "double diamond" setup). The second procedure links time with space. The sounds of the eight live excerpts recorded from the cello are manipulated and sent by the Kyma system to “travel” through the speakers. Each one of these excerpts makes a different “speaker trip” and eventually stops by a specific speaker location, as transformed echoes. Hence, one could say that, in *Ecoando*, the distance in time encounters the distance in space.

The wealth of compositions that embrace sound spatialization have benefited from significant research in acoustics, psychoacoustics, audio systems, and sound diffusion. An important new field of experiments deals with three-dimensional sound spatialization. Nowadays, two major research areas related to these new techniques are Head-Related Transfer Functions (HRTFs) and Ambisonics. According to Corey Cheng and Gregory Wakefield, intuitively, HRTFs are simply filters that mimic the acoustic filtering of the head, torso, and pinna and operate on free-field sounds much as graphic equalizers operate on recorded sounds . . . . Different HRTFs corresponding to different spatial locations can be described by different equalizer settings. HRTFs are useful because they can be used to filter a monaural sound into a binaural, stereo sound which will sound as though it originates from a prescribed spatial location.²⁴²

In respect to Ambisonics, it is worth quoting Ambrose Field:

Ambisonics is essentially a recording format which is very useful to composers, as you can encode spatial information in a form that’s not directly related to the number of speakers that you have in the concert hall or their positions . . . . You can do this with studio techniques or use recordings made with an ambisonic microphone. . . . That information is encoded in a very simple format using four parameters: $x$ (front-back), $y$ (sides), $z$ (up-down), and $w$ (omnidirectional). These signals effectively give a position vector for all sounds in a sound field. So, all the electronics have to do at performance time is to unscramble [decode] this and send it to the appropriate speakers. As a composer, I can be assured that my piece is portable. It enables me to have some consistency in making spatial works, knowing that I can be guaranteed the spatial result that I heard in the studio. That’s the main advantage of the ambisonics technique.²⁴³

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²⁴³ Austin, “Sound Diffusion in Composition and Performance Practice II,” 22-23.
An example of research dealing with sound spatialization, including ambisonics, is the work of Beck and associates at the CCT Laboratory for Creative Arts & Technologies (LCAT), LSU. There, he is leading a project using a computer-controlled loudspeaker environment named Immersive Computer-controlled Audio Sound Theater (ICAST). The objective of the project is to enable simultaneously (during the same electroacoustic concert) various modes of sound diffusion performances, without the need to change the cable configuration or the speaker setup.

At the end of this survey, one could say that the practice of spatialization in music is a very old one. As with any of the other musical parameters, spatialization evolved slowly from ancient times through a certain historic moment when it was definitely incorporated in the music tradition. With the dynamic parameter, for example, that point was Beethoven’s time. With spatialization, as we believe this research has proved, composers from the avant-garde and electroacoustic movement after World War II were the main channels through whom spatialization acquired its independence and final place among the basic tools of music composition and performance.

This evolution started as an unconscious procedure of religious and folk manifestations of antiquity, mainly the very old tradition of antiphonal and responsorial singing. In the Middle Ages, in the plainchant notation development, it became a quasi-latent process. Music spatialization evolved to a latent expression from the invention of polyphony during the last centuries of the medieval era and the Renaissance, culminating in the cori spezzati in Venice.

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244 CCT is the Center for Computation & Technology.

245 Beck, “The Immersive Computer-controlled Audio Sound Theater,” 1. “ICAST is a hardware and software solution, based on a client-server computer control system, commodity audio interface hardware, and high-quality audio amplifiers and loudspeakers.” Ibid.

246 Ibid., 2.
With the advent of opera, some hints of the treatment of space began to appear here and there in scores as the “distant singing” technique. Thanks to composers like Berlioz, “distant singing” slowly migrated from opera to the symphonic repertoire of the 19th century. At the opening of the twentieth century, notations of music spatialization appeared in works of composers like Ives, Bartók, Varèse, and Cage. Spatialization finally became a common element, as we said above, in the works of composers of the avant-garde and electroacoustic movements in the 1950s, to become a normal and omnipresent procedure at the end of the century.

Composers of electroacoustic music were responsible for the birth of a new musical approach to spatialization: sound diffusion. Sound diffusion can refer to three distinct concepts: one is related to the manner of distribution of speakers in the concert hall or environment; the second is the fixed spatial approach of diffusion present in an electroacoustic composition; the third is the completely new performance aspect of distributing sound in real time that created a new interpreter: the diffusionist.

Each one of these evolutions in notation and technique deserves its own more detailed examination. Research on each period, composer, or spatial procedure will clarify some details that were beyond the scope of this survey.

Music spatialization evolved from a simple result of antiphony and responsories traditions to religious and folk grandiloquent manifestations as in cori spezzati; from a metaphor of romantic addiction to past and distance, as in Mahler’s symphonies; passing as a tool to underline the music form, as in Bartók; as a meaning to clarify texture, as in Henry Brant’s music; or as an emancipated (probable serialized) musical parameter in Stockhausen’s Gesang der Jünglinge. Music spatialization has been transformed by history such that it became a primary feature of Boulez’s Répons.

Recent advances in three-dimensional recording and reproduction of sound signals seem to point to the next probable evolution in musical space. One speculation could be reached in
respect to the incorporation of sound movement in music: differentiating between sound movement and space movement. *Space* seems to be moving in pieces where the changes in direction are discrete—as in some instrumental compositions using mainly the space as a dialogue between places in the hall or on-stage (Ives’s *The Unanswered Question* and Cage’s *Williams Mix*, for example). Otherwise, *sound* is what seems to move in moments like Stockhausen’s *Gruppen* described in Chapter 6, and in many electroacoustic works using the illusion of continuous sound movement as well.

Another probable evolution in music spatialization will arise from private home usage of all these technologies. Home audio theatres are now inexpensive and abundant. That along with the improvement and proliferation of personal computers and commercial digital loudspeaker systems over the last two decades has made listening to sound diffusion, whether in music or cinema, a common experience. Paraphrasing Manning’s words, the real challenges seem to be now, as ever, in the artistic domain.²⁴⁷

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Amaro Borges Moreira Filho was born in Porto Alegre, Rio Grande do Sul, Brazil. He received his Bachelor of Music degree from Rio Grande do Sul Federal University (1993) and his Master of Music degree from Bahia Federal University (1996). His major professors were Jean Jacques Pagnot and Gretchen Miller (violoncello), Armando Albuquerque, Celso Loureiro Chaves, Jamary Oliveira, Dinos Constantinides, and Stephen D. Beck (composition).

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