Hansen:
Integrating Interactive, Generative, and Algorithmic Approaches for Game Music

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Contents

Abstract

Interactive music composition practice is constantly pushing boundaries, both technical and aesthetically, with the purpose of achieving variety in sound and more complex immersive experiences. Many systems and techniques have been developed through experimentation in the academic environment of avantgarde and contemporary concert music. The implementation of such methods in the video games industry have been rather challenging due to the technical boundaries of today's commercial hardware and software capabilities. Also the aesthetic limitations of music serving a specific storyline, genre, style and audiovisual content.

This project aims to develop different approaches for music composition of interactive music, that may become useful for creating original soundtracks with efficient methods of implementation and high variety of musical content. The methodologies include multi modal harmonizations of a sole melodic line, traditional variations schemes applied into multilayer composition systems, incorporation of sound design elements into a hybrid music composition and algorithmic composition based on probabilities. The results of these main ideas and experimentation are shaped into the original score composed for a psychological thriller video game based on true historic events.

Acknowledgements

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Also I would like to thank my wife, family and friends for all the encouragement and support.

Chapter 1. Introduction

Interactive audio in video games is constantly developing non-linear musical structures that are both immersive and responsive to player's choices and storylines. As in many other audiovisual fields, the film music industry has served as a beacon in terms of aesthetics and audio production. Marks (2008) suggests the possibility that 'Eventually, video games will be more like interactive movies where the psychological effects of music and sound will be dominant.' Even though the influence of film music will always be there, adaptation in musical structures for interactive platforms requires further research and development.

Finding new methods of composition, based on classical and film music heritage, that suits efficiently the interactive platforms and middleware, is a challenging task that this thesis aims to approach.

Many algorithmic compositional systems have been structured following the *Macrov chain*[1] principles, adapting its functions into the musical language. Ames (1989) proposes a series of examples based on interpretations of the *Macrov chain*, that have served as guidelines for research and implementation of computer generated music. Assigning percentages to musical parameters such as duration, articulations and pitches, and setting a list of commands to generate sounds based on these probabilities are the basis of such algorithmic composition systems that can generate a unique piece or fragment of music, consistent to a style and yet different every time is played.

[1]Mathematical theory by Andrei Markov defined as 'A stochastic model describing a sequence of possible events in which the probability of each event depends only on the state attained in the previous event.' Lexico, 2020

Aiming to create an original score that is immersive, fitting the context of the story and that can be implemented into a specific game, this research is to develop new methods of algorithmic and interactive composition. Setting the ground rules based on specific musical styles and genres according to the storyline, is an approach to be tested through the whole project.

If these methods prove functionality in the project, it might be possible to use them as a frame reference and apply the same principles into other storylines with different background. Furthermore, the project might discover ways of designing processes and methodologies for algorithmic and interactive composition based on common musical parameters despite their style and precedence.

1.1 Project Description

The project aims to develop compositional techniques and production methods for interactive music soundtracks to be tested and implemented in a psychological thriller video game with a story line based on historic events. Music will be composed, produced and integrated to the audiovisual content. The written thesis will be a documentation of the research, methodology, tests and conclusions derived from the process of the music composition.

‘Hansen’, is a psychological thriller inspired by true events that took place in the middle of the twentieth century in Greece. The story happens on a small Greek island, where the inhabitants were patients infected by leper, also known as Hansen's disease. The main character in the game reaches the island aiming to rescue his sick daughter, discovering an unsettling hidden reality in the process. The context of this story will

focus the research and composition within the boundaries of greek and byzantine styles entwined with suspense and horror genres.

1.2 Genres involved in the Project.

Despite the above description that encircles Hansen into the thriller genre, the game and thus the research are based on many other styles and musical forms implied in the historic background, interactive nature of the level to be scored and audiovisual content. The general mood that encompass of the whole Church level is one of mystery and unsettling atmosphere. Nonetheless, the level is divided in 5 different areas that define the music in style and timber accordingly.

1.2.1 Aleatoric Composition based Christian Orthodox Tradition

The first area is located in the ground floor of the huge cathedral. A calmed and meditative state of mind is to be achieved by the music with a coherent sonority of the environment, thus the piece contain elements of the Greek Christian Orthodox Church (GCOC) music such as the modal system and slow melodies with long notes rooted on the tonic and dominant.

1.2.2 Vocal music in the Greek Christian Orthodox Church

The second part of the level is a pathway to the second floor and a passage behind a massive choir, hence the score is a source music piece. The style inspired by the GCOC vocal music and directly related to the classic modes of the renascence. Polyphonic *Motet* based on a *Cantus Firmus* defines the genre of the music which is to be applied in a layer based system. Some contemporary pieces based on the same

principles taken into a more complex sonority, John Tavener for example, where also inspiration for this section.

1.2.3 Species Counterpoint and Baroque Forms

The third area is the church organ. Being a source music piece as well, it is framed into the baroque organ music style. The *passacaglia* form is chosen for its structure based on continuous variations, adapted in the game into a layer system.

1.2.4 Psychological Thriller

The fourth part is the altar, a time limited area that requires a linear linear music piece. The score combines the source music from the organ and non diegetic elements that allow a gradual rise in tension towards the end of the cue. Having a time framed audiovisual content, thriller genre elements are implemented in the piece.

1.2.5 Musical Soundscapes

The final area is the graveyard. A musical soundscape to be looped seamlessly, mixed with traditional greek instruments. Multiple techniques like processing sound design elements, irregular melodic motives and using extended techniques are employed to develop an immersive minimalistic textural style.

1.3 Goals and Motivation

Western music has been privileged with both complexity and emotional depth, transcending time and geography evolving the concept of beauty. Even the most experimental and dissonant styles in the past century share a common ground with the

great classic composers in their process and the desire to find new forms of expression.

Film music has been following the same path to some extent, evolving and constantly searching for new aesthetics, adapting the great discoveries in concert music into a format that is always in the service of a story and visual context. Moreover, film music has evolved for about a century achieving its own style.

Music in video games, as a natural descendant of film music, have been following its footsteps with the additional challenge of interactivity. Marks (2008) notes:

> "As a movie plays, the linear soundtrack follows along, setting the appropriate mood for each scene — building tension or tugging at your heartstrings. However, most video games aren't predictable in that sense and a music score cannot anticipate what will happen next to a player." (p. 8)

The interactive somehow limits the traditional musical prose and can sometimes fall into simple static harmonies with some rhythmic overlays as a form of variation.

This project aims to develop scoring strategies and methodologies that may enrich the musical language of interactive music in terms of harmonic complexity, timbre and historic accuracy with the story and visual content. Borrowing elements of specific film music genre, avant-garde and concert music approaches for application into gaming music formats in the hopes of creating original musical pieces with high dramatical content, immersion interactive flexibility.

As the project develops many obstacles will be encountered. Whether the final musical results support the initial objectives, the process may answer questions about the relationship of traditional and avant-garde music composition with non linear musical forms. This process of research, writing and testing will most importantly

open new paths and perspectives for a film and media music composer to continue developing a style of its own.

It is in my interest to discover if it is possible to integrate different compositional approaches in one same level of the game and maintain the piece and storyline as one single immersive universe. The study of various approaches and their implementation into a particular style of composition might be a good starting point for developing a new implementation method and a voice in the world of music for video games and perhaps other perspectives in the audiovisual field.

1.5 Key Contributions

Many composers develop theories and systems every day, contributing to a vast pool of possibilities. This project intends to look into unexplored areas of algorithmic composition and relationships of common practice music with interactive platforms:

- Developing a customized probability system for algorithmic composition as a new tool in music creation. Through analysis and experimentation, a specific piece of music is fragmented and its melodic structure dissolved into a set of rules for harmonic controlled randomization.
- Implementation of a layer structures based on alternative variation systems such as harmonization of fixed melodic material in different modes. Can a *Cantus firmus* be independent of its original mode? Can it consequently be harmonized in three different modes and still be the same piece?
- To approach traditional musical forms and use their structures as guidelines for multilayer composition. Studying and understanding such structures can be an

efficient way to approach interactive music adding variety and interesting harmonies.

- Blurring the established boundaries between sound design and music composition looking for higher immersion experience. A common practice nowadays but yet not fully explored in the audiovisual arts. Developing an integration system of both elements in an immersive atmosphere may prove a way of keeping the best of both worlds, thus a useful tool for composition.

1.5 Theses Outline

This chapter presents the introduction of the project, hence it defines a general context of the research and makes a brief description of the musical piece that is to be composed in the video game *Hansen*, currently in development by Vasilis Milesis.
Chapter Two will provide an overview of the project background going into the different musical styles, genres and technical approaches involved. Influence of the Greek Christian music and John Tavener for the choral compositions, counterpoint in the style of J. S. Bach and interactive audio in gaming among others.
Chapter Three provides the review of specific works that directly influenced the project:

- *Funeral Canticle* by John Tavener: Choral work written in the twentieth century based on a traditional format, starting with a *Cantus firmus,* followed by a kind of *Motet* using traditional modes with a modern harmonic outcome.
- *Passacaglia & Fugue in C minor* BWV 582 by J. S. Bach: Organ piece used as a raw model for Hansen's church level, borrowing the concept of continuous variations based on a *basso continuo.*

- *Portrait of John Doe* By Howard Shore. Music piece for the psychological thriller film *Se7en*. Motivic evolution, harmonic structure and timbre in this piece as influence for the general thriller mood of Hansen.

Chapter Four describes the methodology of the piece. The division of the game level into 5 parts: The saints, choir, organ, altar and graveyard. In each section the different music and implementation approaches are described, outlining the constant mood of a mysterious sacred place that turns uncanny.

Chapter Five concludes the project by analyzing the results of the process. How the methodology was effective in Hansen and how may it serve as a future reference for other kins of interactive music.

Chapter 2. Background

2.1 Introduction

The systems, tools and integration of different approaches involved in the composition of Hansen, are based on the research and analysis of musical styles related to the story of the game and its historical background. Each section of the level allows to explore a different musical style, therefore the background of the project is articulated as such.

The first topic is related to the music in the GCOC. The Byzantine Legacy, modern reinterpretations of modal writing such as John Tavener.

The second section refers to the aleatoric techniques in composition and the indeterminate music. Its origins in concert music and developments in gaming such as the implementation of *Markov Chains*.

Thirdly, the background on baroque counterpoint in terms of form and music for organ. The potential similarities of continuous variations in the *passacaglia* form and the interactive composition.

The forth section embraces the thriller genre as a musical style. Films in the past 25 years such as *Se7en, Memento* and *Gone Girl.* Video games that have adopted the genre and characteristic sound such as *Silent Hill, Amnesia* and *Limbo*.

The final part goes deeper into the interactive audio principles and techniques such as layering, branching and seamless looping. Adaptation of compositional approaches to the middleware functionality.

2.2 Greek Christian Orthodox Church. (GCOC)

Ecclesiastical music has been a major element of study through the history of western civilization for both religious and aesthetic purposes. The fact that many harmony and counterpoint treatises have been based on the theories originated in the Gregorian chants and later compositions of the renaissance and baroque gives some perspective on the influence of religion over music. No matter the sect or deviation, every church claims to have the "correct" music for worshipping, hence the importance of its preservation. The GCOC is no different: 'If in some contemporary Christian denominations music plays a secondary role, it would be no exaggeration to state that in the GCOC almost all of worship is musical' Karanos (2011).

2.2.1 The Byzantine Legacy.

The conservative nature of the Christian Orthodox music, has kept the main melodies used in the liturgy very similar through the centuries. Karanos (2011) describes the evolution of music in the GCOC as follows:

> 'The Psaltic Art[2] is strictly vocal (…) is also strictly monophonic. In other words, it is performed by a single cantor or a choir singing one melody in unison (…) Polyphony was introduced in Greek Orthodox worship as early as the 15th century, but its usage remained very limited except in the Ionian Islands. In the mid-19th century polyphonic settings of ecclesiastical melodies appeared in Greek diaspora communities in Western Europe, despite an official promulgation by the Ecumenical Patriarchate in 1848 of an encyclical banning four-part harmony. In the 20th century harmonized

[2] Psaltic Art comes form the Greek Christian Roman old term that refers to Musical Art (Karanos, 2011)

settings of hymns were adopted in the Divine Liturgy in the Greek Orthodox Archdiocese of America.' (p. iv)

The composition was based on the original 8 Byzantine modes or *Octoechos* which where defined by the structure of 2 tetrachords and was based on a non tempered logic.

Figure 2.1 (Garinis and Kehagias, 2011)

THE NAMES OF THE NOTES

Nē	*Pa*	*Vou*	*Ga*	*Dē*	*Ke*	*Zo*	*Nē*
Νη	Πα	Βϐ	Γα	Δι	Κε	Ζω	Νη

THE EIGHT MODES

The names of the eight modes are as follows:

(Πρώτος) First Mode
(Δεύτερος) Second Mode
(Τρίτος) Third Mode
(Τέταρτος) Fourth Mode
(Πλάγιος του Πρώτου) Plagal of the First Mode
(Πλάγιος του Δευτέρου) Plagal of the Second Mode
(Βαρύς) Grave Mode
(Πλάγιος του Τετάρτου) Plagal of the Fourth Mode

Also in terms of notation. Fig 2.2 shows an example of a scale in the early form.

Figure 2.2 (Garinis and Kehagias, 2011)

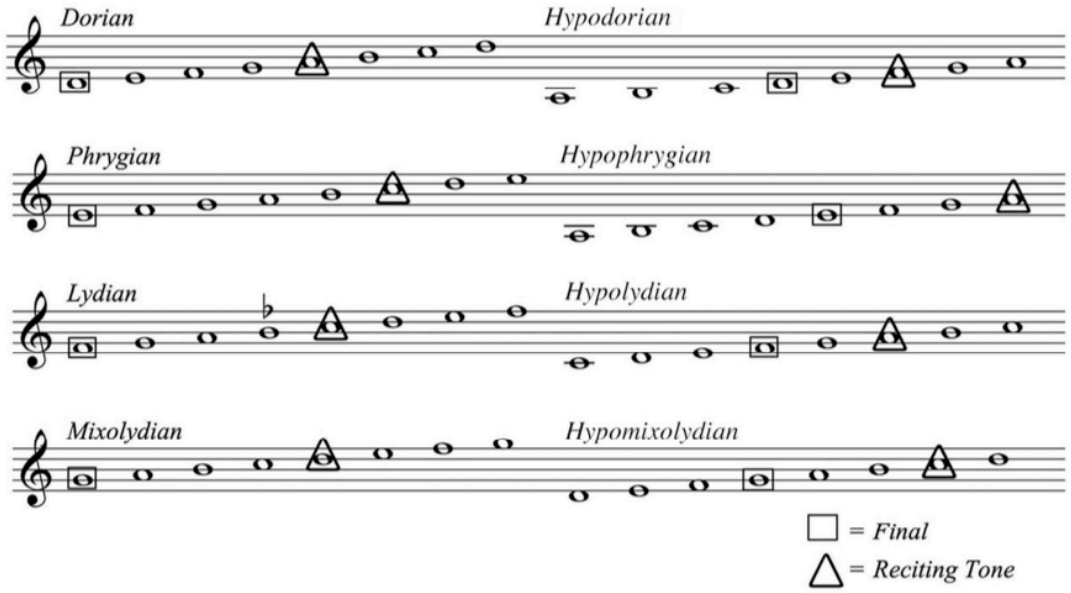
For the purpose of this research, the Byzantine system has been translated into standard western language and notation:

Figure 2.3

Byzantine mode	Gregorian - Equivalent	Modern Name
1st Mode	Dorian	Dorian
2nd Mode	Phrygian	Phrygian
3rd Mode	Lydian	Lydian or Ionian
4th Mode	Mixolydian	Mixolydian
Plagal of the 1st Mode	Hypodorian	Aeolian with 4th grade as tonic
Plagal of the 2nd Mode	Hypophrigian	Aeolian with 5th grade as tonic
Grave Mode	Hypolydian	Ionian with 4th grade as tonic
Plagal of the 4th Mode	Hypomixolydian	Dorian with 5th grade as tonic

Furthermore, Alwes (2015) describes the fact that the modes also have a "reciting note", often the fifth tone of the scale. This secondary note is also related to the *dominant, tenor* or *tubae* in the Gregorian modes (Hoppin R, 1978). The *dominant* evolved through the renaissance and baroque acquiring also a harmonic functionality.

Figure 2.4 (Alwes C, 2015)



Even though the style has been preserved through centuries, variations have been introduced over time also involving melodic and harmonic characteristics. Early

chants dating the fifth and sixth centuries where based on these modes without alterations. Ciobanu (1970) states in his study of musicology that chromaticism was introduced after the 15th century due to the Turkish influence in the music.

Figure 2.5 (Transcription by Ciobanu, G. 1970. Pg 87)

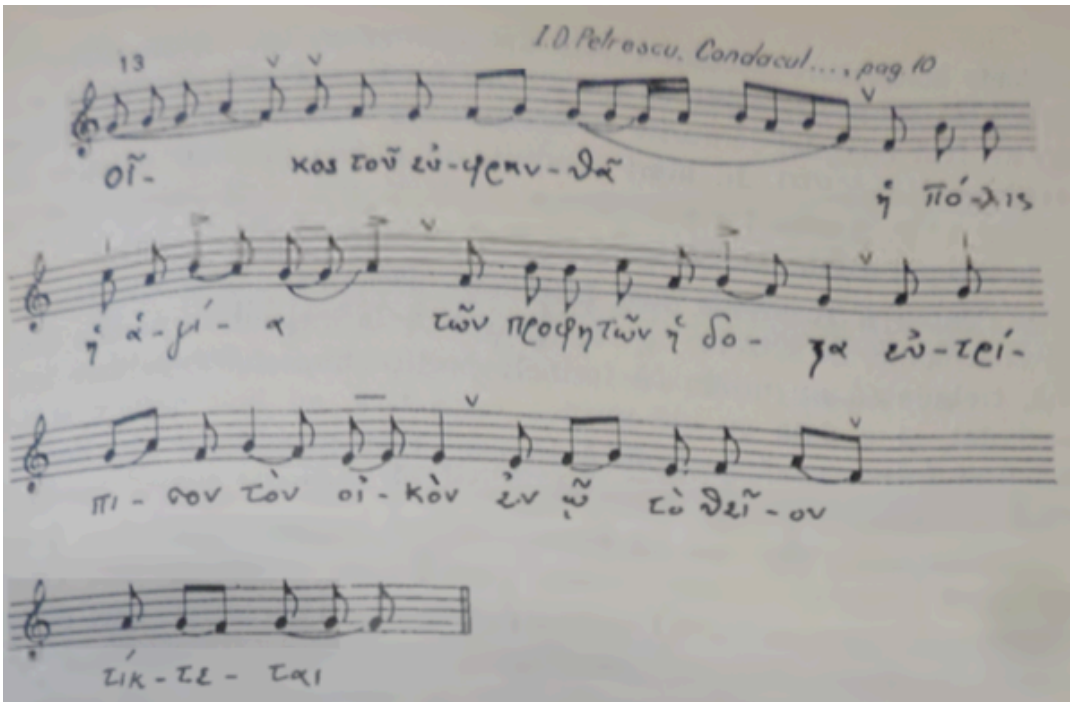


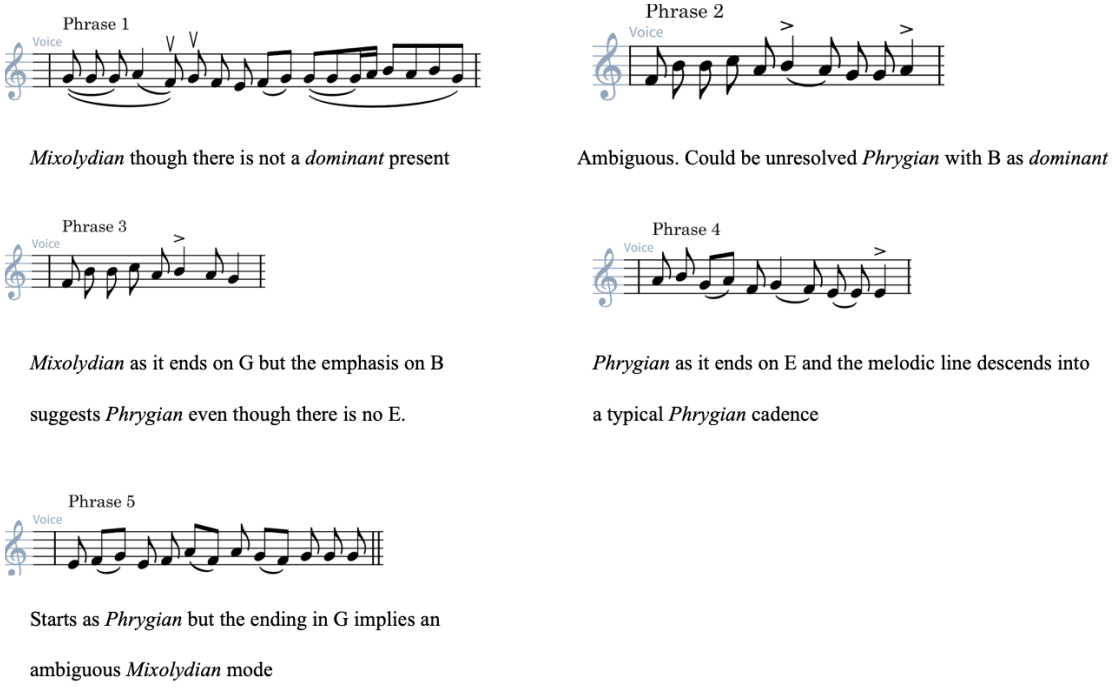
Fig 2.5 shows an example of an anonymous chant of the XIII century, a diatonic melody with no chromatic notes that belongs to the early byzantine style. At first glance it appears to be *Mixolydian* mode as it starts and ends in G. Nonetheless it's ambiguous as it doesn't show a clear *reciting tone* different to its *finalis* and the middle section doesn't sound *Mixolydian*.

Despite the apparent *Mixolydian* mode implied by the beginning and ending notes, Ciobanu, (1970) suggests that the whole chant is 'structured in the scale of the Byzantine *Echoi*[3] II' or *Phrygian*. When playing the melody there is a natural inclination to resolve on E. Also if played played over a sustained pedal on E, it

[3] Echoi or Echos is the old term referred to the byzantine mode.

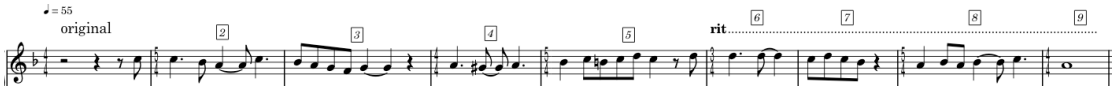
sounds natural and in context[4]. It could also be argued that some interpretations could be misguided by the tonal ear of the present era. The chant is ambiguous in terms of its mode and if it was to be harmonized, it could work in more than one mode.

Figure 2.6



A more recent chant "*Ai Geneai Pasai – O Gliki Mou Aear*" serves a second example of a GCOC song that has its roots on the byzantine music.

Figure 2.7 (transcription)



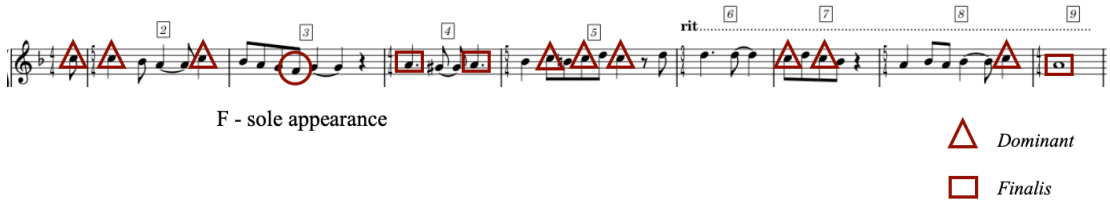
This is a popular religious song in Greece and has been recorded by many artists in the recent time. According to the article *Greek Eastern Hymns* in the site Greek Songs

[4] It was common in the early vocal music to just harmonize a modal melody with its *finalis* or root tone one octave lower.

- Greek Music.com it is the most known hymn of *the good Friday* presumably written by the Greek poet and hymnographer of the sixth century Romanos Melodos. Even though it's a simple and beautiful melody which could have survived fourteen centuries, the presence of chromatic notes (G# and B) may contradict the previous statement of Ciobanu, and could debate that this tune has Turkish music influece therefore could be dated after the 1500s.

In terms of modality this melody also can open different interpretations. The *dominant* seems to be C as it is repeated often in a single phrase and the *finalis* is A. One could argue that having C as dominant, the absence of the note E and the presence of Bb defines the mode as F *Lydian* (in byzantine terminology, F *Ionian* in the modern). Also in modern interpretations, the song has been harmonized with success in major mode (*Ionian* or byzantine *Lydian*). But going back to the melody itself, it is odd that the chant ends in A, instead of F. What's more the F only appears once and not as a structural note but rather as one of embellishment.

Figure 2.8



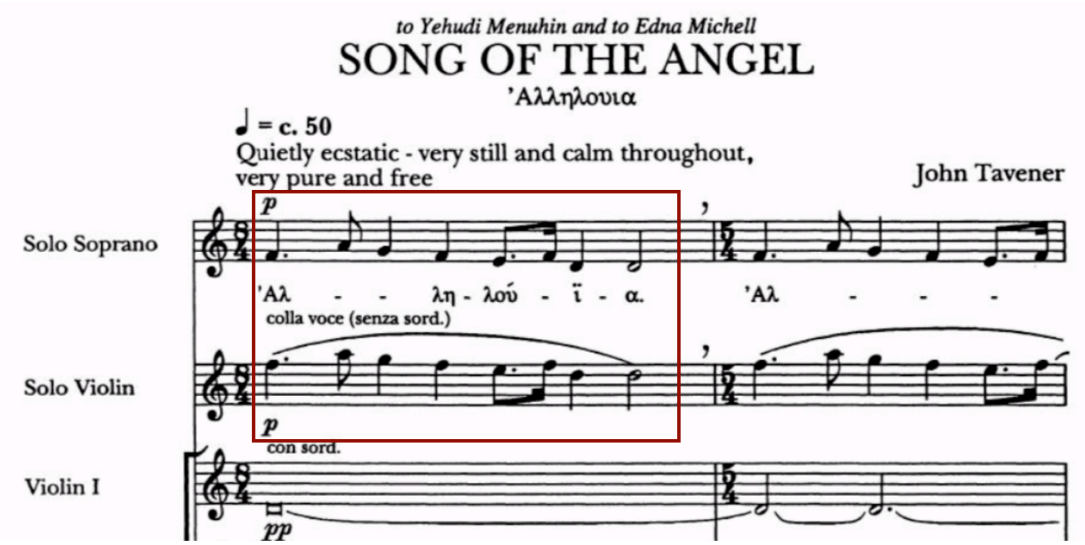
Having the C as *dominant* and A as *finalis,* it is quite difficult to name the melody's mode according to the original byzantine system. However, the ambiguity created by those characteristics would allow harmonizations in other related modes like A *Phrygian,* or C *Mixolydian.*

2.2.2 John Tavener and contemporary approaches

Far from being a religious preacher but rather a composer who by his own words "wanted to produce music that was the sound of God" (Service, 2015, p.1), John Tavener has a series of works based on his beliefs related to the Christian Orthodox Church. Although his music is free of technical dogmatic rules, the lyrics and composition have clear influences on the GCOC.

Tavener's pieces in the 1980s-90s share a characteristic sound that could be perceived as a modern evolution of mystic music. This signature sound is sometimes related to Arvo Pärt due to the simplicity of the sound and yet complex in language and content. The piece *Song of the Angel* (1994) serves as an example of a traditional GCOC style which preserves elements of the early ecclesiastic music in terms of the melody, harmonization and texture. Other aspects such as the instrumental format, melody doublings and harmony, indicates the modern language of the composer.

Figure 2.9



Not only the inclusion of string instruments differs from the GCOC music, but also the violin doubling of the soprano one octave up suggests an intention in timbre, a

common characteristic of twentieth century composers. The piece also exalts the relationship between ecclesiastic and modern music in terms of harmony. Long pedal notes under a single line and the avoidance of hard dissonances such as tritones and minor seconds in close dispositions, are common in traditional GCOC music. Nonetheless, some atypical harmonic colors are present.

Figure 2.10

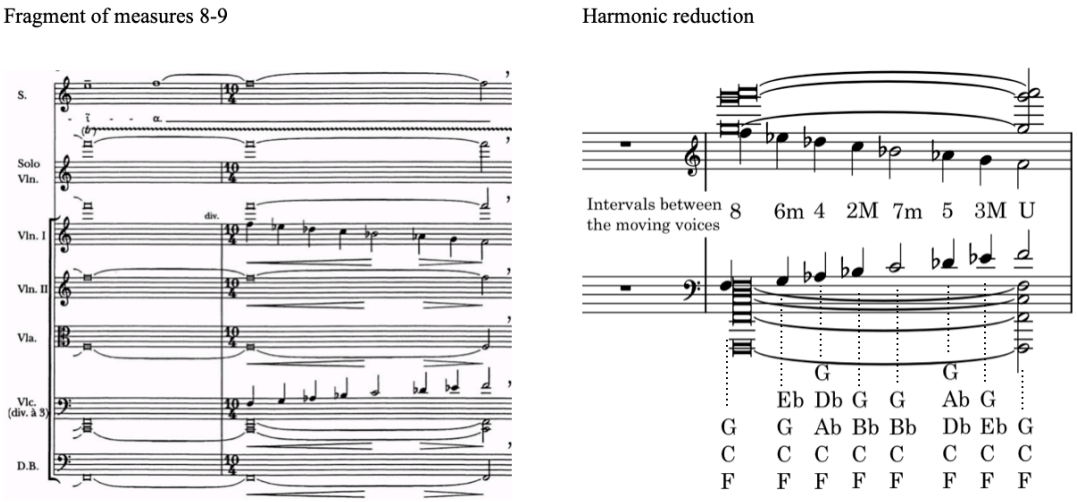


Figure 2.10 also shows some kind of symmetry in the harmonic structure of this cadence, suggesting that the resulting chords where not coincidences but carefully considered. The search of symmetry in music and its representation of the divine is not uncommon in Tavener and can also be found in some pieces by Arvo Part like *Cantus In Memory of Benjamin Britten* and *Fratres*.

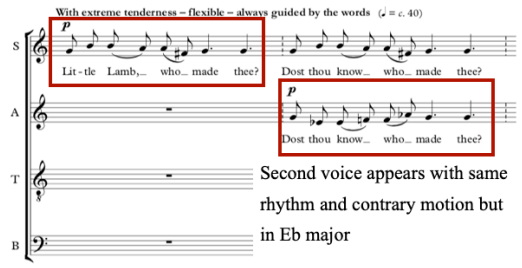
Another example of John Tavener in this period is *The Lamb* (1982). *A cappella* choral piece featuring a poem by William Blake *Songs of Innocence* (1789). Even though not strictly ecclesiastic text, it does describe a Christian holiday ceremony.

Tavener's approach is very much in the style of early religious choral music, but with a bolder statement in harmony, showing hints of polytonality. It starts with a sole melody as a c*antus firmus* to be later harmonized with a second voice in first species counterpoint. Finally the piece widens into a four part choir with no voice independence but rather a parallel motion with a slight variations in the bass.

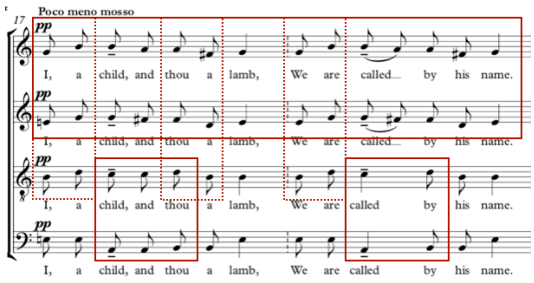
Figure 2.11

The Lamb

Starts with only one voice in G major



Final part: 4 voices in Em with same rhythm and parallel motion



The Lamb has the sound of a modern re-interpretation of traditional ecclesiastic music. Instead of voice independence in terms of texture, sometimes the voices are in different tonalities and in precise symmetric contrary motion. The composer makes his own "rules" to represent a certain idea in the text, in this particular case he could be reflecting two children, equal in the eyes of god but living in opposite realities, as Blake's poem implies social inequity in the London of his time.[5]

2.3 Species Counterpoint and Baroque style

Outside the boundaries of the music of the GCOC, religious vocal music evolved from the Gregorian chants through the *Motet* form in the renaissance and the early

[5] Some analysis on the *Songs of Innocence* (such as the ones provided in Tate's site, where the original illuminated books containing the poems reside) state that Blake addressed social issues of its time such as poverty, racism and moral hypocrisy.

baroque. Broadly speaking, the evolution was mainly on the texture of the music and the harmonic system.

In 1675, the Austrian composer Joseph Fux wrote the popular treatise *Gradus ad Parnassum* where he proposes a complete methodology of species counterpoint (also known as "strict counterpoint"), comprising the theory since the middle ages and establishing a set of rules for polyphonic writing, all based on the fixed idea of the *cantus firmus*. Fux bases its system on the breaks the whole concept of counterpoint into 5 models called species, each one with its own parameters in terms of voice motion and intervals.

- First Species: Note against note counterpoint.
- Second Species: Two notes against one in the *cantus firmus*.
- Third Species: Four notes against one in the *cantus firmus*.
- Fourth Species: The study of suspensions against a *cantus firmus*.
- Fifth Species: The combination of all the previous species against a *cantus firmus*.

This treatise served as a ground rule of vocal music for centuries. It may have not been the only one but certainly the most influential. Grove (1879) points out the importance of Fux by stating in his *Dictionary of Music and Musicians* that his theories "stood midway between the first poly- phonic age and our own".

2.3.1 Baroque Style in the Music for Organ

The organ, with origins in the Byzantine empire was introduced in western Europe by the eight century, but it was not until later that the Christian church adopted and developed it.

> "In the 757 the Byzantine Emperor sent an organ to Charlemagne's father, Pépin, and organs were made in Germany and Britain in the first half of the following century. They were small, with a range of only one octave (…) Much larger instruments were soon built, with Church resources, such as the famous English organ at Winchester, which had forty notes and ten pipes to each note." (Headington, 1980 p.43)

It was arguably not until the late baroque period that the music for church organ reached its peak. Composers like Dietrich Buxtehude, Georg Böhm, George Frideric Handel and Johan Sebastian Bach left a vast repertoire of masterpieces. Headington (1980) suggests that most of Bach's early music was for organ. Choral preludes, fugues and other polyphonic forms where applauded at the time and some of its master pieces are still a reference for today's music.

2.3.2 Continuous Variations and *Passacaglia* Form.

The Grove Dictionary of Music defines the *Passacaglia* as:

> "An early Italian or Spanish dance similar in character to a Chaconne (…) But the feature that has elevated the Passacaglia above the majority of dance forms is the construction of the music on a ground bass, generally consisting of a short theme of two, four or eight bars (…) This form attracted the attention of the organ and harpsichord composers of the 17th and 18th centuries, with whom the construction of elaborate Passacaglias and Chaconnes became a favorite exercise fo contrapuntal skill." (Grove, 1880 Vol II, p.658)

Having a repeated motive in the bass, the *Passacaglia* is a form that challenges the composer to develop variations using a fixed harmonic progression. An alluring example is the *Passacaglia* in D minor by Johann Kaspar Kerll (1627-1693) that with just two bars in the bass line composed 40 different variations. Other celebrated *Passacaglias* where written during the baroque period such as the *Passacaglia* in D minor BuxWV161 by Dieterich Buxtehude and the famous *Passacaglia and Fugue* in C minor BWV582 by Johan Sebastian Bach. This form has been also explored by later composers of the nineteenth and twentieth century like Felix Mendelssohn, Dimitri Shostakivich and Jan Welmers.

2.4 Aleatoric and Indeterminate music

The first well known musical pieces with aleatoric approaches date the 1700s with Mozart's *Musikalische Wurfelspiele* (1792). A series of small pre-composed fragments of music, organized in rows and columns, to be chosen by the chance of throwing two dices. After eight throws, a "unique" piece or section is "composed".

It was only until after the 1950s that the concept of chance in music gained relevance with the introduction of John Cage's piece *Music of Changes* (1951) based on the *I-Ching.* This particular piece used a system of 64 hexagrams to choose randomly the sounds, durations and dynamics organized in a set of charts.

Aesthetically dissimilar, Cage's and Mozat's pieces where based on the same principles of probability system, generating different musical outcomes with each performance. Even though Cage's aleatoric pieces were not extremely popular nor well received in some artistic circles, they opened a path for experimentation. Many composers in the 20th century such as Karlheinz Stockhausen, Pierre Boulez and

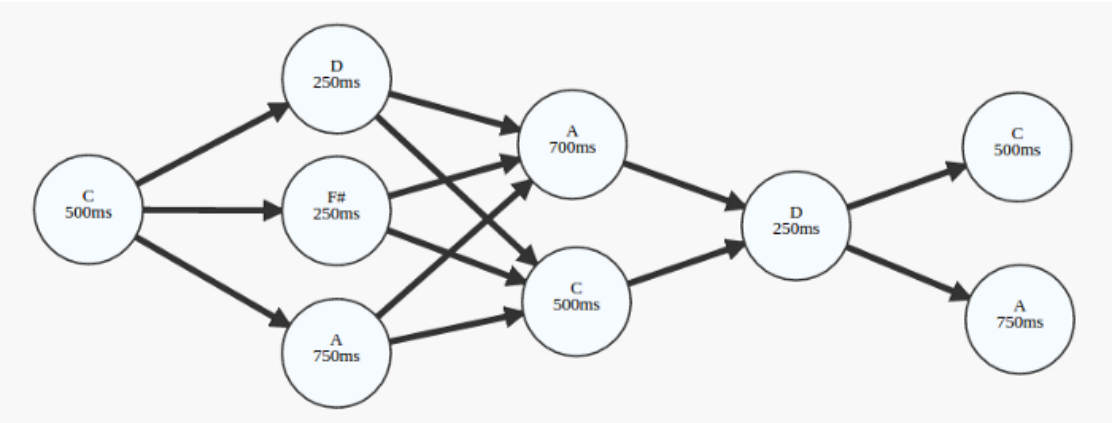
Iannis Xenakis where inspired by the concept of aleatoric music and developed their own processes for composition.

Stochastic music was developed based on these principles going deeper into complex mathematical and probability systems. Xenakis (1992) explains in his book *Formalized Music* many of his experiments since the 1950s, emphasizing the importance of coherence in the aesthetics and precision on his methods.

> "However, we are not speaking here of cases where one merely plays heads and tails in order to choose a particular alternative in some trivial circumstance. The problem is much more serious than that. It is a matter here of a philosophic and aesthetic concept ruled by the laws of probability and by the mathematical functions that formulate that theory, of a coherent concept in a new region of coherence" (pg. 29)

The use of *Markov chains* in composition is a result of such approaches. A probability system based on the analysis of a body (can be a musical piece), which is applied into certain parameters so that the system itself makes the decision of what happens next according to what happened before. Figure 2.12 illustrates an example based on *Markov chains* made by Lin, A (2016).

Figure 2.12



Xenakis, among others, opened the path for such systems that lead to the development of computer generated music using the formulas and probability principles. Ames (1987) in his article *Automated Composition in Retrospect: 1956-1986* describes the development of music aided by computer as a tool for decision making in composition through eleven examples.

It is not until the mid 1990s that an algorithmic composition system reaches the commercial use. In 1996 the software *Koan* was released by a developer company called SSEYO in collaboration with the music producer Brian Eno. This generative music system was a commercial success and it is still in the market under the name of *Wotia*[6]. The software allows the user to "create" music by selecting moods, triggering algorithms that select pre recorded patterns. The machine combines parameters according to the user selection generating endless variations.

Nowadays the experimentation of algorithmic composition for comercial use is considerable and expanding. Google has its own platform called Magenta, defined by "An open source research project exploring the role of machine learning as a tool in the creative process" (GoogleAI, 2018). *Aiva* is another company that uses artificial intelligence methodologies to generate music, focusing its target on video game developers and media composers.

2.5 Music in the Thriller Genre

According to the *The Complete Film Dictionary*, thriller is defined as "any film that creates excitement and suspense, especially a mystery or crime film"(Koninsbert,

---

[6] In 2002 SSEYO was acquired by Tao Group whose assets were sold in 2007, which was why we then started Intermorphic. https://intermorphic.com/wotja/

1987. p.378). A broad definition of a vast genre, and yet it always reminds of one sole director: Alfred Hitchcock.

Since its beginnings, the music has proven to be more than essential. *Vertigo* scored by Bernard Herrmann has brought the power of music to lead the thoughts and emotions with the story hypnotizing the audience, taking their state of mind where is most vulnerable and then striking a final blow. Many where the films by Hitchcock that developed this genre that has endured and evolved through decades.

2.5.1 The Film Music Heritage

Following the Herrmann's legacy, many contemporary composers such as Howard Shore, David Julyan, Trent Reznor and Atticus Ross, have based the score of their films on the same principles but developing new techniques in a modern musical language. Despite the many approaches in music composition, most thriller scores share the concept of hypnotizing the listener by various means, keeping the audience in a loop, in the dark, waiting for the right moment for a dramatic cadence.

One effective process developed in *Vertigo* and still present in films like *The silence of the Lambs* scored by H. Shore is to repeat a single short motive as an *ostinato* with small variations, leading the audience slowly into a desired state.

A less melodic approach but effective all the same was used in the film *Se7en,* also scored by Shore and in the TV series *Dark*, scored by Ben Frost. It consists on playing slow pulsing waves at a constant rate, with small variations in orchestration, timbre and harmony, reserving the most dissonant chords or intense distorted sounds for the dramatic statements in the script.

2.5.2 Thriller Style in Video Games

In the past twenty years, the video game industry has adopted the genre and explored its wide possibilities. Games like *Silent Hill* scored by Akira Yamaoka, *Amnesia* scored by Mikko Tarmia and *Limbo* scored by Martin Stig Andersen are examples of successful productions with interesting approaches of music composition.

In these video game scores, the same principles of maintaining the audience in suspense have been adapted into interactive music. Nonetheless, these adaptations have somehow evolved the the thriller music. Andersen for example has explored the integration of sound design and soundscapes into the music, achieving a direct correlation of the visual content and the soundtrack.

2.6 Interactive Audio

Development of middleware for interactive audio such as Wwise or Fmod have allowed and guided composers to a different approach of creating a soundtracks. Traditional music forms and long melodic phrases have been replaced by symmetrical looping systems and shorter musical segments.

Three main categories of non linear segment based composition can broadly summarize the most used methods in the gaming industry:

- Looping: Usually a complete symmetric musical segment (phrase or group of phrases) to be repeated overtime, aiming to create a continuous flow.
- Branching: Fay, (2004) defines it as: “In the case of *branching* Segments, we change the Segment we are playing at a musically appropriate boundary, based on some event that changes the emotional level we want to convey” (p.66). Later he

illustrates in a simple diagram how it works in terms of the gaming possibilities, serving as a guideline for music composition.

Figure 2.13 (Fay, 2004, p.67)

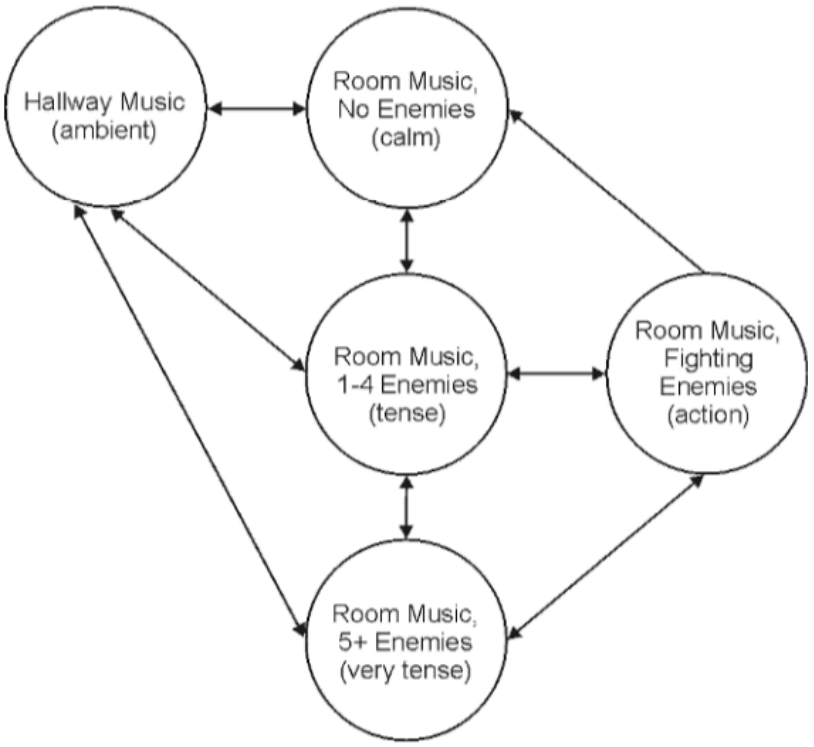


Figure 4-7: A sample diagram for five pieces of music. Each arrow indicates that a piece of music will need to be able to transition to another piece of music. For this scenario, we assume that you have to somehow "engage" enemies in combat, so you'll never jump right to the "fighting" music from the "no enemies" music. Similarly, if you decide to flee the room, you'll disengage from the enemies first, so you don't have to worry about the "fighting" music jumping directly to the hallway "ambient" music.

- Layering: A base piece of music played as a primary segment in a loop that doesn't change to another segment, but is rather layered by a secondary segment, playing both pieces layers at the same time[7]. Usually elements such as percussion instruments, ostinato motives and textures can change between layers but the harmonic progression remains the same.

[7] In some cases the playback engine crossfades and replace the audio file when adding or removing layers. Still the compositional approach is based on the same principles.

2.7 Conclusion

This project aims to select some of the principles from the above overview and implement them into compositional approaches for interactive music. Maintaining unity and coherence in the music is a priority, therefore the integration of all these styles goes beyond simple musical fusion.

The general mood and aesthetics of the score is based on Hansen's background. Extracting ideas from the musical context of the story to develop tools for composition in an interactive platform basis:

- Writing in a traditional ecclesiastic *cantus firmus* style, re-harmonizing the melody on different byzantine modes.
- Continuous variations in the *Passacaglia* form applyed into a layer system.
- Extracting probabilities of melodic behaviors from a traditional GCOC song and building new melodic material based on its percentages.

Chapter 3. Review of Works

3.1 Introduction.

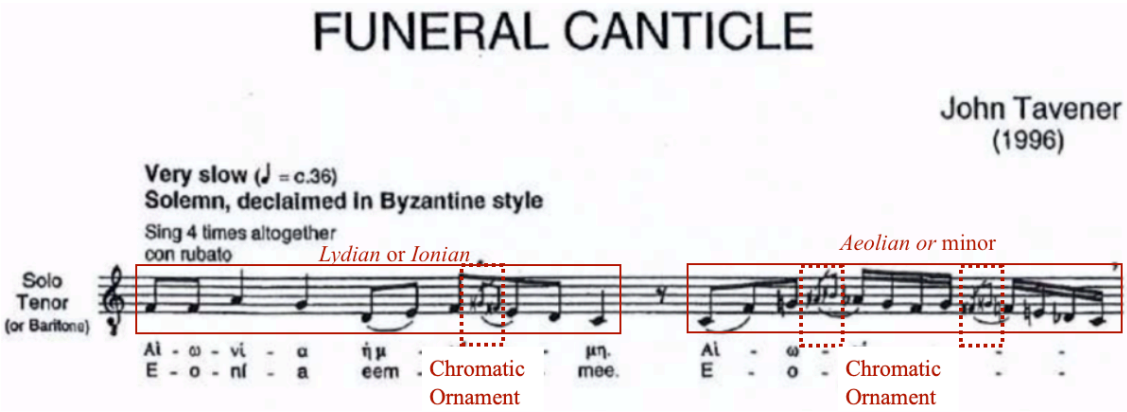
This chapter covers the analysis of selected works that fit in the project background and that influenced directly the music composition of Hansen. The pieces to be analyzed are *Funeral Canticle*, (1996) by John Tavener, *Passacaglia & Fugue* in C minor BWV 582 by Johan Sebastian Bach and *Portrait of John Doe* (from Se7en - 1995) by Howard Shore.

3.2 Example 1. John Tavener - *Funeral Canticle*

The piece is divided in three sections. A *cantus firmus* in the first, four part choral in first species counterpoint in the second and a final section in four voice second species counterpoint.

The first section has not a clear time signature and the composer states "Solemn, declaimed in Byzantine style". The performer must know in advance the style for deciding how to set the accents accordingly. The section is a sole melody rooted in F, with modal ambiguities between *Lydian, Ionian* and *Aeolian/*minor.

Figure 3.1



The first phrase states the *Ionian* or *Lydian* mode (the lack of B or Bb leaves that question open). In the second phrase is an *Aeolian* mode but has E natural as leading tone stating a minor mode.

Figure 3.2

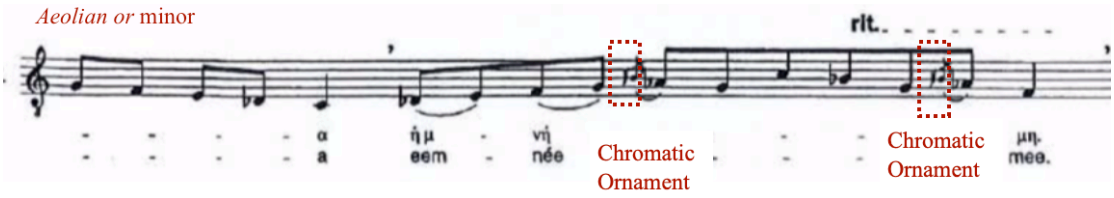
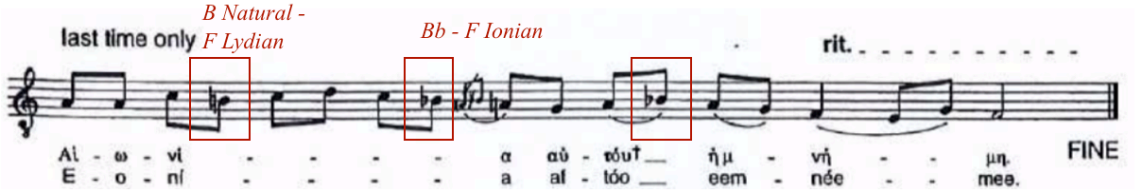


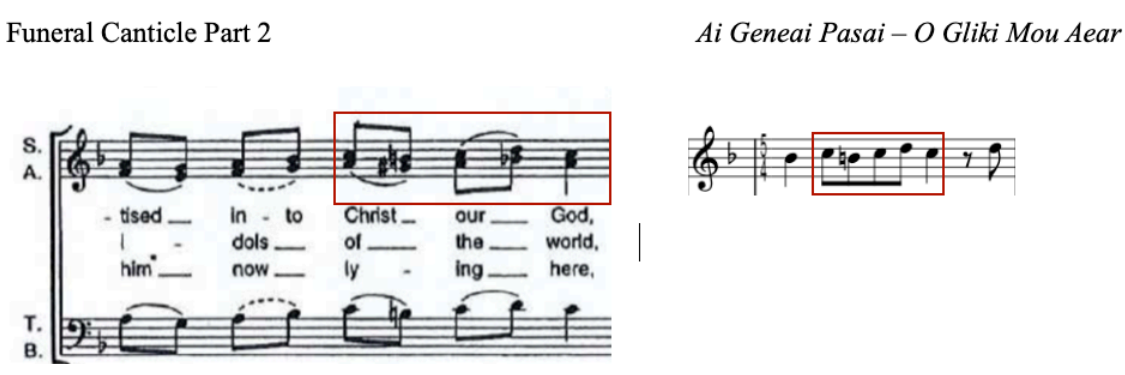
Figure 3.2 shows the second system of the piece where it continues on the minor mode. The third system ends with the same initial phrase of the piece, restoring the mode to F *Lydian* (or *Ionian*). There is a final statement that starts in *Lydian* but ends in *Ionian* as the B changes from natural to flat.

Figure 3.3



The second section states an *Ionian* melody in the soprano, duplicated with parallel motion melodies by the other voices.

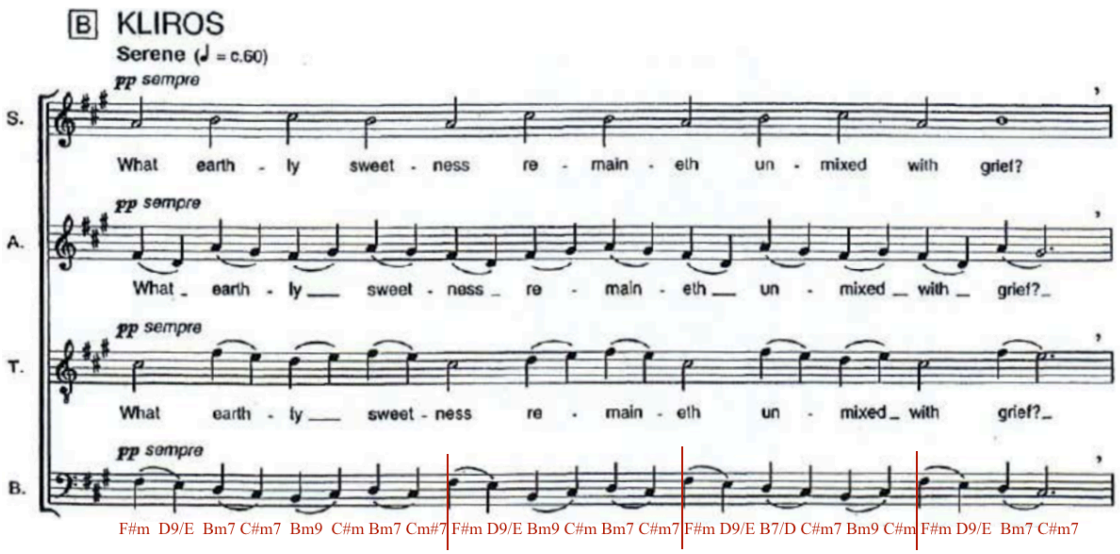
Figure 3.4



The whole section has a clear modality, but it has some ornamental chromatic notes, very common in the GCOC style. This embellishment of the dominant is also present on the song *Ai Geneai Pasai* discussed in Chapter 2.

The third section of the *Funeral Canticle* is a four part counterpoint, all in second species transposed to F# *aeolian*. The register opens wide and the harmony finally abandons the Orthodox style, giving space to modern smooth dissonances, displaying a more personal style of the composer.

Figure 3.5



This section lacks motive development and seems to work based on a harmonic structure. Figure 3.5 shows one complete phrase in terms of lyrics but segmented by a repeated pattern in the bass.

Figure 3.6

Group 1 - - -	8 chords:	F# - D9/E - Bm7/D - C#m7 - Bm9 - C#m - Bm7 C#m
Group 2 - - -	6 chords:	F# - D9/E - Bm9 - C#m7 - Bm7 - C#m7
Group 3 - - -	6 chords:	F# - D9/E - Bm7/D - C#m7 - Bm9 - C#m
Group 4 - - -	4 chords:	F# - D9/E - Bm7 - C#m7

The harmonic pattern repeats it self always starting with the same four chords with slight variations of color (marked in red, Fig. 3.6). Also the group of chords have variable sizes, becoming smaller towards the end of the phrase. This behavior is systematic through the whole piece with slight variations on the size of chord groups.

3.3 Example 2. Johan Sebastian Bach. *Passacaglia & Fugue* in Cm - BWV 582

The analysis is based on the first part, the *Passacaglia* as it's the form to be explored in Hansen. Originally written for organ[8], this work is based on one phrase theme in the bass line and twenty variations, structured in four groups of phrases.

Figure 3.7

Group of Phrases # 1

Content	Theme	Var.1	Var. 2	Var.3
Measure #	1 8	9 16	17 - 24	25 - 32

Group of Phrases # 2

Content	Var.4	Var.5	Var.6	Var.7
Measure #	33 - 40	41 - 48	49 - 56	57 - 64

Group of Phrases # 3

Content	Var.8	Var.9	Var.10	Var.11	Var.12	Var.13
Measure #	65 - 72	73 - 80	81 - 88	89 - 96	97 - 104	105 - 112

Group of Phrases # 4

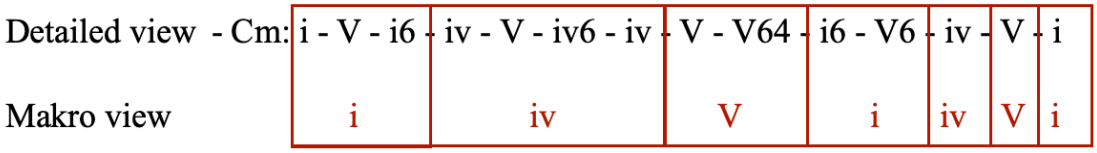
Content	Var.14	Var.15	Var.16	Var.17	Var.18	Var.19	Var.20
Measure #	113 -120	121 - 128	129 - 136	137 - 144	145 - 152	153 - 160	161 - 168

Based on the traditional tonal system, the piece consistently repeats the same basic harmonic progression in each variation, changing the texture, chordal density and rhythmic subdivisions. See Appendix I.

[8] There are many famous versions of the piece fully orchestrated by early twentieth century composers and conductors such as Leopold Stokowsky, Ottorino Respighi, Sir Andrew Davis, among others.

The basic harmonic progression is:

Figure 3.8



Repeating the bass melody on the pedals (except in variations 11 to 15), each variation seems to follow the same macro structure, ending on a perfect authentic cadence (PAC) with just a few exceptions. The less structural chords are changed like the iv chords being replaced with iiº or the non cadential V chords substituted by a viiº. On rare occasions strange chords appear like the *Neapolitan* on bar 70.

3.4 Example 3. *Portrait of John Doe* (from Se7en) by Howard Shore

Shore wrote a complete piece that works as a short suite for the film *Se7en* with a complete musical development, and at the same time it is introduced by fragments along the timeline, like pieces in a puzzle that one must ensemble together to understand the bigger picture.

The piece itself has many elements that can be seen as reflections or strokes of the mysterious character of John Doe. Slow tempo, low register, repetitive motives and complex harmony are characteristics that describe this dogmatic psychopath. See Appendix II.

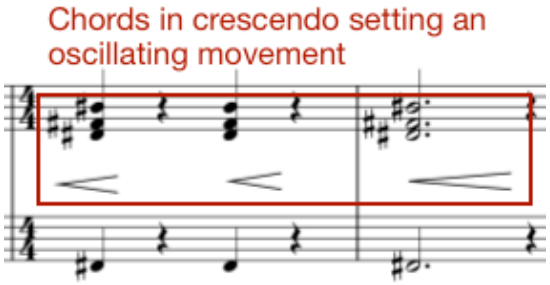
The first seven bars introduce a motivic gesture of a suspension, a repetitive statement resembling a prayer of a fanatic preacher. This element is present every time John Doe's hand is behind a crime.

The two chords, F# and D#m presented in the low register, with the suspended note sets the mood of an intriguing darkness.

Such diatonic triads loose their brightness in the low register. Almost as an analogy to the use of religion, using some ideas of christianity that may have been written with good intentions, but are interpreted by a particular mind that make these thoughts resonate in a differently.

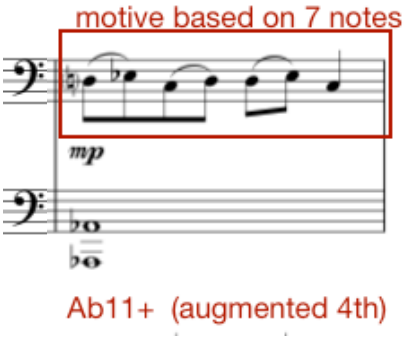
Dynamics are also systematic in the piece. Even the piano reduction shows a short crescendo for each suspended chord. Shore notated it showing the true intention in the orchestral score. In the actual film, these chords sound like oscillating waves that come and go. Almost every non diegetic musical cue in the film have this way of presenting the harmony.

Figure 3.9



After the introduction, a first melodic line is displayed. A seven notes motive based on a major chord with an augmented 4th.

Figure 3.10



The tritone as a starting point of the melody sets an uncanny mood suitable for the killer's psychology and at the same time makes a reference to the early Christian music symbology[9]. The main line plays a seven notes motive repeated with seven minimal variations. Perhaps an analogy, making one variation for each murder.

Figure 3.11

Original motive: **D, Eb, C, D, D, Eb, C**

Variation 1: **D, Eb, C, D**, G, **Eb**, F, F, C

Variation 2: **D, Eb, C, D**, **D, Eb**, F

Variation 3: **D, Eb, C, D**, G, F, Eb, D

Variation 4: **D, Eb, C**, C#, C, D, Eb

Variation 5: G, Bb, A, G, B, D, **C**

Variation 6: **D, Eb, C, D**, Eb, D, C

Variation 7: **D, Eb, C, D**, F, **Eb**, D, Eb

Almost all variations start with the same tetrachord except for variation 5 which is transposed. Possibly related to Doe's change of plans after murder number five.
The piece is systematic in the first two pages. In the final page the music starts to become chaotic, blending the intro and the main motive together, like the chaos generated by the outcome of the murder's scheme.

3.5 Conclusion

Interchanging musical parameters, structures and harmonies among these styles expands the possibilities for composing original music for a game based on historic

[9] "Diabolus in musica [L.]. Late medieval nickname for the *tritone, which in musical theory was regarded as the 'most dangerous' interval." (Apel, 1974, p.230)

events such as Hansen. Approaches such as harmonizing in different modes the same *cantus firmus* can be a way to achieve variety on a looping sequence.

Systematic ways of variations such as the *Passacaglia* may also prove an interesting way to approach interactive audio techniques. The bass line of the organ as a primary layer can be repeated many times when the layers on top have enough variation in terms of texture.

Relating traditional symbols in music with elements of the narrative can prove to be an effective approach for scoring audiovisual media. The music of *Se7en* serves as an example of coherence in the process and aesthetics of a thriller score. Many of these ideas can be translated into Hansen due to the obscure nature of the story and the mystical environment of the church's level.

Chapter 4. Methodology and The Piece

4.1 Introduction: Hansen's Church

The Church is a stealth mode level. It is divided into five main sections which will also defines the formal structure of the soundtrack.

- Saints, the first area where the character enters the church, a riddle is related to the paintings of the saints. The music is calmed and liturgical setting the mood of a sanctuary with a subtle hint of something strange. A meditative piece made out of changing drones defines this endless cue.
- The Choir is the second area. The player solves the first riddle and gets to the second floor ending up behind a massive choir. The soundtrack is basically source music of a liturgical *cantus firmus* that evolves into a *Motet.*
- The Organ is the third part and it's also source music. As the player reaches and sees the church's organ, a baroque style *passacaglia* begins.
- The Altar is the fourth area. The player gets to the other side of the church and descends to the first floor ending close to the altar where a preacher is performing strange actions.
- The Graveyard is the final stage where the player finds a way out of the church. A musical soundscape build up with sound design elements and ancient greek instruments defines the music of a somber cemetery.

4.2 The Saints. Meditative Drones

A major concern in scoring music for games is repetition. Music loops have the risk of overwhelming the listener and breaking the immersion. As Sanger (2003) stated

‘repetition is the problem’. Not only because may become boring or annoying, it is also a problem in terms of creating tension. Film and video game music composer Bear McCrearyl states “The more often the audience is exposed to a sonic idea, the less impact it has.” Sweet (2015).

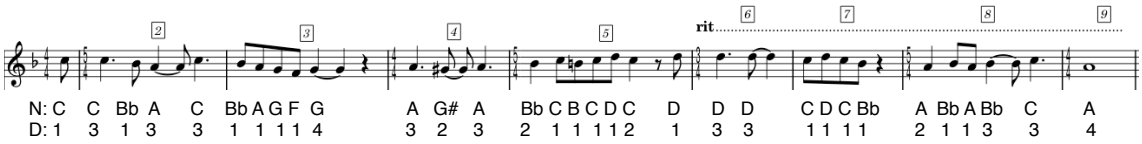
A video game like Hansen requires an immersive soundtrack maintaining the tension while the player discovers unsettling clues.

4.2.1 Compositional Approach

The following process of algorithmic composition aims to avoid looping by letting the computer generate the melodic lines and chords based on a semi random system controlled by probabilities.

The probabilities system is extracted by analyzing the amount of notes present on the melodic line of the Greek Christian Orthodox Song “*Ai Geneai Pasai*”

Figure 4.1



Each note of the melody (N) has an assigned duration (D) where: 1 = eight note, 2 = quarter note, 3 = doted quarter.

Figure 4.2

	F	G	G#	A	Bb	B	C	D	Total
Value # of Points	1	5	2	17	9	1	16	9	60
Total %	1.666	8.333333	3.333333	28.3333	15	1.666666	26.66666	15	100
Rounded %	2	8	3	28	15	2	27	15	100

The piece has an ambiguous tonal center, as discussed in chapter 2.2.1, but the A has a majority in appearance and is the final note therefore it will be assumed as tonal center for the purpose of this system.

Based on those percentages and other musical parameters that fits the mood of the cue, an algorithmic composition system is constructed:

- Pitch: Computer chooses randomly a pitch, based on the probabilities system.
- Rhythm: Computer chooses randomly one of the following durations for each note: 5, 7, or 11 seconds.
- Dynamics: Computer chooses randomly one dynamic: p, mp, mf.
- Texture: The same process is played on 3 different registers on simultaneous playback engines creating a 3 voice polyphony.
- Timbre: The computer selects randomly one of the following timbers: bowed Lyra and the Floyera (from Greek traditional instruments), strings, choral voices and pads created with granular synthesis.
- Rests: Each voice has a 10% chance to stay silent for a duration of 5, 7 or 11 secs.
- Sub bass: A forth voice will play pedal low tones choosing randomly the pitches according to the table in figure 4.3, a simplified version of the previous table.

Figure 4.3

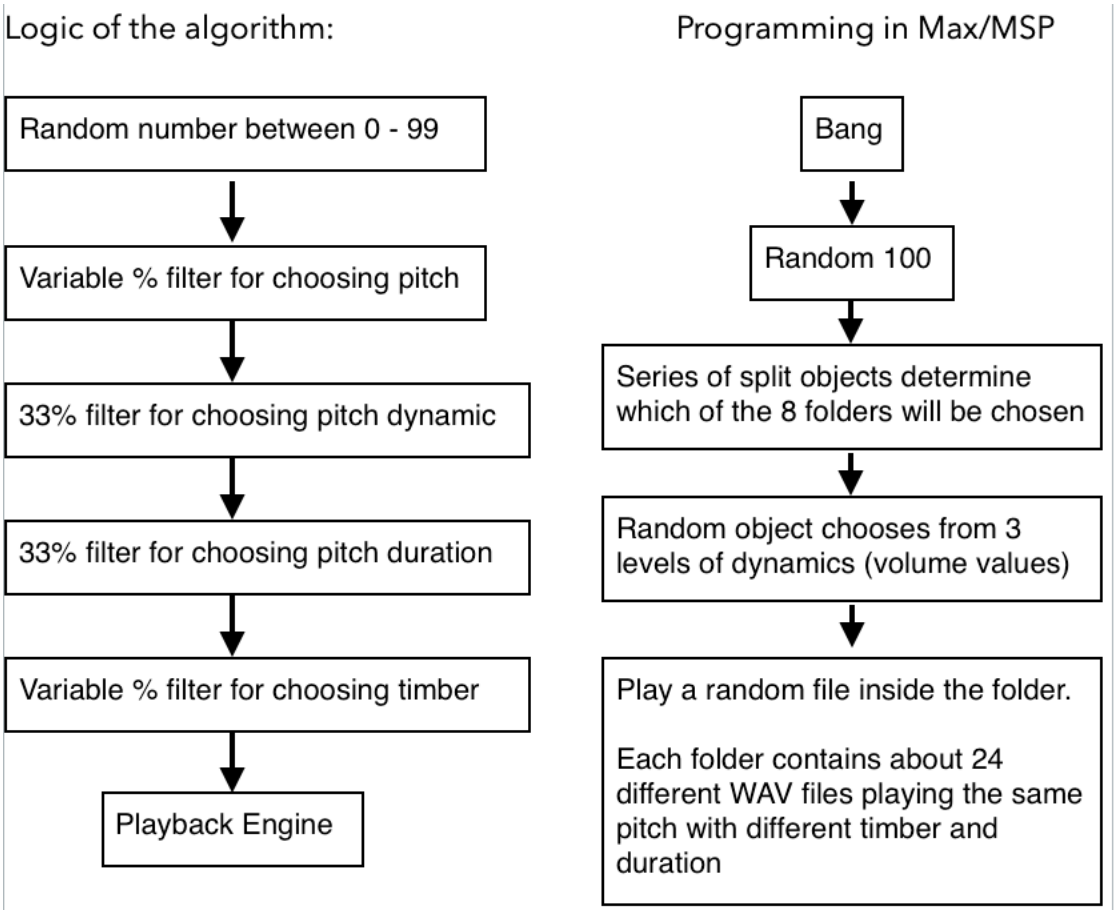
SUB VOICE	A	C	D	F	REST	Total
Total %	28	27	15	2	28	100

Due to the meditative nature of the piece, the sub bass voice plays longer notes and rests, choosing randomly from the following durations: 11, 13 and 17sec.

4.2.2 Implementation

A pool of sounds is created by playing with sample libraries all the possible notes in the system. Each note is organized in a folder according to pitch, length and timber. An algorithm is programmed based on these probabilities. The system has been programmed on two separate platforms. The first one is based on Max/MSP, where the machine creates a random note for each voice:

Figure 4.4



This automatic playback system requires the following folder organization:

Voice 1 (High Register), Voice 2 (Mid Register) and Voice 3 (Low Register) have:

8 Folders (for 8 pitches)

Each folder contains 18 to 24 audio files with:

3 different durations (5, 7, 11sec)

6 to 8 different timbers per note.

Voice 4 (Sub-bass) have:

4 Folders (4 pitches)

Each folder contains 3 audio files with:

3 different durations (11, 13, 17 sec)

1 timber: glassy resonance

The complete system requires: 4 folders, 28 sub-folders and 500 audio files.

Wwise version - Implementing a composition system with 500 audio files for just one section of the game is unsustainable.

A reduced system was developed in Wwise limiting durations, timber and dynamics.

Figure 4.5

High & Mid Voice - 8 Notes: (A, Bb, B, C, D, F, G, G#) - (1 sound = 2%)

	F	G	G#	A	Bb	B	C	D	Total
Original %	2	8	3	28	15	2	27	15	100
# Sounds in folder	1	4	1	14	8	1	14	7	50

Low Voice - 6 Notes: (A, Bb, C, D, F, G) - (1 sound = 3% aprox) divide % by 3

	F	G	A	Bb	C	D	Total
Original %	3	9	30	15	27	16	100
# Sounds in folder	1	3	10	5	9	5	33

Sub Voice - 4 Notes: (A, C, D, F) - (1 sound = 11% aprox) divide % by 11

SUB VOICE	A	C	D	F	Total
Total %	39	37	21	3	100
New %	3.545454545	3.363636363	1.909090909	0.272727272	9.090909090
# Sounds in folder	3	3	2	1	9

Total sounds for Wwise version: 142

4.3 The Choir

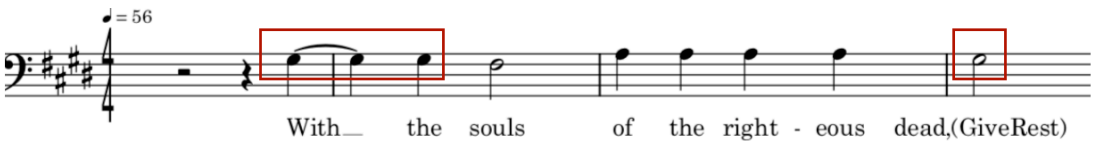
The most realistic cue in terms of story and audiovisual context. A vocal piece composed in GCOC style, based on a *cantus firmus* harmonized in six different versions (fig. 4.6), containing lyrics extracted from *Prayer for the departed* (Orthodox Eastern Church, 1945, p.27), included in the book *A Manual of Eastern Orthodox Prayers*[10]. This prayer fits the story of the game as it takes place in an island of the sick and the dying, taking place in 1950.

The first five variations follow the byzantine traditions duplicating the melody to the octave and using long pedal tones. The sixth version is a four part polyphony, developing the previous five versions. See Appendix iv.

4.3.1 *Cantus Firmus* Based on Christian Orthodox Prayer

Inspired by the GCOC and John Tavener, a melody with modal ambiguity but within the byzantine style was written, structured in 8 phrases.

Figure 4.6



[10] Also included in the catalogue *Prayers in time of sickness, suffering, dying and death.*

For the most part the reciting note or dominant and the final note is G#, as shown in the first phrase (fig. 4.6). C# aeolian might seem the mode but the lack of cadential statements through the whole *cantus* gives the line some flexibility to be interpreted and harmonized in different modes.

4.3.2 Multimodal Harmonizations and *Motet* Counterpoint

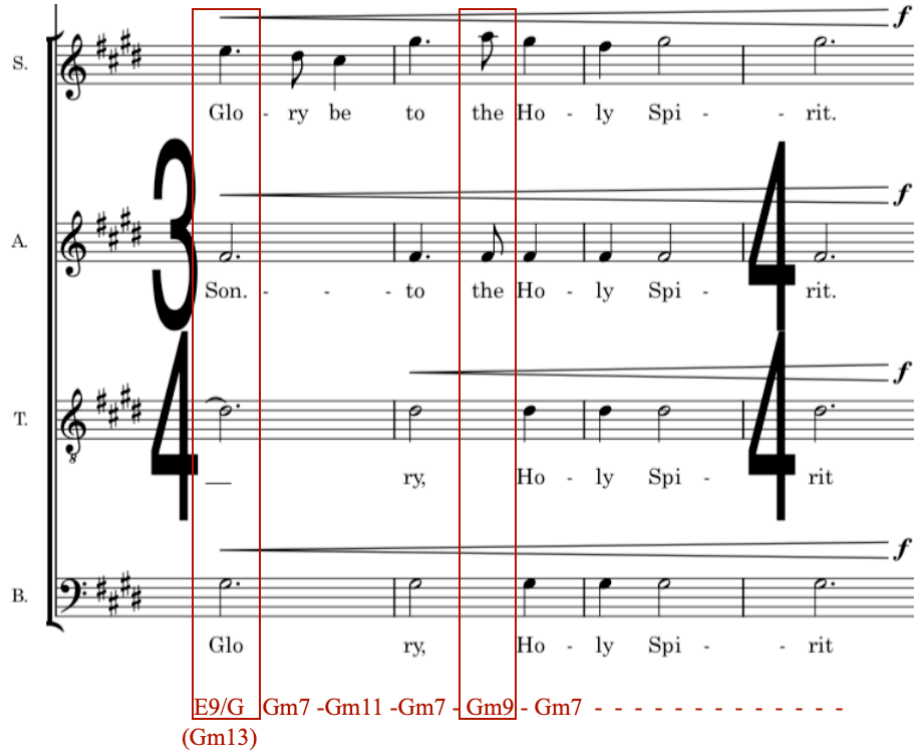
Figure 4.7

Version / Layer	**Texture**	**Mode**
Cantus Firmus	Monodic	Ambiguous: Dominant = G#, Finalis = C# or G#
Version / Layer 1 - Harmonization 1	Biphonic: Melody over long pedal drones	C# Aeolian
Version / Layer 2 - Harmonization 2	Biphonic: Melody over long pedal drones	C# Minor
Version / Layer 3 - Harmonization 3	Biphonic: Melody over long pedal drones	G# Phrygian
Version / Layer 4 - Harmonization 4	Biphonic: Melody over long pedal drones	E Ionian
Version / Layer 5 - Harmonization 5	Biphonic: Melody over long pedal drones	F# Dorian
Version / Layer 6 - Harmonization 6	4 voice polyphony, 4th species counterpoint	C# Aeolian

Each version is harmonized in a different mode, giving the piece variety, harmonic complexity but maintaining the unity through the fixed *cantus firmus*.

The final version changes the texture and goes into a complete four voice polyphony in *Aeolian* mode of C#. This last layer is written in a non strict *Motet* form in terms of polyphony but with some less restricted harmonic rules, allowing some seventh and ninth chords.

Figure 4.8



4.3.3 Interactivity and Implementation

The piece is to be implemented in a layer system divided in 2 sections. In the first, the machine chooses randomly from the first five layers, changing layer after playing each phrase. The second part gets triggered when the player has a full view of the choir so the sixth layer enters with a two bar crossfade.

4.4 The Church Organ

Following the logic of the area, an organ piece in *Passacaglia* form was composed for the moment the player sees the organ. It is inspired in Bach's *Passacaglia,* therefore it follows some stylistic rules of the baroque polyphony and harmonic structure. It is in A minor but following the idea of the previous section, it sometimes falls into tonal ambiguity having dominant substitute chords and mode mixtures. See Appendix iv.

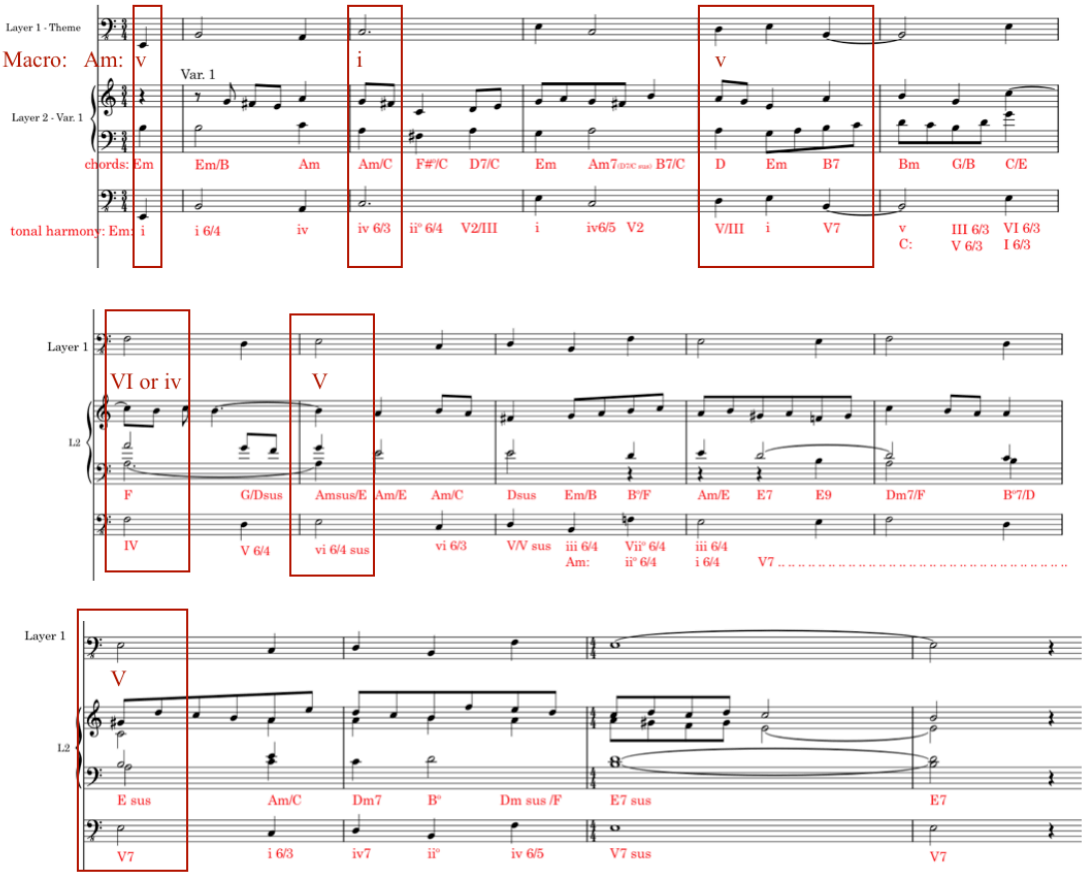
4.4.1 Baroque Organ and *Passacaglia* Form

Hansen's *Passacaglia* is all based on a repeated theme in the bass played by the organ pedals. Maintaining the harmonic progression seven different variations are build on top.

The main macro harmonic progression is Am: v - i - v - VI (or iv) - V

All variations follow this macro structure in harmony but have many other chords in between, acting as passing harmonies or embellishments. Figure 4.9 shows an example of the relationship between the structural harmony of the theme against a more colorful progression on variation 1.

Figure 4.9



Hansen's *Passacaglia* also aims to develop more tension as the piece evolves, variation 7 will be the most dense as it has higher amount of chromaticism and

complex rhythmic figures towards the end. Unlike Bach's, this piece ends always in an open cadence (V7) aiming to leave the section inconclusive and maintain the tension until the next area.

4.4.2 Variations Into Layers Implemented in Wwise

Each variation corresponds to one layer. The machine switches between layers always going fo the next layer (never backwards) with a cross fade of one bar. When the player gets near the stairs, the final layer is triggered and starts a cross fade with the next piece, sharing the same dominant chord.

4.5 The Altar: Baroque into Thriller

The character gets a clear view of the altar. There is something wrong going on, therefore the music slowly transforms its ecclesiastic tone into a horror thriller. The organ is still the main timber as the physical instrument is right above the scene, but some new elements are brought in that transform the soundtrack from a sole source music into a mixture of both diegetic and non diegetic music.

4.5.1 Compositional Approach

The piece starts with the dominant of the organ piece (E major) that turns into a minor chord and begins a sequence of minor chords moving by fourths ending in a dramatic cadence of a viiº7 - V7 of Gm which is the root of the next area.

Harmonic progression: E7 - Em - Am - Dm - Gm - Cm - Fm - Ebº7 - D7

New timbers are added to increase tension such as a child's choir and string waves of clusters that comes and go within every two chords.

4.5.2 Implementation - Linear composition

The whole level has been in a stealth gaming mode. In this area the character must get out unnoticed in exactly one minute[11]. Therefore the cue is a linear piece with a tension buildup. Additionally the strings clusters serves as cadential elements for when the player gets out faster.

4.6 The Graveyard: Musical Soundscape

The last area is outside the church in the middle of a graveyard. The presence of the character has been noticed and the scene of the preacher in the altar reveals that something wrong is going on. Nonetheless the music intends lighter mood as the player is finally out of that dense liturgical atmosphere.

4.6.1 Irregular Melodic Lines and Sound Design for Immersion

Out in the open, the soundscape plays an important role to contrast the ambient change. A nocturnal ambience sound was recorded and equalized, boosting the frequencies of a G minor chord, creating an organic pedal pad.

Figure 4.10

[11] Hansen is still in development so the duration of the time limit is still in consideration.

Boosting up the frequencies that corresponds to a G minor chord[12] while reducing the low and high end is an effective way to create a drone chord within the soundscape itself. A baritone violin plays a melody on top, accompanied by traditional Greek instruments (Santouri, Lyra and Daouli). A violin section plays the Gm chord with occasional added sevenths and ninths in the "spectral scrubs technique"[13]

4.6.2 Implementation: Looping technique

This cue works as a continuous seamless loop. The implementation is just an audio file looped endlessly until the area is completed. The composition aims to make the repetition unnoticeable in terms of music and audio.

For this purpose, the melodic line of the baritone violin is based on short irregular motives without cadential gestures. When the loop starts again it's unclear if the piece is repeating or if another characteristic un-evolving motive is starting. The soundscape is cropped at the beginning and at the end when the audio wave is at zero matching the wave's shape at both ends.

[12] 97.99Hrz is the frequency of the note G2, the root of this cue's chord. Boosting this frequency as well as the equivalent of its octave, fifth, and minor third creates the desired sonority of the Gm chord embedded in the sound of the ambience background.

[13] Spectral scrubs is a technique included in the Spitfire London Contemporary Orchestra Strings sound library

Chapter 5. Discussion and Conclusion

5.1 Introduction

The process of composing interactive music that fits the narrative and aesthetics of a thriller video game is a challenging process that involves research, experimentation and constant trial and error. Working through the process with academic background, technical research and feedback exchange with the developers and experts have been the main keys for evolving and materializing this project. Tools and methodologies developed herewith are open to further discussion according to their success or otherwise in terms of consistency with the story, applicability and relevance.

5.2 Summary of Thesis

This project aimed to develop different approaches to score a level of a video game, based on multiple techniques and styles related with the story. Bringing depth and complexity into gaming music that perhaps has been limited by the implementation systems, has been a major motivation.

Extracting musical information with mathematical methods to develop algorithmic composition and adapting traditional forms and styles into interactive audio has been the proposed methodology. The result is a complete music piece articulated in five sections, synchronized with a complete short walkthrough. The piece has been also presented in separate audio and draft video files to show the composition methods applied on longer versions game play.

5.3 Reflection

Creativity in composition is fueled with every new discovery and implementation wether is successful or not. Many harmonic experiments where unsuccessful for a commercial video game score, however they always opened a new path for a new approach to be considered. In terms of research, the project could have used more analysis on gaming music examples, going into more detail about interactive audio. The implementation process was also far from perfect as the limitations of the software at hand could have been anticipated earlier in the process.

5.4 Contributions and findings.

Arguably the music itself works within the context of the level and the story of the game, however many questions are yet to be answered regarding the thesis motivations and objectives. It's possible that the compositional approaches have brought harmonic variety and complexity to the game's score and the developer has shown a general approval of the results so far. Nonetheless there is still a big question about whether this approaches will be suitable for other kinds of stories within the same genre. Hansen's Church is a very specific level that allows the composer to rely on ecclesiastic styles. Probably these methodologies would need further development and adaptation when scoring other areas or other types of stories.

In spite of still having questions unanswered, the process of developing these compositional approaches expanded the views on what are the real limitations of interactive music and what kind of systems are the most effective when scoring a game. Many of these experiments also have broaden my musical language and sound

palate improving and refining an individual style. Future projects in gaming and film scoring will certainly have a direct influence on the findings of this project.

5.5 Future work

Being a work in progress, Hansen still requires some time for the final implementation of this score. This leaves an opportunity to perfection the production of the score and improve the implementation system working along side the developer of the game. Furthermore, the project left some room for further experimentation in the world of Hansen as much as in the genre of thriller games. The application of *Markov chains* based on other musical parameters is just an example of the next steps to follow.

5.6 Conclusion to thesis

Developing this thesis and project has proven to be a challenging path of research and experimentation. Trying to bring harmonic variety and complexity to a comercial music industry, basing the research and methodologies upon concert music and avantgarde techniques is an ambitious idea that requires a lot of energy and time investment on putting theories to the test. It is nonetheless exiting and enlightening for a composer who comes from a traditional academic music background and is willing to expand its language further into other kinds of media.

The following questions have been answered up to some extent:

- What level of harmonic complexity in the music will actually work on gaming?

  Hansen's score have proven a high amount of chromaticism, however it has been

justified by the context of the style and environment. It would be impossible to generalize this as a statement for other types of genres and visual aesthetics.

- How much of the music can be completely aleatoric and still fit in the story?

  Only the first part of Hansen's level was based on a highly aleatoric compositional approach. The other four areas required more structural rules for composition matching a style and the visual content.

- How can these scoring techniques become systematic and develop an efficient workflow in the video games industry?

  The music for Hansen proved some efficient methodologies based on basic interactive audio principles. Translating multi-modal harmonizations and continuous variation techniques into a layer's systems are approaches that can be applicable for other kinds of gaming music. However the algorithmic composition system developed proved to be demanding in terms of programming and efficiency, thus very difficult to implement on other platforms until further refinement.

Further research and development remains open to improve the systems used in Hansen's church. Nonetheless the combination of the five different compositional approaches proved to be effective for the level, giving variety and complexity within an ecclesiastic environment, and yet maintaining a coherent unity through the level.

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