

**ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF ARTS AND  
SOCIAL SCIENCES**

**USE OF SPECTROGRAM ANALYSIS AS A TOOL TO IDENTIFY FORMAL  
ELEMENTS IN SELECTED WORKS FROM BEFORE AND AFTER THE  
COMMON PRACTICE PERIOD**



**M.A. THESIS**

**Deniz KIRAN**

**Department of Music**

**Music M.A. Programme**

**JANUARY 2020**



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**Thesis Advisor: Assoc. Prof. Jerfi AJİ**

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**İSTANBUL TEKNİK ÜNİVERSİTESİ ★ SOSYAL BİLİMLER ENSTİTÜSÜ**

**KLASİK DÖNEM ÖNCESİ VE SONRASINDAN SEÇİLEN ESERLERDE  
FORMAL YAPILARIN BELİRLENMESİNDE BİR ARAÇ OLARAK  
SPEKTROGRAM ANALİZİ KULLANIMI**

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Deniz KIRAN, a M.A student of ITU Graduate School of Arts and Social Sciences student ID 409151007, successfully defended the thesis/dissertation entitled “USE OF SPECTROGRAM ANALYSIS AS A TOOL TO IDENTIFY FORMAL ELEMENTS IN SELECTED WORKS FROM BEFORE AND AFTER THE COMMON PRACTICE PERIOD”, which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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*To my grandparents,*



## FOREWORD

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## ABBREVIATIONS

**mm:** Measures  
**mvt:** Movement





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# **USE OF SPECTROGRAM ANALYSIS AS A TOOL TO IDENTIFY FORMAL ELEMENTS IN SELECTED WORKS FROM BEFORE AND AFTER THE COMMON PRACTICE PERIOD**

## **SUMMARY**

Although musical analysis is conventionally score and listening based, we can now think of new ways to make analyses. This study is based on the assumption that spectrogram could be used to see formal designs of compositions. Such a use of technology is rare in that it is generally used not to analyse but to produce music. Because form must be thought together with many elements of music such as harmony, rhythm, tempo, themes, motives, dynamics etc. it could be claimed that spectrogram analyses could provide us with hints regarding the formal designs.

In the introduction, the concept will thoroughly be explained along with methods and other analytical tools that would accompany the main analysis method. Therefore, introduction and methodology will be handled together. There will also be philosophical approaches to the concept of form and recent considerations regarding the contemporary music forms.

In the second chapter, familiar pieces with familiar formal designs will be exposed to spectrogram analysis and the concept will be made even clearer.

In the third chapter past repertoire will be explored in terms of form. Common microstructures will be discussed and shown in the visual representations of the sound provided by the spectrogram.

In the fourth chapter, formal analysis will be conducted on contemporary repertoire. Certain elements constituting formal design will be discussed.

In the conclusion general approach in these analyses will be summarized and several drawbacks of the analytical tool will be added to those mentioned within the scope of cases. Improvable aspects of the method will be discussed and certain suggestions will be made.



# **KLASİK DÖNEM ÖNCESİ VE SONRASINDAN SEÇİLEN ESERLERDE FORMAL YAPILARIN BELİRLENMESİNDE BİR ARAÇ OLARAK SPEKTROGRAM ANALİZİ KULLANIMI**

## **ÖZET**

Müzik analizi geleneksel olarak skor ve dinleme temelli olsa da bugün analiz için yeni yollar düşünmek mümkündür. Müzik analizinin amacına göre farklı analiz yolları geliştirilebilir ya da elimizdeki analiz yolları beraber düşünülüp hibrit bir analiz yöntemi ortaya çıkarılabilir. Müzik analizinin armonik materyalleri ve yapıyı belirlemek, yapısal unsurları saptamak ve bunların bir araya nasıl getirildiğini ortaya koymak, dönemsel olarak nasıl besteleme yöntemleri ve yaklaşımlarının kullanıldığını anlamak, müzikteki tarihsel değişimi anlamak ve benzeri birçok amacı olabilir. Bu amaçlar yalnızca müzik disiplini içinde var olabileceği gibi sosyal bilimlerin diğer alanlarıyla ilişkili bir karaktere sahip olup disiplinlerarasılık da sergileyebilirler. Bu çalışmada böyle bir disiplinlerarasılık söz konusu olmadığı gibi burada anlatılan analiz yönteminin diğer disiplinlerde müzikle ilgili yürütülen çalışmaları destekleyebileceği düşünülmektedir. Salt müzik disiplini içinde bir uğraş olduğu söylenebilecek olan form analizi, bu çalışmada teknoloji ile desteklenmiş, geleneksel form analizi yöntemlerine destek olması amacıyla spektrogram ve spektrogram görüntüleri, form saptamasında teknolojik araç olarak kullanılmıştır. Bu çalışma eserlerin formal dizaynlarının spektrogramda gözlenebileceği varsayımına dayanmaktadır. Basitçe X ekseninde zaman ve Y ekseninde enerji seviyeleri ile frekansları, dolayısıyla notaları gösteren spectrogram form hususunda sıkıntılı sayabileceğimiz repertuvarlardan seçilecek eserler üzerinde bir form analiz yöntemi olarak denenmiş ve sonuçlar bu çalışmada paylaşılmıştır.

Müzik özelinde teknolojinin analiz amaçlı kullanımının üretim amaçlı kullanımından daha az olduğunu söylemek yanlış olmayacaktır. Form kavramı, armoni, ritm, tempo, temalar, motifler, dinamikler vb. müziğin birçok unsuru ile birlikte düşünülmesi gereken bir fenomen olduğundan, spektrogramın form analizinde işe yarar ip uçları sağlayacağını söylemek yerinde bir iddia olarak düşünülebilir. Bu iddianın test

edileceđi ilk nokta form konusunda olduka normlara uygun hareket eden eserler olmalıdır. Biimsel kalıpları bilinen eserlerin spektrogram grntleri ile formlarının korelasyon gstermesi alıřmaya devam etme kararı alınması aısından byk nem arz etmektedir. Dolayısıyla alıřmanın giriř blm ile birinci blm bu dođrultuda kurgulanmıř, yntemi test etmek iin analizi yapılacak eserler bu hususa dikkat edilerek seilmiřtir.

Giriř blmnde konsept etraflıca aıklanmıř, ana analiz metoduna eřlik edecek diđer metodlar ve analiz araları anlatılmıřtır. Bu sebeple giriř ve metodoloji beraber ele alınmıřtır. Spektrogramın fonemler ile iliřkisi mzik eserlerinin biimsel dizaynlarının spektrogramda grntlenebileceđi varsayımının ıkıř noktasıdır. Fonemlerin ve dolayısıyla kelimelerin spektrogramda bařka hibir veriye ihtiya olmaksızın okunabilmesi, spektrogram grsel verilerinin mzikal unsurları da yansıtabileceđi dřncesini dođurmuřtur. Bylece metodoloji hem orijini hem de bu alıřma zelindeki amacı ile beraber ele alınmıř ve etraflıca aıklanmıřtır. Form konseptinin klasisizm ile olan iliřkisi sebebiyle diđer dnemlerde ikincil duruma dřmesi sebebiyle řekilsel zelliklerin mzikal yaratı srecinde rol oynamadıđı sylemine varan yaklařımlar yine bu blmde yer alan tartıřmalarda ele alınmıřtır. Ayrıca form konseptine ve ađdař mzik formlarıyla alakalı dřncelere iliřkin felsefi yaklařımlar da bu blmde bulunacaktır.

Bir nceki blmde form kavramını ele bir dizi tartıřma sonrası, ikinci blmde tanidik formal dizaynlara sahip bilindik eserler spektrogram analizi ile incelenmiř ve bylece metodoloji daha belirgin hale getirilmiřtir. Bu blmde ele alınan ve spektrogram ile formları incelenen eserler basit formal dizaynlara sahip olan rondodan karmařık temalardan, kprlerden ve tonal maniplasyonlardan meydana gelen sonat formuna uzanan bir yelpazede ele alınmıřtır. Ayrıca hcrelerden, motiflerden, temalardan, melodilerden ve dnřmlerden bahsedilmiř, bu yapısal unsurların spektrogramda gzlemlenip gzlemlenemeyeceđi ile ilgili analizler yapılmıř ve tartıřmalar yazılmıřtır.

nc blmde klasik ncesi dnem form aısından incelenmiřtir. Yaygın mikro yapılar anlatılmıř ve spektrogram tarafından sađlanan grsel ses temsiliinde gsterilmiřtir. Rnesans ve Barok dnemden seilen eserlerin incelendiđi bu blmde her repertuvarın kendine zg kompozisyon unsurları ierdiđi ve bestecilerin bu unsurları kullanarak bilerek ya da bilmeyerek řekilsel dizaynları da

bunlara göre sonuca ulařtırdığı fikrine ulařılmıştır. Eserler arasında ortak olan özellikler farklı kayıtların spektrogramda incelenmesiyle sesi temsil eden spektrogram görsellerinde de gözlenmiş böylece bu unsurların bir nevi fonemlerde olduğu gibi spektrogram tanımları yapılmıştır. Tüm frekansları üretme özelliğine sahip enstrümanlar ya da bu frekansların kayıt mekanına bağı olarak frekans aralığını tamamen doldurması sonuca ulaşma konusunda en problemli durum olarak belirlenmiş ve bu duruma çözüm olabilecek bir uygulama sonuç bölümünde gösterilmiştir.

Dördüncü bölümde modern/çağdaş repertuar üzerinde form analizi yapılmıştır, formal dizaynı oluşturan belli başlı unsurlar tartışılmıştır. Modern/çağdaş repertuar söz konusu olduğunda belli başlı formal unsur tanımları yapılması gerektiğinden öncelikle isimlendirme ve hangi yapının nasıl yorumlanması gerektiği üzerinden bir tartışma bu bölümde yer almaktadır. Bu repertuarlardan seçilen eserlerin belki de en çok tarihsel, felsefi ya da son dönem bilişsel çalışmalardan hareketle ‘duygu içeriği’ yönüne vurgu yapılmıştır. Bazı eserlerde form açısından verimli sonuçlar elde edilse de çoğu eser için kesin sonuç elde edilememiş, spektrogram şekilleri üzerinden benzerlik prensibine dayalı olarak niteliksel gözlem düzeyinde kalınmıştır. Bu bölümde varılan sonuç bir algoritma gerektiridir. Niteliksel analiz becerilerinin ötesine geçen ve böylece analizi imkansıza yakın kılan müzikal unsurları sayısal olarak analiz etmek daha güvenli sonuçlar verecektir.

Sonuç bölümünde ise bu analizlerdeki genel yaklaşım özetlenmiş ve analiz aracının olumsuz yanları, analiz altlarında bahsedilen repertuvara özgü olumsuz yönlerle eklenmiştir. Metodun geliştirilmesi gereken yönler tartışılmış, çeşitli önerilerde bulunulmuştur. Yine bu bölümde sonuç alınamayan bir eser, başka bir spektrogram yazılımına konulup analiz edilmiş ve yöntemin başarısızlığının yazılıma bağı olup olmadığı test edilmiştir. Performans kaydındaki frekans aralığının dolu olması sebebiyle spektrogramda uygun bir şekilde analiz edilemeyen bir eserin, yine bu bölümde, piyano transkripsiyonu yazılmış, bu piyano transkripsiyonu analiz edilmiştir. Yöntemin başka analiz amaçlarıyla kullanılması için tavsiyelerde bulunulmuş ve olumsuz yönlerin elimine edilip yöntemin geliştirilmesiyle iyi bir analiz aracı olması temennisiyle çalışma nihayete erdirilmiştir.



## 1. INTRODUCTION

Ever since the technology has been available in the area of music, or sound more broadly, processing, transforming and many other interventions have come to light for creative purposes primarily. However, such availabilities are rarely used reversely. In other words, people prefer to use music technology as a means to produce music, be it a hiphop song or highly intricate spectral music, but the analysis of those productions is still conducted mainly on paper. There are new approaches to musical analysis such as structural listening or conceptual approaches but as the names imply, they are dependant on auditory data rather than visual ones which are provided more by digitalisation than the former. In this study, spectrogram analyses have been used in order to determine whether they could be used as a means to identify musical forms mainly in pre-baroque and contemporary music and to attain commentaries about musical pieces based on visual data provided by the spectrogram. Spectrogram is a tool in which sound signal is analysed and a visual representation of the sound is created thereby. In the visual representations it might be easy to see parts where sound signal demonstrates alteration. The probability that such variations in the sound signal, or actually in its visual representation, could elicit implications regarding formal structures might be useful in evaluating contemporary pieces which are difficult to label in traditional terms and whose scores are difficult to obtain. Even in cases where traditional scores are not available as in the cases of graphic scores or improvised sections between written music, spectrogram analysis might yield good results in terms of analyses of all kinds. Spectrogram analyses might be used to further the quest and one could attain commentaries including semiotic/semantic analyses, mathematical analyses depending more on digital data than on the score, so-called language based analyses such as syntax analysis or grammatical analysis etc. In this study, spectrogram commentaries will include a general formal overview of pieces in conventional terms using the letters or familiar form analytical annotations and a brief commentary

about the structures of them for which conventional analysis methods cannot be easily employed due to its lack of ability to convey these structures' function or meaning. Moreover, syntactic, grammatical, semiotic or any other kinds of analyses might be used for the purpose of concretisation of the piece. Concretisation is an important process for understanding such pieces as they are often of abstract nature or due to the fact that we are accustomed to perceive them so, maybe because of that the abundant availability of tonal tradition has shaped our understanding in such a way that two completely different musical traditions, one coming before the functional tonality and the other one after, sound supposedly similar in terms of familiarity, expectancy, cadences, style, components, form, narrative, purpose, accentuation and so on.

At this point, it is also necessary to define form, formal structures and form analysis in order to constitute a basis for the analyses and commentaries ahead. Form is defined as the phenomenon that makes it possible for music or any other creation to be organized and built in terms of structure and design (Whittall, 2001). In my opinion form is a necessary condition of existence as 'being' is a form of definition. Etymologically, *definition* comes from Latin *dēfīnītīuus* which turns into various words via Old French in English with meanings *to limit*, *boundary*, *an end* (Partridge, 2009). In case there is an end in something, there must be a beginning, as well. Definition, therefore, requires a beginning and an end which could be regarded as the most basic components of form. Philosophically, 'form' is used as an equivalent to the Greek word '*eidos*'. The term is actually the denotation for Plato's forms and ideas. Approaches to form by the two great philosophers of antiquity, Plato and Aristotle, indicate perspectives that are used even today, form as a tool to grasp the nature of music and form as a tool to perceive it and its units, respectively. For Plato, form and idea are virtually the same concepts probably due to the fact that he regards ideas as the basic schemes according to which things come into existence. For Aristotle, though, form is a necessity to be understood by human mind. In accordance with the first approach by Plato, one might use ideal schemes and understand the nature of a partial piece, which is reminiscent of analysis-oriented musical form perspectives. Aristotle, on the other hand, focuses on the limited perception abilities of humans and asserts that 'a being' must have some sort of form in order to be intelligible, which reminds us of pedagogy-oriented musical form.

Both philosophers further their comments on form with a tendency to go beyond matter and make idealistic statements such that Aristotle asserts that human soul is the form and body is the matter which accomplishes the form whose immanent knowledge is provided by the former. However, form should not necessarily be taken as ideal as it is treated in these philosophers' approaches. Nevertheless, it is striking that Aristotle, after making many comments which could be taken as ideal, adopts a view incorporating physics and claims that when unsupported a material falls to the ground in order to reach its most immanent form. Therefore, it is revealed that from time to time there could be conflicts between form and matter according to Aristotle. The fact that it is matter that changes to reach its form but not form might be implying the hierarchy between form and matter (Flew, 1979). Comparing these approaches with ones on music forms might be a good start point for a philosophical pursue regarding musical form which is not in the scope of this study.

Schoenberg gives a both philosophical and practical definition for form in his book *Fundamentals of Musical Composition*. The author begins with explaining that form might have associations with different components of music such as parts, size of parts and dance characteristics such as rhythm, meter and tempo. Philosophical approach associates the concept of form with organization and the possibility of such organization is accepted to depend on form asserting that without form it would be a corpus which is vague, and such a bulk would not be perceived by human mind as they are not capable of understanding something too extended (Schoenberg, 1970).

Taking these approaches into consideration, one might assert that form is still a major component of creative processes. Musical forms are also significant in my opinion for a thorough understanding of a composer's creative mind although formal analysis is sometimes seen as a practice that is in the scope of theory only and that is archaic when it comes to composition. As another way of analysing form, this study will use spectrogram to put music or sound in front of our eyes.

One might state that the visual data that would be provided by the spectrogram will occupy too much place. However, syntactic analysis will become a part of the analysis in that case and only meaningful structures of the pieces will be taken into consideration. In a string quartet whose first ten minutes continues with the same idea or in the same formal manner will not be presented with real-time visual data that cover the piece from start to finish. It is therefore obvious that different

analytical and interpretive tools and methods will be employed when the occasion arises. Another downside of the spectrogram analysis approach might occur with orchestral pieces as the visual data looks similar in almost all the analyses because these pieces use a wide range of frequencies from the lowest to the highest, and thus the visual representations turn out to be very close to each other in most cases. Nevertheless, a spectrogram analysis might be conducted depending on the implications the scores bring forth for the purpose of consolidation. It is hoped that in the study many occasions will arise depending on different pieces and definition of the analysis method will become clearer. After all the cases, downsides of spectrogram analysis will be mentioned as they will primarily depend on individual pieces.

### **1.1 Different Analytical Tools In Accordance With Music Type or Styles and Spectrogram Analysis**

As mentioned above, there are different analytical tools that could be employed in the analysis process of the music in question. However, few are covered in the current literature and studies mainly focus on one analytical tool at a time mostly in an experimental setting. It is difficult to encounter a study that employs different tools in accordance with function and analytical needs. Nevertheless, it is useful to mention those approaches and tools at the beginning of this study as they will be used extensively at later points. In terms of form and structure, there are cognitive approaches, highly intricate and theoretical mathematical approaches, the familiar set theory and similar approaches. Other than these structure-oriented ones, one could make use of the semiotic analysis, syntactic analysis, grammatical analysis and other language-based approaches in terms of music. However, there is the risk of elusiveness in these approaches unless they are used together with more music-based ones as it is difficult to merge syntactic and grammatical approaches with form analysis tools and to find material from score to interpret in terms of meaning and extrapolate. Therefore, it is not surprising that when somebody searches for music syntax, they primarily find research dealing with simple Gregorian chant melodies with linguistic materials (Treitler, 1965). The more one gets closer to music, the harder it gets to render a syntax analysis. Alternatively, if meaningful definitions between syntactic or grammatical elements and musical elements are established, it

is then easier to interpret music in terms of the former approaches. For instance, the comma might be associated with the half cadence and the semantic and/or functional content conveyed by the comma could then be re-defined for the half cadence. Such associations between the two realms might be helpful for those who wish to analyse music from different times as we could encounter a half cadence in a piece but its function might not be the same as the half cadence we see/hear in common practice period in terms of form. However, such associations are rare and one might have to go beyond musical realm and make allegedly arbitrary associations based on their subjective interpretation.

Speaking of problems of interpretation and form analysis, one could observe that these concepts themselves pose some problems in philosophical terms. Form analysis is a broad concept in which an analyst could find many approaches. Although one immediately thinks of the familiar Austro-German tradition when it comes to form and form analysis, it has been proposed by Adorno that in his approach form analysis does not necessarily depend on common formal formulae such as fugue, sonata, rondo etc. but on the background elements that constitute the piece and its wholeness that is also called organicism by other writers. Moreover, the second component of the approach that would be found in this paper, semantic/semiotic interpretations are considered to be either dull or incorrect as we cannot find music in nature in the way we find other elements constituting other arts such as poetry, painting, cinema etc. Certain scholars assert that music and musical analysis only make sense within themselves, in their own terms using a language that is based on music alone. This might be true to some extent but not being able to find something in nature does not (or at least should not) mean that we cannot associate them with what we find in nature or with the immediate tool of ours for both concrete and abstract communication, our language(s). If poetry is considered to be representable by other means due to the fact that its material is language in the first place, a question springs to mind. How to represent elements of abstract poetry examples such as The Turkish Avant-Garde (The Second New Movement), where one would observe many linguistic deviations and different reality (Harmancı, 2013)? Or how to associate what we see in an avant-garde painting with what we find in nature? Music might be seen more abstract than the other two arts mentioned above as they have something that appeals to eye, an obviously more concrete organ in cognitive terms than the

ears. Though, music is not sound only today. By means of technology, what is thought to be mere sound could be a material to the eye if the only problem is the abstract nature of music (or sound) in terms of making sense of its elements. Therefore, in this study, spectrogram will be used for making sense of musical elements in terms of concreteness. Although spectrogram provides material that appeals to the eye, it should be mentioned that regarding the contemporary repertoire there are conceptual approaches in form analysis and the results are promising. Nevertheless, conceptual approaches could only be applied to rather short pieces as long listening processes might (and actually would) wear listeners and mislead the results. Similarly, in a study conducted by Irene Deliege, relatively short pieces by Luciano Berio and Pierre Boulez, *Sequenza VI* for solo viola and *Eclat* respectively, have been subjected to conceptual analysis in terms of form. Listeners, both musicians and non-musicians, have been able to discern formal groupings. The principles of sameness and difference proposed by Frisse (1967, p. 126) were the basis for such a distinction. Listeners basically pushed a button when the texture, or the atmosphere, if you will, in the music, changed. The experiment has been repeated three times, the first and the second ones named Session 1 and Session 2 respectively, and the final one named Confirmations. All three sessions show parallelism with each other although there are slight differences which could be ignored. This study clearly shows that in terms of form, psychological processes play an important part. Although conceptual approaches yield good results, they have a number of shortcomings. Firstly, an analyst needs a group of people on whom they would conduct their experiments and this might not always be possible. This difficulty also includes that one should have experimental setup and this might not always be possible and accessible, either. When an analyst should conduct a formal analysis personally, conceptual analysis cannot be the first option. Moreover, it consumes time and it is again impossible when one have concerns regarding time.

Spectrogram analysis, on the other hand, provides convenience in terms of the aspects mentioned above. As no method is perfect, spectrogram analysis also has some shortcomings and maybe the most important of these is that visual hints regarding the form should be thoroughly checked up on. The analyst must understand how shapes and formal sections correspond to each other and should not fail to

notice any repetitions or implications of the shapes as it would result in a wrong analysis.

## 1.2 Spectrogram and Spectrogram Reading

In order to obtain data out of visual representations, it is necessary to be able to read the spectrogram. As one of the main usage areas of the spectrogram is speech analysis, an experienced spectrogram reader is able to identify actual words by using the frequency components and energy levels provided by the spectrogram visual representations of waveforms. Because speech, as a significant analysis material in terms of spectrogram, has vibrations as formative elements and these vibrations are produced in the vocal tract, we also have the possibility to see the waveform of speech. But waveforms do not provide any hints regarding the content of the sound signal. The content of the sound signal could be deciphered by means of spectral analysis of such waveforms. In speech analysis, spectral content of phonemes makes it possible for a spectrogram reader to identify the syllables, words and so forth.

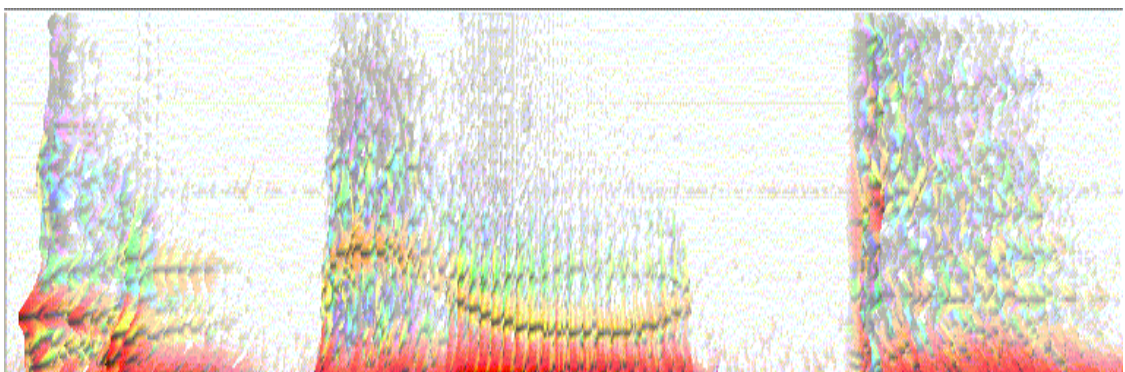


**Figure 1.1:** Spectrogram of the word “compute” (Retrieved from: <http://cslu.cse.ogi.edu/tutordemos/SpectrogramReading/spectrogram.html>).

The figure above is the visual representation of the word ‘compute’ under spectrogram and it is claimed that the phonemes forming the word can be clearly seen in the shapes. For instance, the energy burst in the right side of the image after

the second white area represents the ‘t’ sound that comes at the end of a syllable. This part is actually mentioned to be typical of the ‘t’ sound ending a syllable. The middle shape represents the plosive /p/ burst and the vowel /u/ and the first one represents the phonemes /k/ (Carmell, 1997). Phonemes are perceptually distinct units of sound in a particular language that give different meanings to words based on difference in sound. For instance the words *pan* and *ban* have different meanings due to the fact that /p/ and /b/ are different phonemes (McArthur, 2019). As well as meaning and produced sound difference, phonemes are observed in the spectrogram as shown in the example above. Based on this, one might consider establishing a similar system for music in order to identify similar – if not exact – spectrogram shapes. Just like phonemes, phoneme-like structures in music that provide us with different idiomatic, semantic, rhetoric or discursive musical elements could be defined to be identified at a later point for different analytical purposes.

Formal analyses on spectrogram, in general, could be conducted by using different aspects of the spectrogram. In spectrogram, positive x axis stands for the time and y axis stands for the energy levels with frequencies. Spectrograms nowadays use colours to denote energy levels. Generally, red stands for the maximum energy and in decreasing order of significance orange, yellow, green, cyan, blue and magenta. Gray areas have less energy than magenta and finally white areas have an energy level that is below the threshold decibel. Using colour is a rather late feature of spectrograms as traditional ones used gray-scale visual representations. The basic logic in gray-scale spectrograms is based on the darkness of a given point in both axes. The darker the point is the more energy is in question at the point. Colours also denote energy changes, as in the example above, red shades in the Y axis represent energy increase, blue ones represent energy decrease, yellow and green parts denote maximum energy level and white parts represent the absence of enough energy (Carmell, 1997).

Spectrograms usually show the frequencies between 0 and 8000 Hz. However, the software I have used in my study shows the frequencies between 0 and 21059. Higher values than these could be considered to have no significance as we, humans or primates more broadly, are not able to hear the frequencies lower than 20 Hz and higher than 20 kHz. Frequencies play important roles in terms of both music and speech. In music they are the basis of pitches as each pitch has a certain frequency

value and in speech they contribute to our understanding in the form of toning. Although we cannot hear the upper frequencies as properly as we can hear the frequencies in the range mentioned above, they have significance in that they are contributing factors to the notion of timbre in terms of music and to our understanding of speech. The reason why we ask for repetitions in phone conversations or why we cannot understand such conversations from time to time is the fact that telephone conversations cut off frequencies above 3500 Hz. Although they are not as crucially important as the fundamental frequencies, upper frequencies are also a part of the whole speech and music phenomena (Carmell, 1997).

To sum up, one should be aware of the three dimensions of the spectrogram. They are time (X axis), frequency (Y axis) and energy levels (colours). Speech could be identified in spectrograms easily as there have been extensive studies on this issue but existing musical structures remain to be classified in accordance with their spectrogram visuals if it is possible to obtain unique shapes for unique musical phenomena.

These features of the spectrogram will be used in accordance with the repertoires below. For instance, tonal works, which are put into this study for the purpose of introducing the methodology, will primarily be evaluated based on the X and Y axes respectively as the music is primarily time and tonality bound. Time will represent the consecutive formal structures and frequency axis, Y, will show the tonal areas. When functional tonality is not in question, as might be in Renaissance and Baroque pieces, bass movements, melody progressions, outer voices and such traits will be observed in the frequency axis. For instance, a musical piece based on repetitive ground bass movement might be observed in the frequency axis primarily and time axis when it comes to repetitions. Because dynamics do not play a crucial role in terms of form in Renaissance and Baroque repertoires, energy levels will not constitute a significant analysis criterion but due to the fact that they gain importance with the paradigm change in the twentieth century, the second aim of this study, to identify formal designs of contemporary pieces, will extensively use the data regarding the energy levels. Energy levels, as the third main feature of the spectrogram, and the X axis might show us the formal designs of the pieces. Frequency levels might be thought to have a subsidiary role in determining the formal designs as pitches are manipulated in a very different way in this repertoire.

In spectrogram analysis, using lossless audio such as WAV or FLAC might be considered to be important or ideal. This might be necessary for studies that deal with audio primarily. However, this study aims to analyse formal structures and designs out of spectrogram data and extreme high frequencies of the recordings are not necessary as one might observe the main body of the music in the frequency range within normal limits. Therefore, in this study, MP3 recordings of the pieces have been used as audio sources and it is thought that using MP3 as audio sources will suffice for the scope of this study. The software I use, *Sonic Visualiser*, opens the audio file and immediately creates the spectrogram for both channels in stereo recordings. The methodology does not involve further details as the observations that will be conducted are rather qualitative based on a visual interpretation than quantitative.

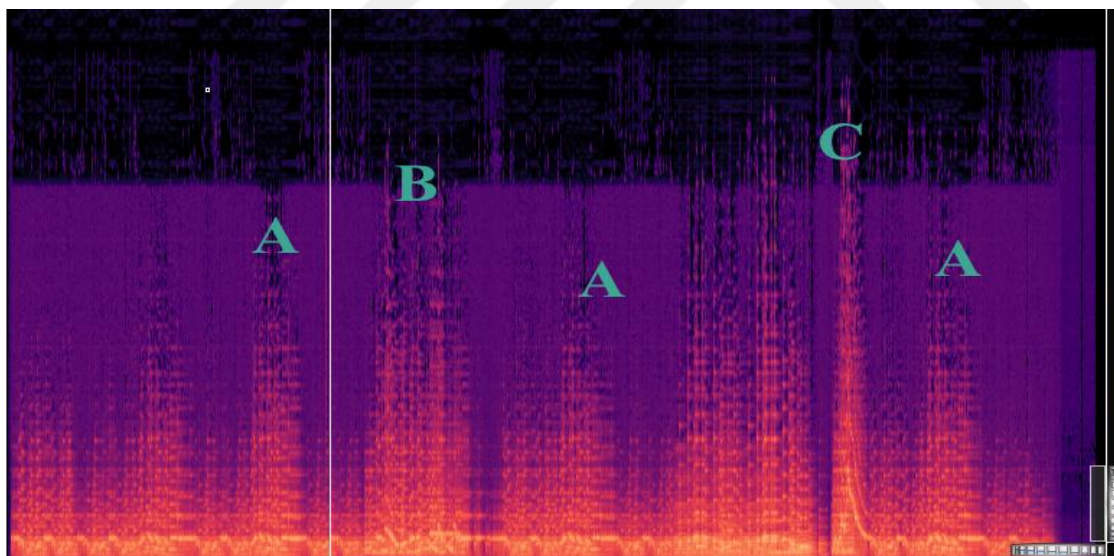
## **2. FAMILIAR FORMAL STRUCTURES IN SPECTROGRAM ANALYSIS**

In order to put an end to these abstract descriptions, formal analyses will be conducted on selected works from the common practice period with familiar formal structures by means of spectrogram. This will provide us with an insight regarding the analytical approaches that should be followed when it comes to the visual data provided by the spectrogram. Familiar music formal structures such as rondo, sonata, minuet and trio etc. will be analysed under spectrogram and the way it proposes these formal structures will be made clear and obvious.

### **2.1 Rondo In Spectrogram Analysis**

The first piece for which spectrogram analysis will be conducted for introductory purposes is *Für Elise*, Clavierstück in A minor WoO59 by Ludwig Van Beethoven. The piece, as known by many, is a five part rondo following the scheme ABACA. Rondo is a form where a repetitive musical context is mingled with different ideas and after each new idea the familiar idea returns. In this case, repetitive idea is A, which returns after B and C, and the new ideas coming after As are B and C. There are different kinds of Rondo forms such as seven part rondo, sonata rondo and nine part rondo and again in this case we observe a five part rondo consisting of three A sections, one B and one C (Caplin, 2013). Taking the rondo form of the piece into consideration one must expect to find what they see in the beginning of the analysis after the first differentiation and at the end. As might be estimated, the first differentiation will symbolise the B section of the rondo and the second one will symbolise the C section. There might be some considerations regarding the possible confusions of the sections which bring into being intricate forms but it should not be forgotten that this Austro-German example is only for providing insight about the spectrogram usage in the practice of formal analysis and the actual repertoire, which we aim to analyse by means of the spectrogram, is not that sensitive or vulnerable to a possible confusion of a section with another. As such a so-called confusion will be

taken as a different interpretation, there is no need for such self-possessed considerations. This analysis will only provide us with the visual version of what we hear or listen to. The interpretation or formal labelling will be carried out by the analyst. Maybe the most important convenience is that we can see the beginning and the end and even all the parts of the music (or sound) simultaneously in the visual version. When it comes to listening, such a convenience is not in question. Music has to be listened to from the beginning to the end if one wishes to conduct a formal analysis based purely on auditory material. Therefore, spectrogram analysis is similar to looking at the score in terms of visual data it provides. Nevertheless, the level of convenience it provides is far more developed than the score due to the fact that traditionally one should conduct a harmonic analysis on the score if the piece is from the common practice period or other type of analysis on the pieces from different periods before starting their formal analyses and from time to time composers might write the same idea in two ways that do not look like each other at all. Analysing the sound data of the music is, on the other hand, more promising in reflecting the pure nature of the piece and its components. The figure 2.1 shows the spectrogram



analysis of *Für Elise*.

**Figure 2.1:** Spectrogram Analysis of *Für Elise*.

At first glance it might be difficult to distinguish all the formal sections but with a cautious look, one can understand that the first two ascents represent the familiar theme of the piece beginning with E and E flat and continues with the arpeggiations. We can label these two ascents as A section of the piece, and the fact that similar

ascent comes after the B section and at the end supports our labelling. Again based on the principles of sameness and difference, we can assert that the different rise in the analysis represents the B section and following the repetition of A after B, the most obtrusive rise, or the energy burst, represents the C section which is followed by the final return of the A section. If we create a sketch for each formal section based on the spectrogram data, that would be more convenient for those who would find spectrogram image difficult to interpret. Therefore, for pedagogical purposes, as well, sketches might be produced in order to represent the formal structure of pieces and they could be given to the listeners who do not have theoretical background for making a formal analysis or even they can conduct such analyses in this repertoire, which could be seen as a perk beyond the main aim of the spectrogram analysis in terms of form.

## **2.2 Sonata Form In Spectrogram Analysis**

Another analysis will now be conducted on a piano sonata to see the representation of the familiar structures of the sonata. 13addence reason, a piece which has the characteristics of the sonata form has been chosen, the first movement of Mozart's F Major Piano Sonata K.332. Sonata is a name given both to the structural construction of the first movement of a sonata, which is also called Sonata Form, Sonata-Allegro or First Movement Form, and three or more movement cycle with differing characters in terms of tempo and key. The three sub-sections are called exposition, development or elaboration and recapitulation. In the exposition, we observe a main theme or theme group which is in the home key of the cycle and transition aiming to establish the related key, usually V in a major home key and III in 13adde home key, and subordinate theme in the newly established key followed finally by the closing section consisting of small codettas which are fragmented structures with finalizing character. The exposition comes to an end in the related key and development follows the repetition of the exposition. Development or as put by Schoenberg, elaboration, is a modulatory section wandering from one key to another usually without establishment of a united tonal entity in order to elaborate the contrasting middle section with modulations to remote tonal areas. Materials used in this section are usually derived from the exposition 13addenc purpose of motivic integrity. After modulatory musical deeds, the development arrives at a section where convenient

circumstances 14addenc arrival of recapitulation are provided. Most of the time, recapitulation takes us to the home key both in the main theme and subordinate theme heard in the exposition. Recapitulation, in the most convenient sense, might be followed by a coda section of closing character. Nevertheless, that the coda section is employed or not depends wholly on the composer's construct (Schoenberg, 1970).

Main themes vary within large formal structures. A section might be constituted by sentences, periods, small binary, sentential units, compound themes etc. Because the main approach in this study is that these theme types will probably not be observed in the spectrogram analyses, theme types will not be covered in depth. However, in case a theme type is obvious in the visual representations, the theme type in question will be explained theoretically. It is my belief that determining the theme type is not a practice of formal analysis when it comes to the contemporary repertoire and the pieces from the times preceding the common practice period. Yet, there might be some structures reminiscent of familiar theme types in the latter and these analyses might involve defining the similarity between these and exploring the difference thus putting across how much evolution is observed.

The piece that will be analysed now starts with F major main theme and continues with D 14adde transition which finally arrives at C major in which we hear the subordinate theme. The subordinate theme is followed by the development and sequences in the development section bring about the recapitulation which is in the main key, F. As expected, subordinate theme follows the melodic/motivic deviations which 14addenc the sake of remaining in the main key and the piece ends without any unorthodox traits in terms of sonata form. We also hear a sequence after the subordinate theme ends and C major becomes C 14adde. The sequence is followed by another section which obviously has a purpose of ending the section. This is followed by a codetta consolidating the 14addence. The development derives its melodic/motivic material from the beginning of the exposition, arpeggiations of Alberti character and in the development sequences we hear the actual sequences utilized in the exposition. Let us now analyze the exposition of the movement under spectrogram and see whether these familiar traits of sonata form are observable in the visual representation or not.

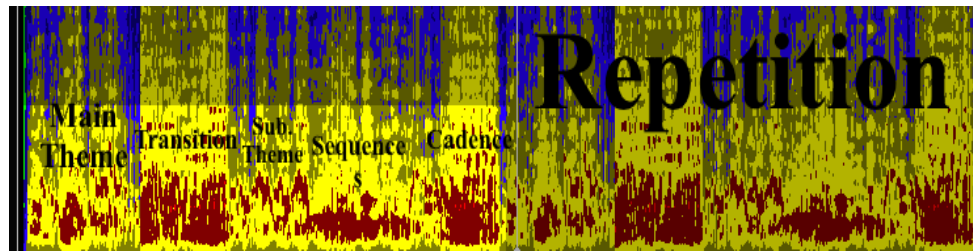


**Figure 2.2:** Mozart Piano Sonata in F Major First Movement Exposition.

With a cautious look at the exposition section under the spectrogram, one can notice different sections after they figure out the repetition point. In this case the repetition of the exposition is very clear and easily noticed as the second half of the image begins with the same figure as the one at the beginning. The highlighted part of the image above represents the debut of the exposition and the unlighted part represents the repetition. The beginning figure, arpeggiated chords, is then followed by more intense figure which is the second half of the main theme, which is again observable in the repetition. The most outstanding figure due to the dynamics, after the main theme, is the transition in D minor, which is followed by the subordinate theme. Sequences catch attention in the visual representation again due to the dynamics. After the sequences, as the final structure, we observe an arpeggiated cadence in *forte* as observable in the image. Following the cadence, codetta is not observable in the image as a separate structure but it is rather a part of the cadential section, which is actually the case given the function it serves. What is lost or what must be ignored in the spectrogram analysis could be claimed to be minimum taking into account the volume of a codetta compared to the whole exposition. Therefore, it would not be incorrect to assert that formal sections are made clear by this type of analysis not only at larger scales such as exposition, development and recapitulation in the case of sonata form but also at thematic and sometimes melodic/motivic levels. It is not surprising that the analysis also provides data regarding dynamics of the sections, which might be utilized in different stylistic settings for different analytical purposes. At this point it is not wrong to say that the visual data are very similar to convenient graphic scores. Using the same approach, let us now analyze the remaining sections of the movement, development and recapitulation respectively.

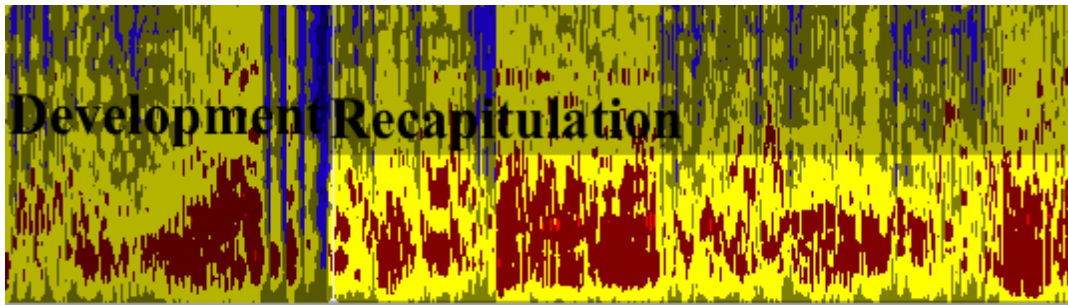


**Figure 2.3:** Mozart Piano Sonata in F Major First Movement Development and Recapitulation.

Being a new element in the movement, development is observed as an unfamiliar structure. Nevertheless, one might observe some similarities between development and exposition as they share common melodic/motivic content, most importantly arpeggiated style at the beginning, by zooming enough, but that is not the main purpose here and as there will be plenty of chances while analyzing contemporary pieces, such an effort will not be put here. As one might expect, recapitulation is almost immediately discerned by means of the sameness of the figures. The same F major arpeggiations turn back and we observe the same figures as in the exposition. The main theme, now in the recapitulation, is followed by transition but this time with deviations. Such deviations are also observable in the visual representation due to composer's effort not to modulate as the figure representing the transition occupies a larger place in this case. The subordinate theme is relatively more similar than the transition and we see the same cadential section at the end of the movement after the sequences.

Although recapitulation looks similar to the exposition at first glance, it is necessary to compare the visual representations of the two sections in order to see the similarities or differences more clearly. Therefore, before analysing the development, let us now compare the two sections.

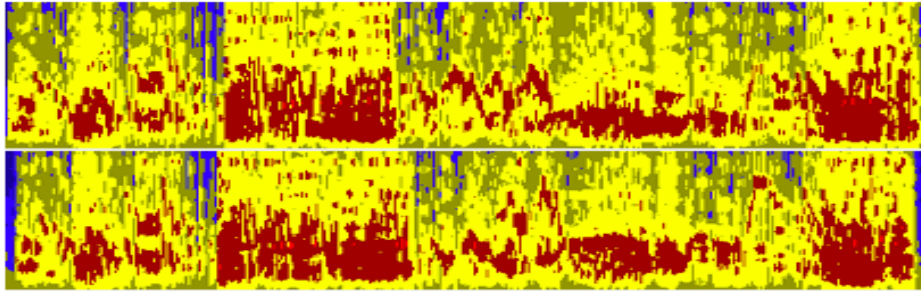


**Figure 2.4:** Comparison of Exposition (above) and Recapitulation (below) Mozart's Piano Sonata in F Major.

As clearly seen in the figure, the two sections begin with the same formal material but in the transition we observe deviations in the recapitulation. This is again another observable trait that supports the sonata form. Relatively minor deviations in the transition for the sake of remaining in the home key are followed by more obvious differences in the subordinate theme part. As known by many, it is the subordinate theme section in the home key that gives the recapitulation its characteristic and function within the Allegro movement. Sequences in the recapitulation bring back the similarities according to spectrogram visuals only and cadence sections look mostly the same. Similar shapes in cadential parts are in different areas in the image due to the key difference between exposition and recapitulation, C major and F major respectively. However, such differences are difficult to observe therefore it is not within the scope of spectrogram analysis to suggest key changes, key areas or such relations concerning tonality or pitch content to put more broadly. Nevertheless, when pitch content has importance in terms of form especially in the 20<sup>th</sup> century music it might be necessary to look for pitch relations in visual representations of the pieces. For now it is adequate to limit our perspective on structures as reflected as visual patterns.

As the final section, let us now investigate the development of the sonata form by zooming it under spectrogram. Developments generally derive their material from the exposition (Caplin, 2013) and this is true in this case, as well. Arpeggiated elements open the development and immediately after those, we hear the syncopated chordal elements that open the road to sequences. Sequences are prolonged in order to serve to the purpose of modulating and following this section there is a rather minimal structure which seems to be looking for the right key to begin the next section and which consists of only two notes, and even one might claim that one of these tones are of ornamental nature. This motive climbs and when it finally

establishes the ground for the recapitulation we hear the arpeggiated F major which begins the exposition and development comes to an end. In the spectrogram image, one can see the boundaries of the development or even other sections without listening. This is one of the most important assets of this kind of analysis. Such an ability is not provided by the score, not to mention graphic scores or score-free cases, as it, compared to the visual representation, requires more to have control over the formal structures of a piece.

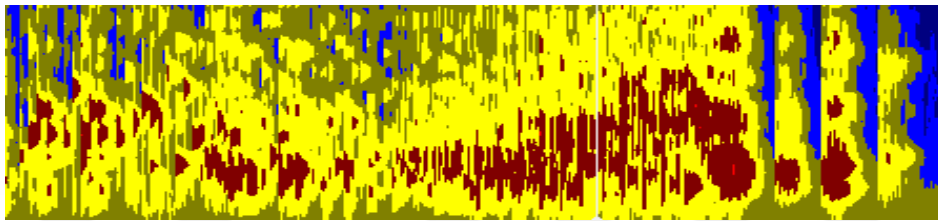


**Figure 2.5:** Development, Mozart's Piano Sonata in F Major.

As mentioned above, development in this movement begins with arpeggiations and this is observed at the left part of the image. The same figures we observe at the beginning of the exposition are found in the initial part of the visual representation of the development. One can conclude here that each spectrogram analysis provides unique analysis experience and must be evaluated within its own, which means for instance here figures representing arpeggiations might and actually would not necessarily be about arpeggiations and naturally not have the same functional and structural value. Reversely, what defines a structure or a function in the spectrogram analysis will be defined by itself, as well, and will be observable easily in the forthcoming sections as in this case. After looking at the visual representation and listening to the music, strong associations are made between the two and one starts to see the music on the image even when they look at it after a while. For instance in the figure above, the second association that catches attention is the pattern consisting of abrupt ascent and interruption in the second half of the image. This pattern, within the context of this piano sonata, reminds me of syncopated chords and the shapes actually represent the syncopated chords in question. It is observed that the similar shapes occur at different frequency levels. The similar shapes represent the same melodic-motivic material and the fact that they occur at different frequency segments suggests that the same melodic-motivic material is played on different

scale degrees. However, one cannot say for sure that these figures represent the syncopated chords without listening to the areas where these figures occur. Therefore, it could be concluded that without listening, sequences-like smaller structural elements in music cannot be identified consummately. The development derives the motivic material for syncopated chordal structures from the sequences which are also syncopated, in a three-four meter, two crotchets between two quavers, one at the beginning of the measure and the other at the end. Surely, one can see similarities between the two sections in question by zooming enough into the figures. Because such analyses between shapes will be conducted abundantly, this analysis will not be further extended.

The two analyses on two familiar formal structures, rondo and sonata, reveal some facts regarding the spectrogram analysis. Because positive traits have been covered and mentioned enough it is now fruitful to discuss drawbacks that could occur to readers' minds. In form analysis, it might be important to determine theme types such as sentences, periods, sentential structures etc., depending on the function of the analysis. This type of analysis, however, does not provide knowledge about theme types. Again, when tonal areas are important in terms of form as in the cases of tonal pieces, spectrogram analysis cannot be depended on wholly as it might be misleading for the analyst. Introductory analyses give us the opportunity to think about the repertoire on which such an analysis could be conducted full-fledged to give the maximum insight. It should also be noted that large formal designs are observed more accurately in the spectrogram than the smaller elements. Therefore, we might assert that this method is good for observing the overall design but additional knowledge is necessary to identify small elements such as sequences in the case above.

Dynamics might be used to get an idea as we can clearly observe dynamic content in the spectrogram. Motivic content is observed but melodic content is not. Therefore the analysis might yield good result in motivic transformations.

### **2.3 Rhythmic Transformations In Spectrogram Analysis**

Because the most complex music formal structures are observed in the analysis, there is no point in conducting further analyses of common music formal units such as strophic (AAA), binary (AB), ternary (ABA), arch (ABCBA) etc. Presumably, these

will also be observed in the figures. Therefore, the next step of this study must be taken now and the alleged relationship between styles and form must be set forth. But before that, because it is asserted that motivic transformations could be observed in the analysis, I would like to continue with the analysis of the first movement of Beethoven's Fifth Symphony, which heavily features those transformations. Actually, the piece itself is speculatively said to be based wholly on such transformations, as the main material is considered to be two notes divided in to four rhythmic configuration, three short ones and one long one. It is always marked that the piece is based on the same figure as the one that opens the symphony. However, scholars or those who speculatively say that the piece is based only on 'a motive' do not thoroughly indicate what material is derived from what. At this point, spectrogram analysis is thought to be capable of providing visual representation that would make the reader see clearly where motivic similarities are in question due to the fact that motivic qualities might be detected in spectrogram analysis. Such an analysis would incorporate recognizing shapes and figures, rhythmic implications put forward by visual representation and formal consideration as put forward in the previous two analyses. In such cases, where similarities are sought, an analyst must define their main material and manipulate the visual representation in order to find exact relationships or associations. Therefore, the first thing in such an analysis would be finding out what the initial motivic content would look like in the image.

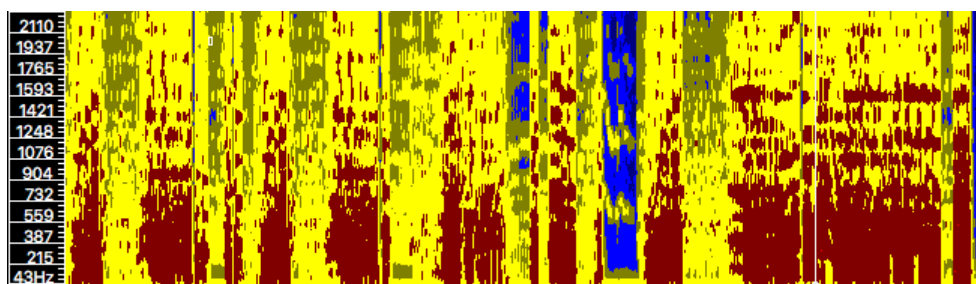
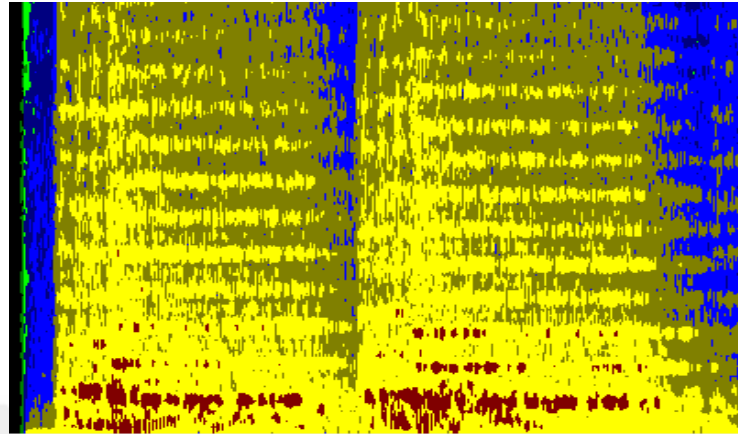


**Figure 2.6:** Beethoven's 5<sup>th</sup> Symphony 1<sup>st</sup> Movement.

The general overview of the spectrogram analysis is shown in Figure 2.6 and at first glance it is conspicuous that the main structures we observe in the image have similar shapes in both low and high frequencies. When the sound becomes dense due to dynamics of the piece, we observe the red shapes (darker in gray-scale printing) and the other parts are less dense and observed to be yellow (probably grey in black

and white). For someone who knows the formal units of the movement it is clear to see the exposition with the first dense part representing the main theme, yellow part representing the subordinate theme and then the closing section which is followed by



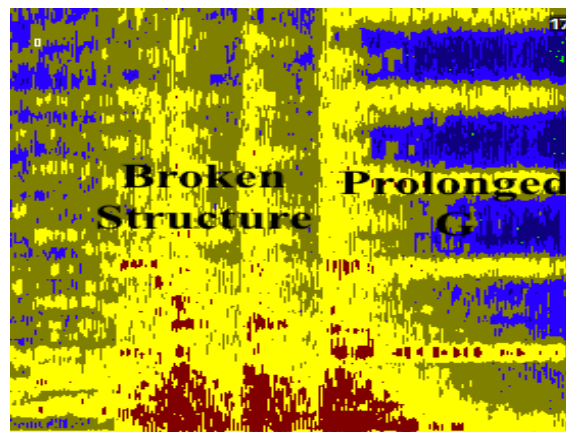
the repetition of the exposition. The yellow part, which represents the subordinate theme, might be significant in that it constitutes an example of the representation cases of dynamics. In conventional sonata form expositions, the subordinate theme is given in a context that brings contrasting elements to the main theme (Caplin, 2013, p. 268). In this case, one of the most important contrasting elements is dynamics.

**Figure 2.7:** Beethoven's 5<sup>th</sup> Motive.

In the main theme we hear (and observe here) *forte* theme with strong motivic energy and after the transitional motive that is derived from the initial motive in the horns we hear the subordinate theme in so called softer dynamic nature. Bearing this in mind, one might claim that formal structures that depend on dynamics could conveniently be determined, if not identified with full certainty in terms of theme types. Nevertheless, theme types are not as crucial as common practice period pieces when it comes to contemporary music and therefore this much recognition power provided by the spectrogram would be enough to grasp the idea of formal structures. The same might not be valid for the repertoire preceding the common practice period but there we could look for style and form relationship that might provide good answers to this quest when it comes to the analytical perspective based on dynamics. Again by means of dynamics, we could see in the visual representation the interruption of the orchestra where oboe plays a very distinct material in *Adagio* and this distinction both in terms of material, tempo, dynamics and solo character is obvious and attention grabbing as an isolated section marked with blue between

other repetitive units. Speaking of the repeating units, let us now discuss how the main motive looks under spectrogram.

The main motive, which prevails throughout the entire movement in the symphony, is observed in the Figure 2.7 above and the main motivic content is also observed in the left side of the image as three short strucks and in the right side as a prolonged single tone. The first shape is the first statement of the motive which opens the movement and it is obvious that the second statement is one tone higher if one looks carefully at the shape. Looking through the whole movement under spectrogram reveals that the movement is rather constituted on the motive following the pattern short – long notes than three short notes and one long note coming after those as we observe the former more than the latter in the visual representation. For instance, although the score indicates a fermata on the quarter-rests, violins continue playing G in this moment of silence in other members of the orchestra and the spectrogram analysis turns out to be similar to the one representing the main motive. As opposed to the main approach, spectrogram analysis reveals a different perspective on which we could further our claims regarding material derivation. The prolongation of G in the violins is brought about by open strings as revealed by a score analysis after observing a dubious situation in the spectrogram. Score-based analysis might fail to provide one with the perspective to notice such a situation. Therefore, seeing sound proves to be fruitful in identifying the phenomena that might go unnoticed in

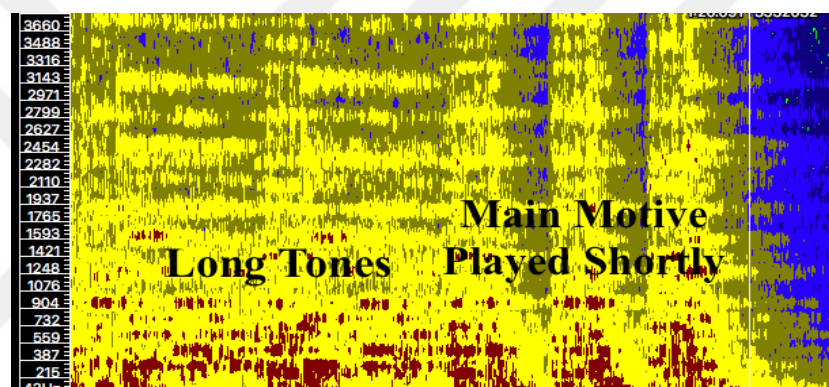


traditional analysis methods.

**Figure 2.8:** Mvt. 1 mm 19 – 25 (Beethoven 5th Symphony).

Sometimes the motive consisting of three short notes and a long one is given in different ways. Therefore it might be possible to assert that for the sake of motivic

derivation, the composer might have used his main motive reversely. As revealed by the shapes of the spectrogram regarding the section closing the exposition just before the repetition point, long tones are followed by the main motive. However, this time the long note of the motive is cut short and from a cognitive perspective it is nearly perceived as four short notes although the final note is twice as long as the previous three notes. Considering the context including long notes before the section that has just been mentioned above, one might claim that the main motive is less discernible here than the long – short contrast following one another respectively. Of course this might be considered to be an over-interpretation as the score does not provide us with enough material to support this claim but depending on ear and spectrogram visuals, this claim might be further pursued in a broader context dedicated to this



particular issue. Nevertheless, for the sake of objectivity, it would be fair to say that smaller musical units are not effectively observed or identified in spectrogram. An algorithm might work in such cases as it would be more accurate in determining the structures computationally.

**Figure 2.9:** Alleged Reverse Order of Short - Long Motive mm. 119 – 122 (Beethoven 5th Symphony).

What we see in the figure is interesting and contrary to the usual motivic interpretation of the piece, however, because the visual representation provides us with concrete data upon which making comments are more closely related to the listening experience than listening to the music and following the score, it would not be bold to say that this way of analysing the motivic manipulations is also possible. Otherwise, there is the risk of acting biased by falling under the influence of the score in which an analyst tries to find what they want to find but does not find what they actually hear. Another example of this is the fact that it is hardly ever, if not

never, mentioned that two motivic characters, short and long, are used simultaneously in two layers especially in the formally loose sections. Formally loose or instable sections are encountered in sections where a differentiation purpose is pursued like transition and development (Caplin, 272). In this case, as well, we observe the two layers with different motivic content are superimposed, one over the other in the subordinate theme. This is another distinction of the subordinate theme which is made even stronger by means of a new melody in E flat major. When the tranquil melody gives its place to another structure of more intense nature the familiar motive returns but in the background we still hear prolonged tones with accompanimental purposes this time. Thus, it might be claimed that the contrasting nature of the subordinate theme is quenched by means of returning to the main theme material in terms of both motive and dynamics in the cadence point. Considering the allegedly reversed main motive at the end of this section, it is also possible to say that there is a purpose of ending the section and beginning another. The familiar speculation asserting that the piece is constructed over two notes might be true to some extent but obviously not enough to describe the whole creation and material manipulation processes fulfilled by the composer and this claim is further supported by the spectrogram visuals which propound data in favour of more complicated processes and manipulations than composing based on two notes. The reason behind presenting these findings in the form of rather new claims is the fact that they are compatible with the conventional sonata form approaches such as the contrasting features of the subordinate theme, formal loosening of the structures in particular sections and instabilities in these units in question. Another consideration is the fact that such new approaches provide new insight regarding the formal construction processes and motivic manipulation which have rarely or never been mentioned. Tonal repertoire seems to be taken for granted in terms of analysis as there has been a lot of effort in this area but there are always new things to be found with a different perspective due to the richness of the repertoire and compositional effort put by the composer. Although jumping to absolute judgements about these analyses and figures might be bold and misleading, it is possible to say that the spectrogram analysis is interesting in that it sometimes provides us with what we hear in the actual music as shown in Figure 2.9 and sometimes it reflects what we can observe by looking at the score as shown in Figure 2.10. This trait of the analysis could be a good point to advance the method.



**Figure 2.10:** Two Layers of Contrasting Motives in Sub-theme (Beethoven 5th mm. 65 - 70).

Because the short tones are played softly, they are not obvious in the visual representation. Nevertheless, in some places we can see red points representing the double basses and cellos. The long notes are played by the winds and the new melodic material travels between the parts. When the arpeggiations arrive in the violins, the whole movement is taken over by the short notes. The long tones and the familiar main motive are again put together five measures into the beginning of the development. One could be sure that they would encounter a very similar figure in spectrogram analysing this part as the texture is very similar. I believe analysis of a large scale piece, a symphony in this case, must incorporate an analytical approach which looks into the piece in layers as from time to time we could observe different things going on at the same time stacked on each other. In such a case, an analytical approach one adopts while analysing a solo piece might mislead the analyst and result in a missing analysis. Here, for instance, a view that considers this piece consisting only of the main motive would lose sight of the two different layers, melodic content of the subordinate theme, oboe interrupting the orchestra and even coda as the melodic – motivic contents of these sections are not limited to the main motive. These ideas might be supported by the spectrogram analysis or reversely spectrogram analysis might provide one with a material upon which they contemplate and produce new ideas on pieces whose analyses are taken for granted and are not further pursued due to the bulk of existing literature. As in this case, this practice might yield good results. It is also important to know the general characteristics of formal structures. Having a general knowledge on sonata form for instance will help the analyst obtain deductions more efficiently.

## **2.4 Thematic Transformation In Spectrogram Analysis**

Because different manipulations of motivic materials are observed in the spectrogram analysis, it would not be wrong to claim that thematic transformations would also be observed, as in my opinion, the idea of motivic manipulations as encountered in the previous analysis of Beethoven's Fifth Symphony is similar to the idea behind thematic transformations, only the latter being more obscure depending on the composer's effort and transformation aim and having semiotic/semantic meaning most of the time attributed psychologically by the listener or not. At this point, right after Beethoven's manipulations of the famous motive, it would be beneficial to initiate a discussion regarding 'whatness' of motive, melody, theme, melodic/motivic material, transformations and usage of these as preferred by different composers whose names occur to mind when these concepts are named.

Motive is defined as a short idea in which the main components of music could be incorporated. In other words, melody, rhythm and harmony could be employed in the creation process of motives, either singly or joint. Motives could be regarded as the shortest structures with capability of carrying musical meaning or ideas. If smaller units in motives are recognizable these are then called 'cells', usually two-note mini-structures. The most famous motive is considered to be the one in the first movement of Beethoven's 5th Symphony (Drabkin, 2001).

Like cells build up motives, motives might build up units larger than themselves as in the example of 5th Symphony. The main motive is used to form a melody in the exposition right after the famous opening. Together with dynamic differences, the melody accomplishes a different sound from the motive thus generating a new formal unit within the exposition. This enables us to emphasize the importance of dynamics in the form analysis, which is underestimated by many and which is observed and brought forward by spectrogram analyses.

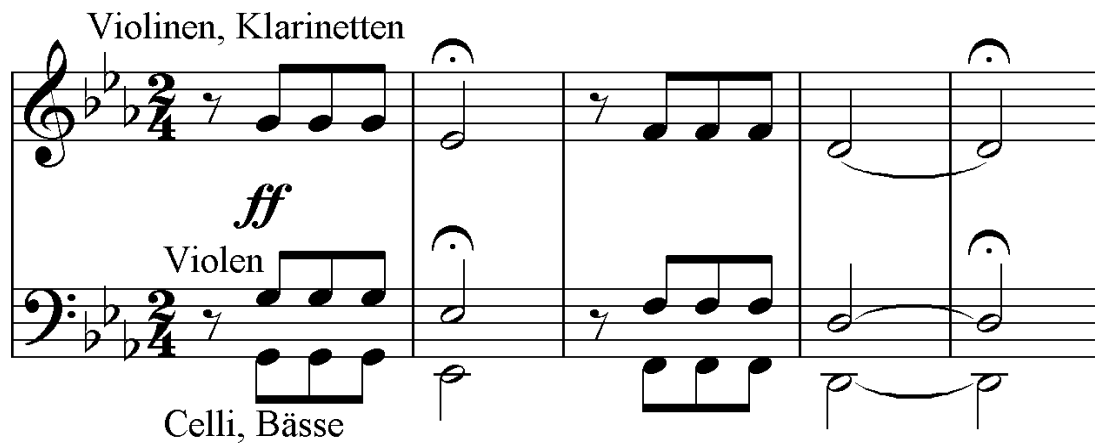


**Figure 2.11:** Motive – based melody in 5th Symphony.

Regarding such a design, where melody cannot free itself from the motive, it would be accurate to say that formal integrity depends on the manipulation of compositional elements but it would also be true to assert that melody had better be classified somewhere between motive and melody in terms of hierarchy because there is a limitation in creating the melody to some extent. The subordinate theme melody, for instance, is ‘more melody’ than this one as its creation does not depend on any prior condition.

Although there are huge amount of data regarding melody, only core traits will be covered here. Melody is accepted to be pitches arranged in accordance with time. Melody is thought to be in relation with vocal practices in music due to the fact that requirements of vocal performances, counterpoint rules, result in *cantabile* structures, melodies (Ringer, 2001). There might be other approaches in terms of nomenclature such as figure for motive, phrase for melody etc. but by means of the three denotations it is possible to make mature explanations. Considering J. S. Bach’s Two Part Invention No. 4 in D minor, for example, we could assert that the cells consist of the two-note units in the first two measures, main motive consists of three cells and melody, which is an arch, consists of two motives.

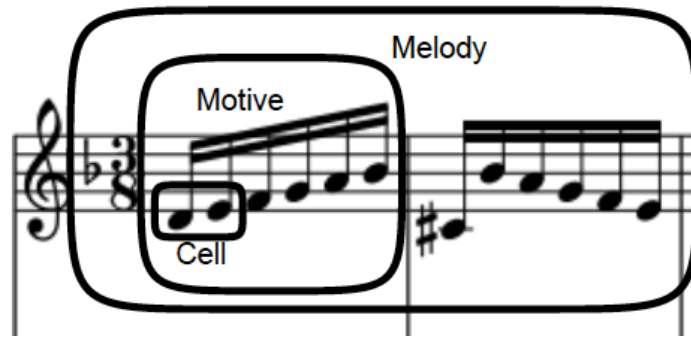


**Figure 2.12:** Structural Elements in Bach's Two Part Invention No. 4.

The melody might be interpreted to be incomplete due to harmonic implication provided by the last note of the melody but this is actually a strategy of the composer for manipulating the material he created, to give shape to the compositional process. Therefore, it is important to remember the importance of harmony, harmonic implications, pitch degrees and formal momentum of pieces. If a tonic tone follows the supertonic in the second measure then the piece is finalized, which is not desirable at the beginning of the piece. Such a propelling force in the form of the piece would probably be observed in the spectrogram as interlaced shapes that look like each other a lot. To put it allegorically, the shapes would probably look like chain of mountains specific to this kind of lines including imitation close to each other spatially on score and chronologically in the performance. Let us now look at the spectrogram analysis of the D minor invention.

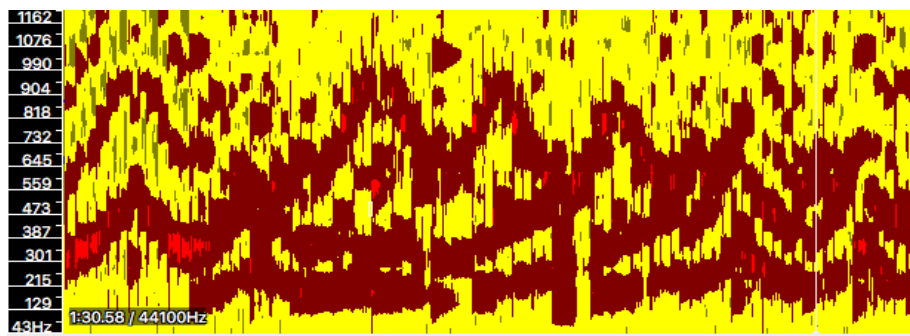


**Figure 2.13:** Bach's Two – part Invention No. 4 mm. 1 – 17.

Apart from consideration on tonalities and keys, one could see here a section consisting of similar, if not exact units due to the low frequencies, behaving in the same manner musically. Looking for further formal implications in the visual representation, one could observe the contrasting section which is intense in lower frequencies and the return of the main shapes after the alleged middle section.

Therefore, it could be claimed that the piece has an ABA design. It is also promising for the analysis method that after the middle section, whose lower frequencies predominate, a false recapitulation like structure is observed and immediately after that, predominance of lower frequencies arrives again signaling the continuation of the contrasting section or announcing itself to be a bridge with an aim to connect the middle section and so-called A'. One observes the piece under spectrogram as follows.

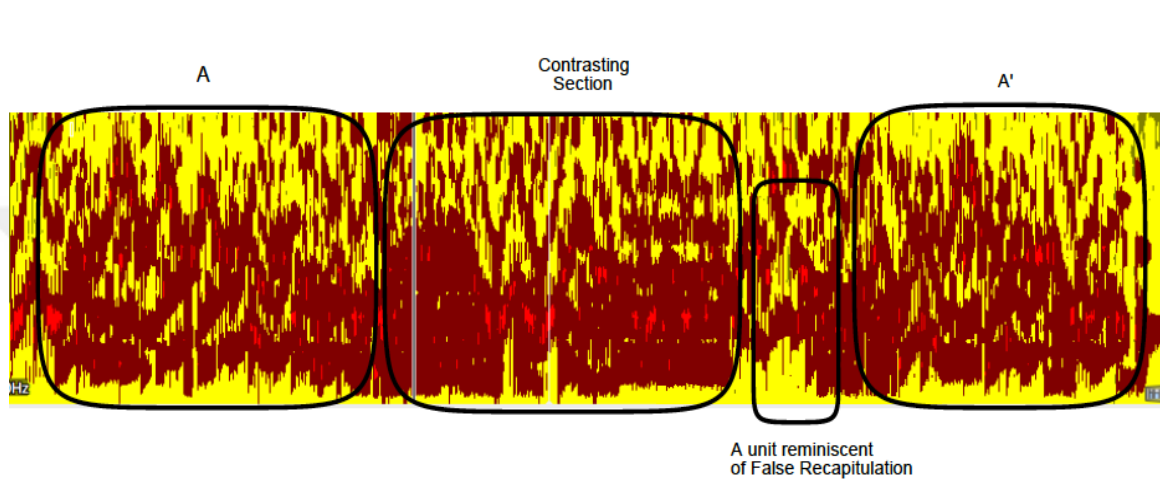


**Figure 2.14:** Bach's Two – Part Invention No. 4 Complete Spectrogram Analysis.

Therefore, it would be accurate to say that motives and melodies might be observed in the spectrogram analyses on condition that they are the basis of compositional strategy, due to the fact that it is easy to observe recurring compositional materials by means of spectrogram. What looks like a chain of mountains in the A and A' sections is nothing more than repetitive motives that prevail throughout the whole piece and that are played by both hands in canonic manner. Canonic or fugue-like nature of the melodic-motivic material creates superimposed similar shapes and that makes it easy to see the form both at section level and generally, as shown by the Figure 2.14. In larger contexts where music is longer, instrumentation is more complex and where more than one idea is observed, identifying motives, melodies and other smaller structural elements is difficult as in the Beethoven case.

Motives and melodies, which do not transform, are identified in the analysis but one question remains unanswered. Could spectrogram analysis be utilized for recognizing thematic transformations? Now let us analyse thematic transformations under spectrogram and see whether we could observe hints that would help us

identify transformations. Thematic transformation or thematic metamorphosis is a process where a musical idea is changed and put into another musical context that is different from the one in which the musical idea dwelt originally. Difference usually concerns the emotion behind the idea. The concept of thematic transformation is associated with Liszt as he is one of those who accomplished the best transformations (Macdonald, 2001). Because Liszt is considered to be the composer to have further developed the concept of thematic transformation, it is no surprise that the literature incorporates him as a reference point in terms of transformations, and this analysis, as well, will treat him as the reference point, taking into account the transformation in B minor piano sonata. The opening of the sonata presents a bass figure which is obviously dark and demonic, then the figure is transformed in such a way that the content of the figure is no longer recognizable in terms of emotional content which is now rather wistful. See below the figures in which the two themes are given



**Figure 2.15:** Demonic Bass Figure in Liszt's B Minor Piano Sonata (mm. 13–15).



**Figure 2.16:** Transformed Theme in Liszt's B Minor Sonata (mm. 153 – 154).

The transformation is accomplished by means of tempo and expression differences. The first appearance of the theme in diabolic style is fast and *forte*. Also it says *marcato*. The second appearance, on the other hand, is slow and it says *cantando espressivo*. *Espressivo* means ‘with expression’ and *cantando* is another form of *cantabile* which means singable (Fallows, 2001). Tempo and expression marks are important for spectrogram analyses as tempo bears on X axis which is time bound, and because expressions have a direct effect on dynamics and consequently energy of the sound, we observe their effect in the Y axis which indicates energy density and frequencies of the sound. Because tempo is slower in the transformed theme, we need to zoom out to make its visual representation similar to the one of the untransformed theme. Such interventions or manipulations might be required in order to obtain good materials for analytical purposes.

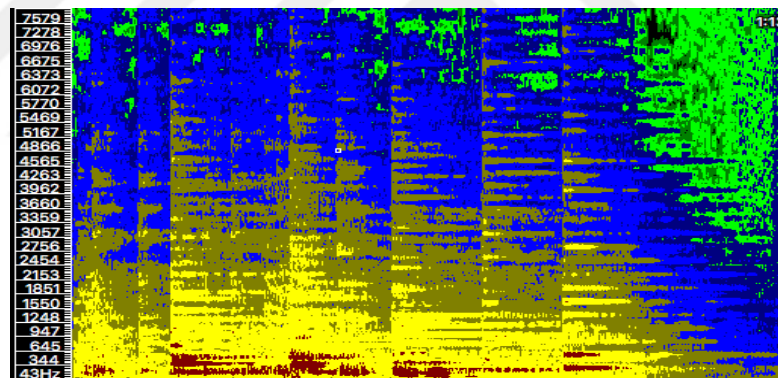


**Figure 2.17:** Diabolic Bass Figure in Liszt's B Minor Piano Sonata.

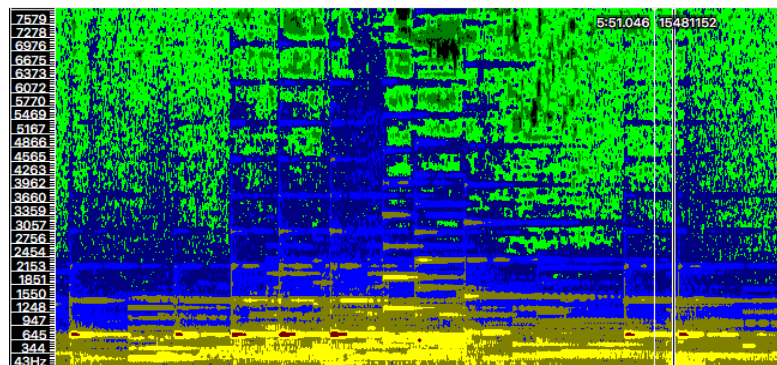


**Figure 2.18:** Transformed Theme of Liszt's B Minor Piano Sonata.

The first feature that catches attention is the similar fractured shapes in the upper frequencies in both visual representations. A difference, however, is different colours regarding energy intensity. As discussed above, one should take into account the dynamic difference of the two themes. Comparing the visual representations of both themes an observation like the one below is possible.

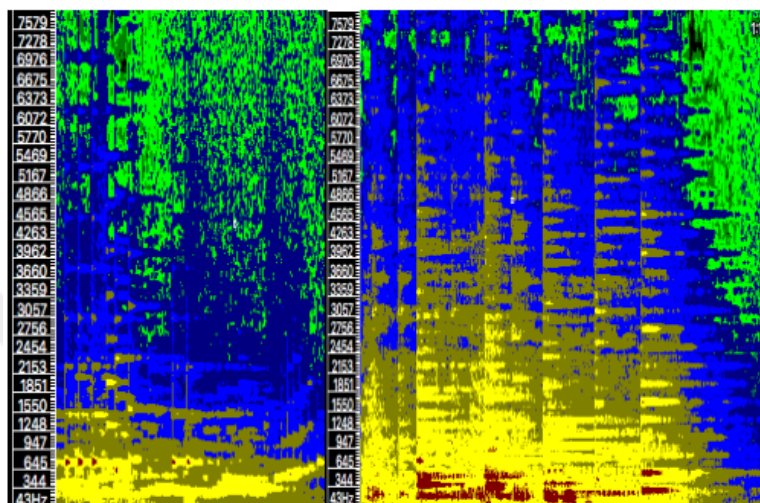


**Figure 2.19:** Transformed (Left) and Untransformed (Right) Themes of Liszt's B Minor Piano Sonata.

One can see the general similarity as the result of decreasing dynamics in both images. Figures in the analyses seem to draw a slope that forms a triangle with the positive X and Y axes. Maybe because the transformation mainly concerns the *marcato* measure (see Figure 2.17 above) and the top line of the *cantando espressivo* for three measures (see Figure 2.18 above), the observation is obscured by the other elements in the measures, especially in the case of transformed theme. Therefore, it should be noted that thematic transformations cannot be satisfactorily observed in the spectrogram due to several reasons. One of the reasons is that the transformations are accomplished by means of other musical elements surrounding the 'theme'. The surrounding materials obscure the theme and it gets even harder to see it in the spectrogram. Because transformation is not only about rhythm or tempo, zooming in or out to manipulate the X axis does not yield sufficient result. There are themes that sound more irrelevant to each other than this one and considering all these factors, the idea of observing thematic transformations in the spectrogram analysis proves to be ineffective.

### **3. ANALYSES OF RENAISSANCE AND BAROQUE REPERTOIRE**

Pieces from especially the Baroque period are not unfruitful with respect to form due to the fact that familiar classical forms historically developed from formal designs observed in the Baroque period, mostly court dances. The Baroque period is accepted to date back to the mid-18th century and its beginning is considered to be 1600. The term is used for different chronological periods but the common traits of these are strangeness, bizarreness, irregularity and excessiveness in terms of texture. Compositional techniques of Baroque music incorporated thoroughbass, which is a technique of indicating the harmony by means of the outer voices. Also, counterpoint prevailed as another composition technique, which surpassed thoroughbass and caused it to remain only as an accompanimental practice (Palisca, 2001).

We also observe other elements such as ostinato, chordal texture or monody, improvisation, ornamentation etc. in not only Baroque but also Renaissance music. These structures, with my own word, will now be analyzed under spectrogram and visual hints will be sought in terms of formal identification.

#### **3.1 Monteverdi's Lamenting Tetrachord Under Spectrogram**

As a basic example, let us begin with a piece of Claudio Monteverdi, who is thought to be the most important musician in the late 16th and early 17th century. As a composer who consummated the styles of Renaissance composers and who propagated a basis for Baroque music styles, he produced works in nearly all significant genres. He composed nine madrigal books and produced in the area of musical drama. Both contrapuntal textures and expressive abilities of words were utilized by him (Carter and Chew, 2001).

The piece that will be analyzed is from the eighth Madrigal book bearing the date 1638. Although it is widely known as *Lamento della ninfa*, its actual name is *Amor*

and by means of this piece the development process of *lamento* genre witnessed a different period. *Lamento* is a vocal piece which makes use of a forlorn text and which is usually constructed over a descending tetrachord (Rosand, 2001).

Let us now look at the piece under spectrogram and try to observe the formal microstructures bringing together the whole structure.

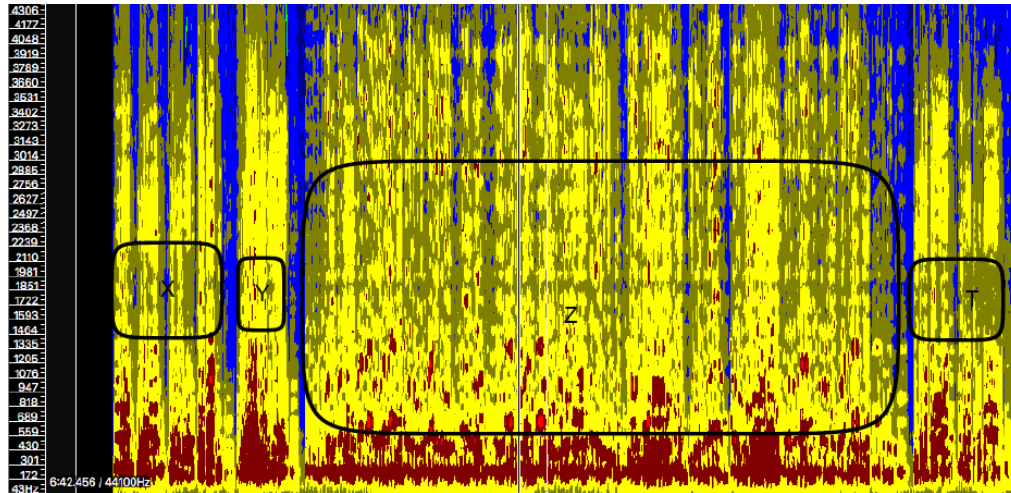


**Figure 3.1:** Monteverdi's *Lamento della ninfa* under spectrogram.

It is easy to hear the main sections of the piece as there are two contrasting elements, men's choir section and solo singing section. The visual representation also supports this.

Men's choir sections are marked with X, Y and T and solo singing section is marked with Y. Although from a textural point of view there are two contrasting sections, functionally they have different purposes. For instance, the section marked as X is like an exposition not in sonata form but in its literal sense and Y is similar to a transition connecting two contrasting sections. There is a long *lamento* following the transition and T ends the piece taking on the task of a coda. Different interpretations regarding formal design are possible but as this analysis is observed in the spectrogram analysis and other analyses will probably be similar to this one, it is better now to look for microstructures in the individual sections, especially in the middle section consisting of solo singing, the descending tetrachord as a fundamental element of lamenting and the dialogue-like intervenience of men's choir. The first microstructure to be sought must be the lamenting tetrachord and each turn of the tetrachord is observed in the visual representation without a need to zoom in.

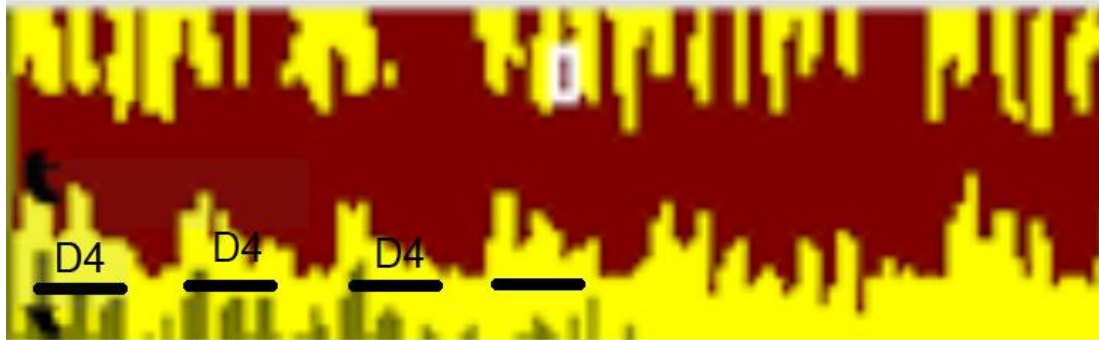


**Figure 3.2:** Descending Tetrachord in Monteverdi's *Lamento della Ninfa*.

Repetitive descending tetrachords, in the visual representation, are marked with D4. As it could easily be seen in the analysis, the bassline draws a slope that intersects the positive X and Y axes on an imaginary coordinate plane. Such slopes encountered in analyses could be associated with lamenting idea in this repertoire on condition that the span of the slopes in the Y axis is a perfect fourth. The concept of *lamento* incorporating descending fourth is accepted to have achieved its evolution with this piece but there is also one more piece to have contributed to this process before Monteverdi. *Lamento di Madama Lucia* was published as *Il Fasolo* in 1628, a decade before Monteverdi's eighth book of Madrigals (Rosand, 2001).

Now let us analyze that piece to find a similar figure regarding the descending fourth.

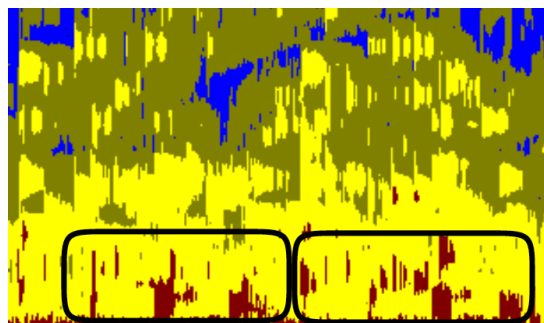


**Figure 3.3:** Descending Tetrachord in *Il Fasolo*.

The first attempt to find the descending bass movement proved to be a failure due to the fact that the recording was mastered with ducked bass frequencies. A quick mastering intervention was performed by me and bass frequencies were turned up by using one of the DAW softwares. This intervention, however, caused a deep frequency which had little effect on visual representation. Ignoring the deep bass

noise, the analysis was accomplished after improving the bass frequencies. The slopes, which represent the lamenting bass, are observed in the analysis and they are marked with boxes in the figure above. Nevertheless, the slopes found in this piece are not as obvious as the ones found in the previous piece. It could then be claimed that differences might occur in the analyses of pieces of similar nature, which might be noted as another drawback of spectrogram analysis in addition to those mentioned above. Case by case certain drawbacks come to the fore and for the purpose of understanding these within the context of repertoires, drawbacks are mentioned immediately after each analysis case if any.

As an important observation, fractured structures might be mentioned in the parts which include the descending fourth. Compared to other parts, descending fourth sections seem to be designed in accordance with the rhythmic pattern of the bass which indicates equality between all four tones. Upper lines above the bass play along with the rhythmic quality of the lamenting element, either in homorhythm or with syncopated elements from time to time and this creates the fractured texture observed in the analyses.

At this point, it might be good to say that as in other examples, these two pieces prove to be effective in the spectrogram when it comes to general overview and to their most basic feature, the descending tetrachord. However, it seems difficult to identify more structural elements probably because of the repetitive characteristics of the pieces. In these cases, bass movements, large sections and rhythmic manipulations of the composers could be observed in the analysis method. Fractured structures in the visuals are also common in both pieces.

In the figures below one might see the similarity of two composers' rhythmic utilizations over the lamenting bass and its reflection in the visual representations of the sound.

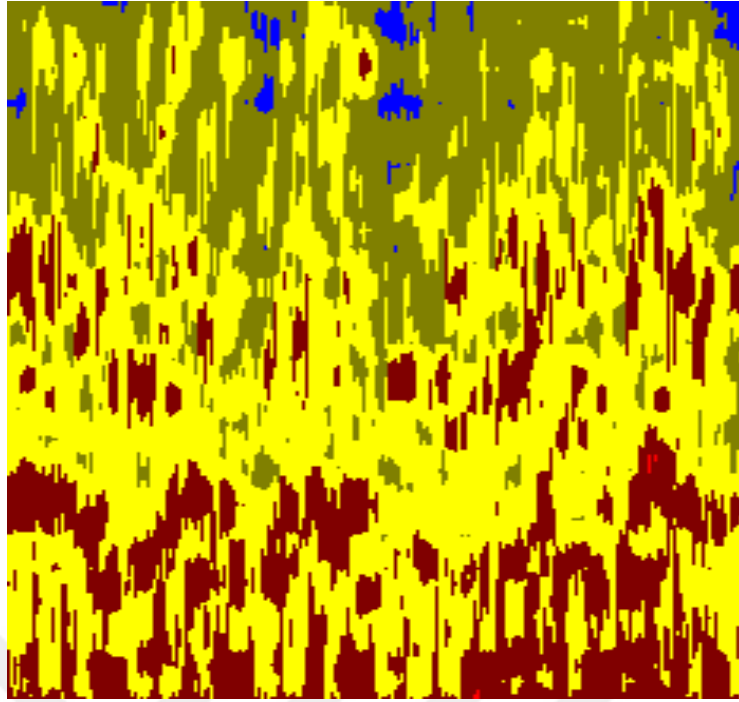


**Figure 3.4:** Fractured structure in *lamento* section of *Lamento di Madama Lucia*.

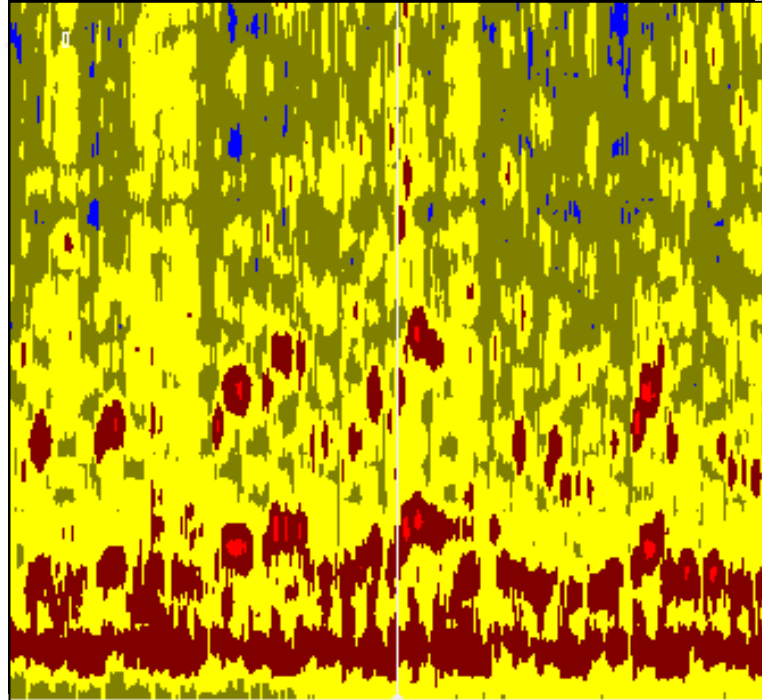


**Figure 3.5:** Fractured structure in *lamento* section of *Amor*.

### 3.2 Giovanni Girolamo Kapsberger's *Toccata no. 5*

Now let us analyse a piece from the beginning of the seventeenth century. Dated 1604, the piece is called *Toccata no. 5* by Giovanni Girolamo Kapsberger. The piece is in his book named '*Libro primo d'intavolatura di chitarone*' (The First Book of Theorbo Tablature) which bears the date 1604 and place name Venice (Hill, 2005, p. 43). Giovanni Girolamo Kapsberger is an Italian composer coming from a German origin. The composer is an important figure for theorbo as he is considered to be among those who established the solo identity of the instrument. As a prolific composer, he produced music of different genres from solo instrumental music to vocal music and from masses to secular works such as madrigals and stage pieces (Coelho, 2001). The piece to be analysed seems to have two distinct stylistic character, one of which is prolonged arpeggiations and the other is homophonic chordal texture. After the homophonic section, we encounter a mixed section which might be in favour of the latter as the prolonged arpeggiations might be obscured by the following chords. There are occasional ascending steps in eighth notes and prolonged arpeggiations finalize the section in common time. Following this, a section in triple meter arrives and creates a contrast between the preceding section and the next one. The section in triple meter has a very distinct rhythmic character which is sustained all through the section. The section follows a rhythmic pattern consisting of a dotted crotchet, a quaver and finally another crotchet. The first struck is always chordal and ascending two notes fill the other beats. The piece finishes with the prolonged arpeggiations which open the piece.

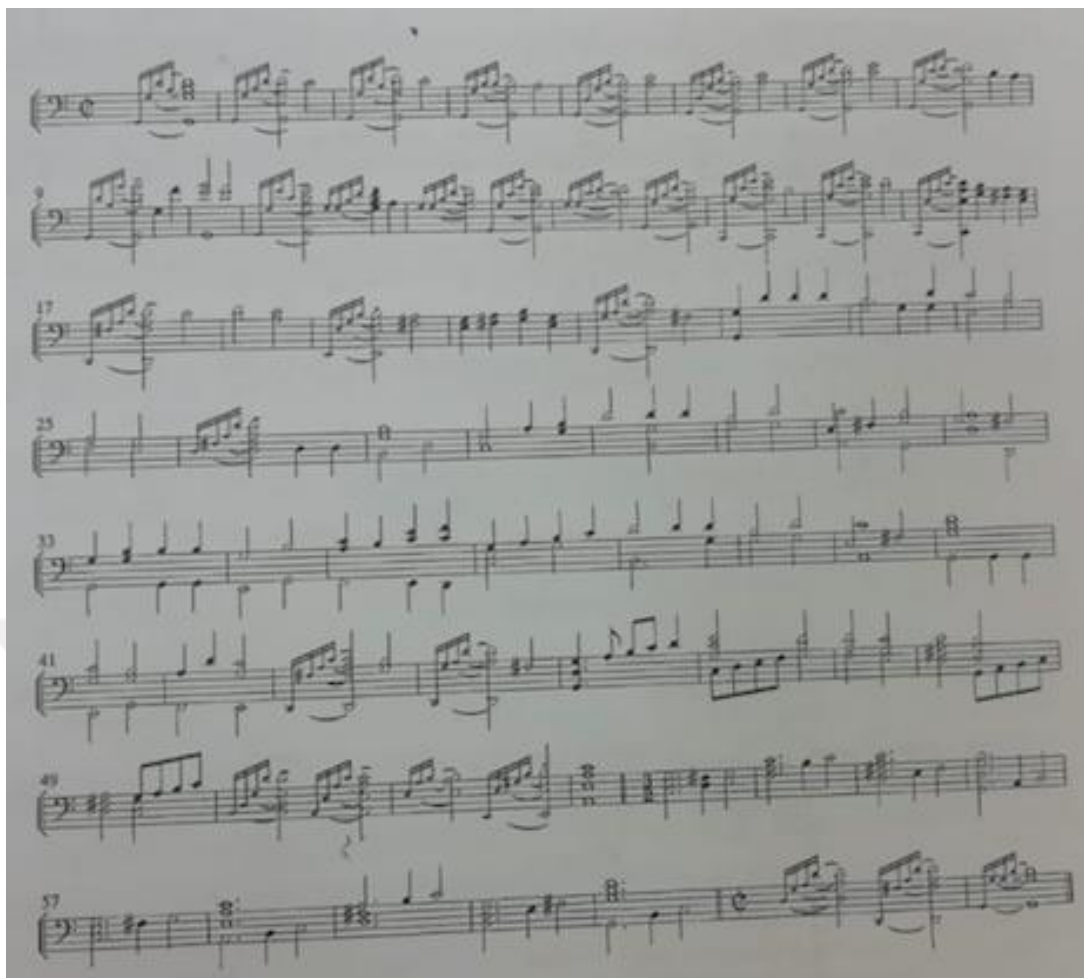


**Figure 3.6:** *Toccata no. 5* by Giovanni Girolamo Kapsberger.

As it might be observed from the score, the first indications of change in the course of the piece comes in measure 16 where the prolonged arpeggiations are followed by descending thirds. Measure 21 brings about a significant change in the style of the piece by the dominant chord built on D. Speaking in terms of tonality, we even hear a 4-3 suspension, G going to F sharp over D. Although this dominant chord over D is also the dominant degree of the previous measures, we do not observe an F sharp that is highlighted as in the measure 21. The next measure changes from prolonged arpeggiations to block chords and melody style, which could be analyzed as a B section. On-score-B-section seems to continue until measure 43 where we observe the return of the prolonged arpeggiations. Nevertheless, the arpeggiated chords might not be perceived by the ear and might be perceived similar to the preceding ones. In this sense, the real change that would convince the listener in terms of a change in the design comes in measure 50 where each half of the measure is filled with prolonged arpeggiations. Measures 51 and 52 bring about a tonality change by means

of a quasi cadential six-four structure in A minor. The change in the tonality is further supported by the change in the meter. Therefore, we could label this section as an idiosyncratic section. The section between the beginning and this one, however, could not be labelled as an independent section. But it might be possible to assert that this could be of a transitional character. The general formal design of the piece according to the score could therefore be claimed to be A – B – C – Codetta.

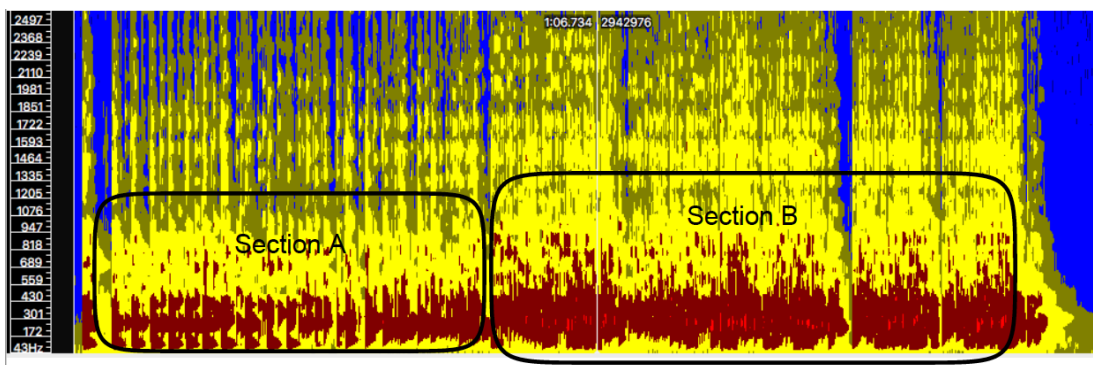


**Figure 3.7:** *Toccata no. 5* Spectrogram Analysis.

The spectrogram analysis of the piece, however, provides a different view by which one cannot assert that the piece has the formal design mentioned above. The visual representation of the performance shows that there are two major sections in the piece and in addition to those major sections there are a few subsidiary parts with complementary functions. For instance, the very beginning and the very end have the same shape in the analysis and these parts are rather functional. In this regard, in reflecting the little parts with the same functions, spectrogram analysis is parallel with score-based analysis although major sections are found to be different in the two analysis methods. At this point a significant question arises. Which analysis method should we choose for the sake of analytical accuracy? To answer this question we could use another agent that would help us decide the right analytical method. Listening to the piece and conducting a quick quasi-cognitive formal analysis could provide us with a material with which we could compare the score-based analysis and spectrogram analysis.

The A section, with a closer look, could be observed to have, from the beginning through the middle of it, distinctive shapes representing the prolonged arpeggiations, and the second half of the A section indicates a change in the texture as a

consequence of the frequencies that intertwine. The B section is marked with higher frequencies representing the melody or monody that usually accompanies the chords above them and just after the first half of the B section we observe a caesura after which the familiar chord and melody texture is observed. Although the score-based analysis provides insight regarding the formal discrepancy caused by melody and accompanying chords, it does not indicate the caesura probably due to the fact that it is brought into the forefront by the performance itself.

This piece is an example of those whose scores are difficult to obtain. When such pieces are difficult to obtain and do not use modern notation, conducting a form analysis on score becomes even harder. This edition is taken from the Hill Anthology and it could be said that in such cases where the scores are unavailable, the music could be observed in spectrogram not only for formal considerations but for other aspects such as dynamics, styles, notes (if zoomed in enough) and so forth.

Because conventional Austro-German formal analysis nomenclature might lead us in that we are accustomed to them, they might give us a second thought while working with pieces that do not belong to the tradition in question. Nevertheless, purer analysis of the sound might be claimed to produce more reliable results. Moreover, functional parts with secondary formal significance might not be detected in the score-based analysis while in the performance it is easy to hear and see these parts in the case of spectrogram analysis, which is important in determining the formal/functional design.

### **3.3 Piccinini's *Ciaconna in parteite variate***

Let us now analyze another piece with a similar style and see whether we could observe similar shapes in accordance with the stylistic use of the musical material. This time a piece by Alessandro Piccinini, *Ciaconna in parteite variate* bearing the date 1623 will be analyzed. The piece was brought together in Bologna and it is in the composer's collection named *Intavolatura di liuto, et di chitarrone, libro primo* (Hill, 2005, p. 46). Piccinini is an Italian composer, music theorist and lutenist born in 1566 and died in c1638. Coming from a family whose members were also lutenists, he chose to be at the service of different royal figures, too. He wrote two

volumes of lute works and he is claimed to have developed the instrument ‘archlute’ as he describes what an archlute is in the preface of the first volume. He also gives detailed information or instructions regarding performance and he is claimed to have different toccatas in terms of form and style. He also discusses the concept of *gruppo*, so by giving particular significance to the basic elements of form such as *gruppo* as mentioned above or phrase in today’s terminology, we can assert that formally we could attain good results out of his pieces (Scattolin, 2001).



**Figure 3.8:** Piccinini’s *Ciaccona in parteite variate* (1623).

The piece is in G major and makes use of familiar progressions. Its formal design is also remarkable as it is based on four-measure phrases repeated each time. By means of repetition each four-measure phrase ends up becoming an eight-measure sentence-like structure. After repetition the piece continues with the next phrase. It is expected that the four-measure organization idea will be observed in the spectrogram analysis. Listening to the recording yields some results that could be compared to the score-based analysis. On the score we observe that the bass line gives the formal design hints. The piece has a design that is reminiscent of the rondo form. It starts with a bass line G-D-E-B-C-D and repeats it, then in the second four-measure structure we observe the same bass line G-D-E-(A)-B-C-D. The second statement of the bass line has an A but due to the rhythmic insignificance of the note we could ignore it asserting that it is an appoggiatura. Thus we hear the same bass line twice for sixteen measures. The fourth four-measure idea brings about the first formal deviation as exposed by the upper line. Here we have a descending stepwise motion till E then a downward leap to C and finally an ascent to D, the dominant degree of the tonality. This might be labelled as Section B assuming that we have labelled the first sections as A and A'. In measures from 13 through 20 we observe the bass motion labelled as A. This return is what makes one think of the rondo form but after another two sets of A's, we observe a return different from the familiar rondo form as B' returns with a highly different melodic identity especially in terms of register. The bass line is again descending stepwise motion down to C this time and an ascent to D as the previous time. B' is enveloped by two sets of A' both from the left and the right. From this point on, we observe and hear a section which might be thought to be a closing section which makes use of the bass movement of A. However, the first occurrence of the closing A is different in that the melody begins on the weak beat and the second statement alters the bass line. This might be a good reason to consider these two A's as finalizing sections rather than main parts of the design that is reminiscent of the rondo. Therefore, the score-based analysis provides us with a formal labelling as (AA')B(A'A')B'(A'A')+Closing(A'A'). Now let us take a closer look at the piece under spectrogram.

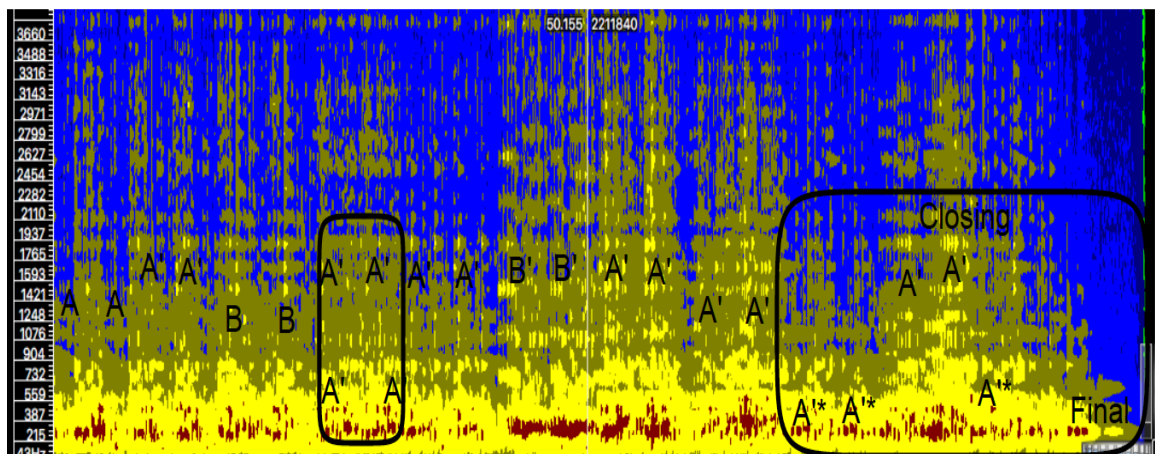


**Figure 3.9:** Piccinini's *Ciaconna in parteite variate* (1623).

It must be mentioned before making further comments on formal design hints in the spectrogram analysis that this particular performance on which the analysis is conducted repeats the measures 33, 34, 35 and 36 just before the final measure. Therefore the analysis looks different from the expected result based on the score analysis. In the closing section measures 33 through 36 are marked with A'\* and as it could be observed in the visual representation A'\* comes twice after the final statement of A'. The fact that the performance alters the analysis might be considered to be another drawback of the approach but it might also be claimed that from the aspect of organicism of the pieces, the performance could be considered to be more important than the score alone and therefore it reflects the allegedly altered form of the piece as a consequence of an evolution that stems partly from uncertainty of historical accuracy and partly from prevalence of today's musical practices.

Specific to this piece, we might say that the spectrogram provides good data for making comments regarding the formal design and the data are in accordance with the score-based analysis. However, it must also be noted that the data cannot be obtained by a superficial look. Shapes change depending on the frequencies produced by the instrument. Sometimes we observe intense shapes and some other times we observe uncertain shapes due to the volume of the sound. Therefore, it is necessary to analyze very cautiously the shapes in order to find similarities that could represent identical or similar formal structures. One might obtain formal hints out of shapes at lower or higher frequencies, which means that one should not limit

themselves to certain frequencies. Minuscule changes in the upper frequencies should also be considered.

### 3.4 Girolamo Frescobaldi's *Canzon quarti toni, depo il post comune*

Moving on to the next decade, let us now make an analysis on another piece with different timbre quality. Bearing the date 1635, *Canzon quarti toni, depo il post comune* by Girolamo Frescobaldi, from his *Fiori musicali di diverse compositioni*, is an organ work for four voices, clearly having a setting for SATB (Hill, 2005, p. 50). The piece rather seems to require some degree of virtuosity due to four horizontal lines whose independence is based on rhythmic difference and register. The level of difficulty brought about by the style of the piece reminds one of the keyboard abilities of the composer as he was himself a keyboard virtuoso. The piece presents itself with six sections and these are *Canzon*, *Adasio*, *Allegro*, *Adasio*, *Allegro* and *Adasio* respectively. We observe tempo, meter and style changes between these sections. Therefore, we must first look for hints in the spectrogram that would represent these different sections. The section names are actually familiar to us, *Adasio* being *Adagio* as we observe the word spelt in this way in Frescobaldi's scores (Fallows, 2001). *Canzon*, on the other hand, means song in Italian and is used to denote arrangements and reworks that put existing musical material or idiomatic materials in polyphonic setting (Caldwell, 2001).

The piece might seem complicated under the spectrogram due to the fact that it is played with organ and the frequencies might be more complicated than an instrument with non-prolonged sound character such as piano. Strings, winds and choirs could be somewhat problematic with this analysis method unless they present different use by the composer in terms of composition process between sections with different formal functions. If, for instance, these instruments are used identically in different sections, then the visual representation will turn out to yield no meaningful result in terms of shapes of frequencies upon what we base our formal interpretations and therefore we will not be able to discern a form functional structure from another one. Sometimes different formal sections might end up seeming the same due to timbral character and the nature of the instrument, in which case it becomes very difficult to see and discuss the form but maybe incorporating listening might be helpful in those cases.

The image displays a musical score for Frescobaldi's *Canzon Quarti Toni*, Page 1/2. The score is written for a single instrument, labeled "Piano" and "Pno." in the original notation. The score is divided into two systems. The left system contains measures 1 through 14, and the right system contains measures 17 through 34. The tempo markings "Adagio" and "Allegro" are present. The instrument is labeled "Piano" and "Pno." in the original notation.

**Left System (Measures 1-14):**

- Measures 1-3: *Adagio*
- Measure 4: *Allegro*
- Measures 5-14: *Allegro*

**Right System (Measures 17-34):**

- Measures 17-20: *Allegro*
- Measures 21-24: *Allegro*
- Measures 25-27: *Allegro*
- Measures 28-30: *Allegro*
- Measures 31-33: *Allegro*
- Measure 34: *Allegro*

Figure 3.10: Frescobaldi's *Canzon Quarti Toni* Page 1/2.

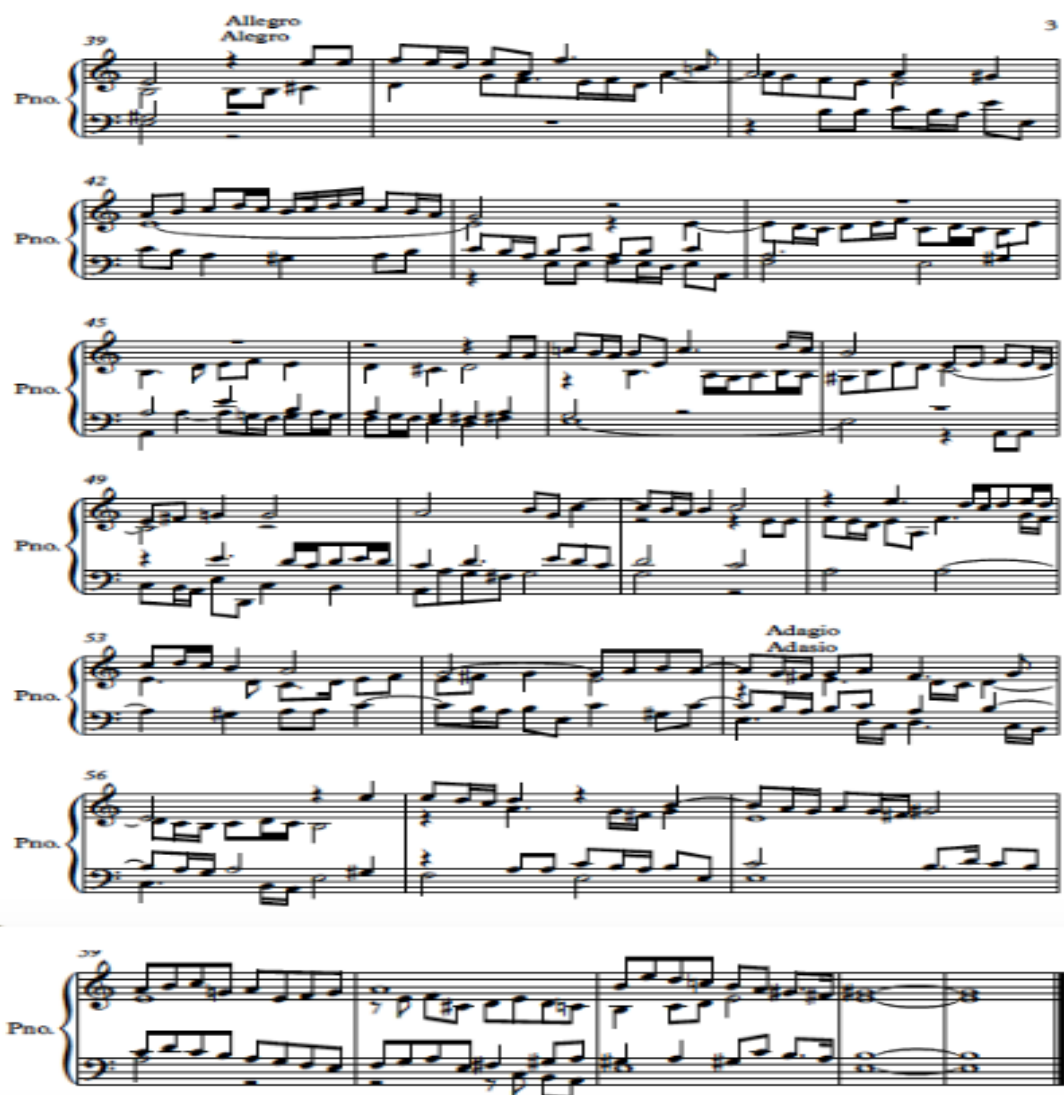


**Figure 3.11:** Frescobaldi's *Canzon Quarti Toni* Page 2/2.

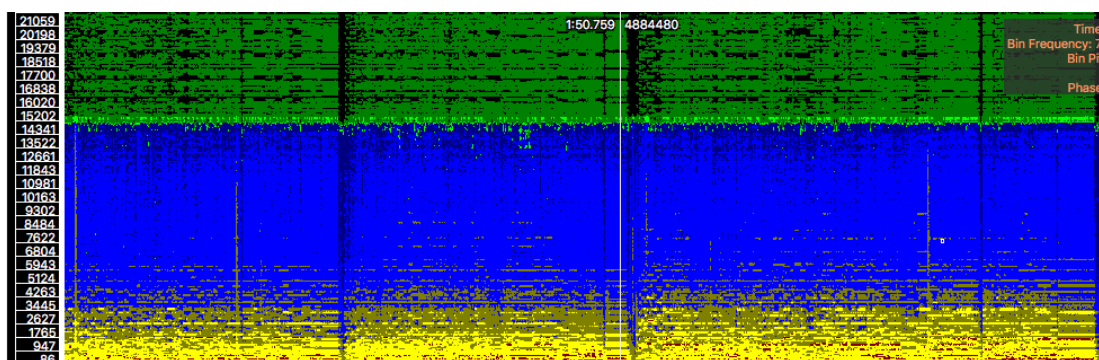


**Figure 3.12:** *Canzon Quarti Toni* Spectrogram Overview.

As estimated, the spectrogram analysis of the piece does not yield a good result, due to frequency qualities of the instrument. The instrument is capable of producing virtually all the frequencies and the frequency area of the spectrogram is filled as

shown by the Figure 3.12. It looks uniform in the visual showing the whole piece. Because we could not obtain results regarding the formal design of Frescobaldi's *Canzon Quarti Toni*, whose score is provided in Figure 3.10 and Figure 3.11 in the chapter, another method that could prove to be useful in some cases will be utilized now. In cases where all the frequencies are extensively used in the recording and where the spectrogram could not show us shapes upon which we could base our thoughts about the piece's form as in orchestral pieces or organ pieces like this one, we could use transcriptions and expose transcription recordings to the spectrogram analysis to see if we could observe any formal elements. In this analysis instance, the organ piece has been written again by me in one of the notation softwares and converted into MIDI. Then, the MIDI file has been imported into a DAW software, in which the file has been played by the piano. This simple intervention has basically created the piano transcription of *Canzon Quarti Toni*.

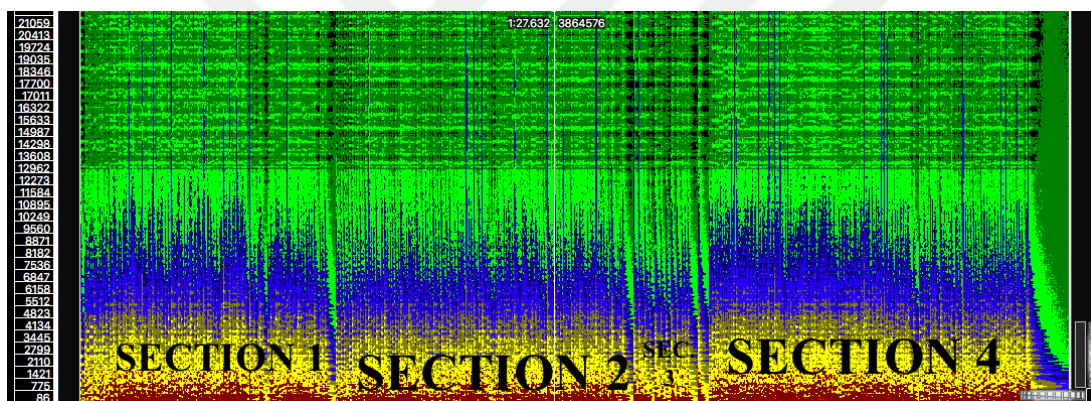


**Figure 3.13:** *Canzon Quarti Toni* Spectrogram Overview.

The energy levels in the spectrogram analysis reveal four major sections. One might zoom into the individual sections to see the details but before that the next step should be comparing the sections based on the energy levels to the recording.

A quick comparison between the recording and the first stage formal observations obtained from the spectrogram visual reveals that although there are some correct aspects of the formal commentary above, we need to take the minuscule changes in the energy levels into consideration more carefully. For instance, in the first section there is a tempo change and it comes at the extreme right of the Section 1. Changes in the dynamics are not very obvious and therefore we have been misled by this fact. It should also be noted that this minuscule change in the energy levels is observed in the upper frequencies, in blue section in terms of colour. Therefore, it is revealed that

we need to take the upper frequencies into account in the process of determining the formal design although we do not hear them as properly as we do the lower ones. Based on this, we could assert that such an observation is also found in the Section 4 as we observe a diminution in the energy level, which is revealed more clearly by the frequencies represented by blue parts. Another listening to the section in question reveals that the energy level diminution is actually a tempo change from *Alegro* to *Adasio*.

Based on these observations and comparisons, we could come up with a formal design, which is mainly based on the manipulation of the tempo concept in the piece. Because we cannot take tonality as our focal notion, it might be possible to render a formal analysis based on tempo and rhythm manipulations. Before zooming into the sections, I would like to pose another question. The piece seems to have a design which is reminiscent of the ABA from the perspective of rhythm. It starts with a quadruple tempo then changes to six-four and returns to quadruple tempo again. Could this return be interpreted as a recapitulation accomplished by means of tempo?

Score based analysis supports this claim but spectrogram visuals reveal sub-sections within these three major sections. How could we label these sections between the major ones? One might come up with a formal interpretation primarily based on tempo and length of the sub-sections secondarily. Using the familiar formal denotation terminology, could we assert such a formal design as revealed by the spectrogram visuals? What spectrogram visuals reveal is given in the figure below.

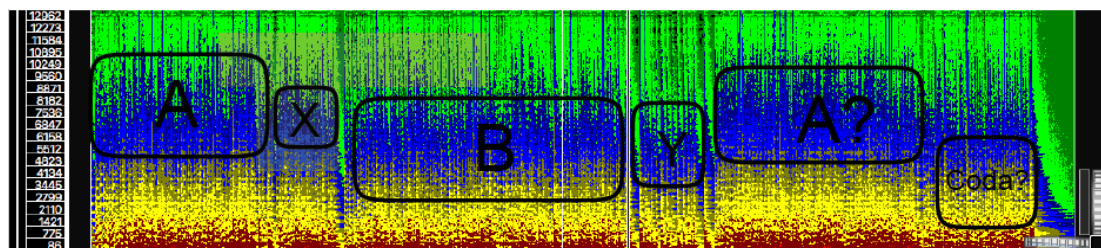


**Figure 3.14:** Formal Sections According to Energy Levels and Section Length.

The section coming after B as a major one, alleged A', might not be interpreted as an exact repetition of the initial A but from the aspect of rhythm and tempo we could associate it with the initial A and thus claim that there is a return in the design of the piece in terms of style and as mentioned above of tempo. The return reminds one of the recapitulation idea although we do not have to call it so. Little sections between

the major ones could also be acknowledged as auxiliary structures keeping the whole organism together. Because the purpose of this case is not a thorough analysis it is best to stop formal considerations here and continue with another benefit we get thanks to the piano transcription of the piece.

Although we have not been able to see any hints in the analysis of the original recording, transcription analysis makes us see the harmonic rhythm, the speed at which the chords change if a basic definition is needed. When we place the notion of rhythm into our focal point, we get good results out of the analysis of *Canzon Quarti Toni*. This might be connected to the importance of rhythm or priority of the concept of rhythm for especially the Baroque music to speak speculatively to some extent. It would not be wrong to say each repertoire could be based on a certain approach regarding compositional elements, tetrachords, tonality, rhythm, timbre and so forth. Let us now see what the harmonic rhythm of the piece looks like under spectrogram.

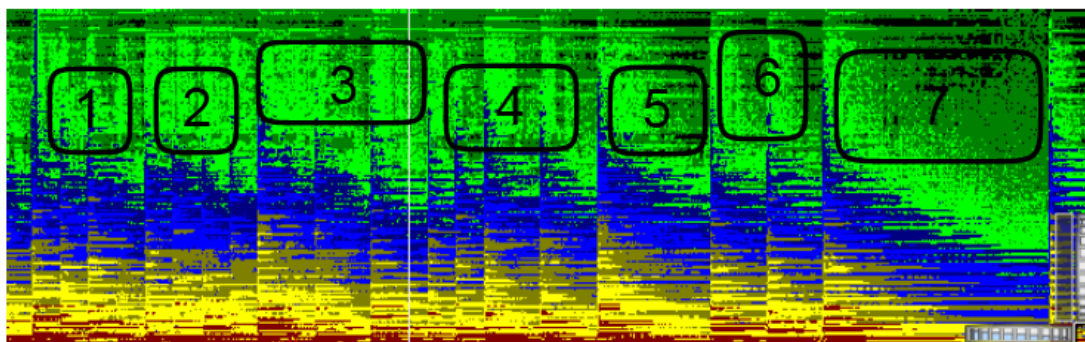


**Figure 3.15:** Shapes Showing the Harmonic Rhythm of the Piece.

Strucks are obviously observed in the shapes above. Whenever a strong beat is in question, at that point we observe an energy increase. Peculiar to the chordal strucks, energy levels start to decrease as one might expect. Another energy increase would therefore necessarily mean another struck unless the style of melody and accompanying block chords changes. Each ascent in the shapes represents chord strucks and therefore they could be taken as harmonic rhythm. The areas marked with Box 1 and Box 2 indicate similar harmonic rhythm. In the area marked with Box 3, the distance between strucks increase therefore we could say the harmonic rhythm slows down here. Box 4 indicates a faster harmonic rhythm and the following areas, Box 5, 6 and 7 indicate slower harmonic rhythm, probably because the formal section, X (See Figure 3.14), finalizes at the point shown by the Box 7.

One might find other ways of finding musical traits in a piece by using this method but to cut it short it is necessary once again to say that in a case where frequencies are filled in the recording, transcriptions might save us with regard to this method. However, it should be admitted that this is not a very practical method as it consumes time and requires effort to write pieces in a notation software in cases where transcriptions do not exist. However, when someone needs to conduct such an analysis and to choose between an orchestral performance and a piano transcription, for instance, it would be better to continue with the latter.





#### **4. ANALYSES FROM MODERN/CONTEMPORARY REPERTOIRE**

As there are common traits found in the pieces analyzed before, there might be similarities regarding contemporary music, which can be observed by means of spectrogram analysis. However, before starting analyzing individual pieces, it might be necessary to talk about the historical evolution of form and other elements of music within the context of contemporary music or twentieth century more broadly. Historically the act of composing saw a drastic change even in the early decades of the twentieth century. The change actually began in the preceding decades when composers felt a necessity to extend the possibilities of tonality. Eventually atonality and other means of writing music out of tonal context arrived and changed the way we perceived music for centuries as well as form. Some even claimed that form is abandoned in such musical pieces but as discussed above, existence requires form.

##### **4.1 *Les Yeux Clos* by Toru Takemitsu**

Analyses should be conducted on examples containing idiomatic elements of contemporary music to obtain a more realistic perspective of form. For this reason, one of such pieces has been chosen to put across the formal relationships in the spectrogram if they are observed. Toru Takemitsu's *Les Yeux Clos II* will be found below as analyzed by spectrogram analysis.

A Japanese composer, Takemitsu was born in Tokyo in 1930. He first encountered Western art music during his time in the military and he decided to become a composer although he had no formal education in the area of composition or music. He took lessons from different composers but he is mostly an autodidact composer (Narazaki and Kanazawa, 2001). This piece is a reinterpretation of a painting with the same name, *Les Yeux Clos* which was painted by Odilon Redon in 1980.

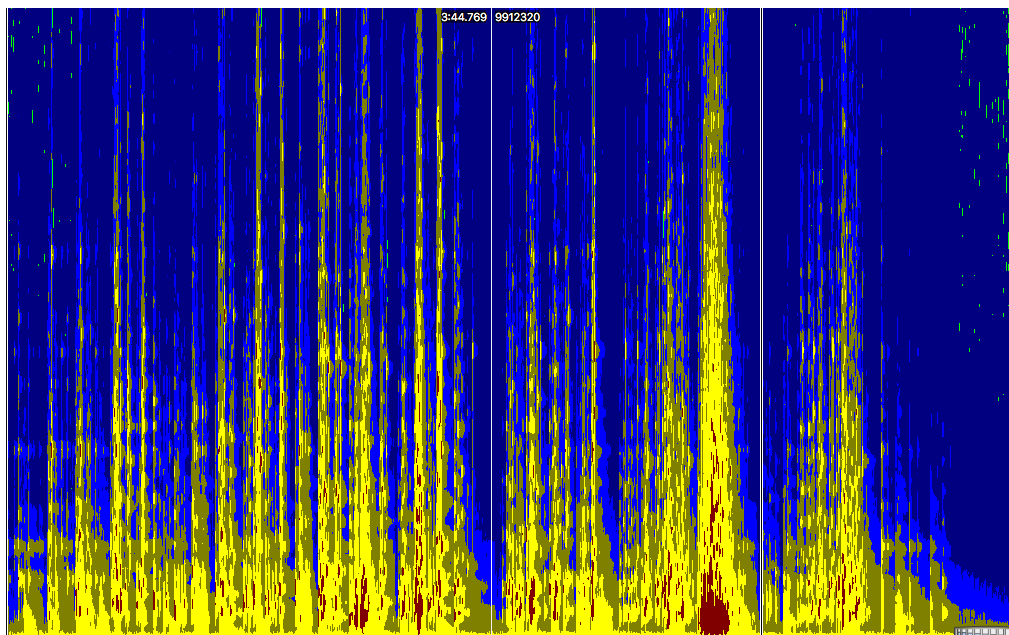


**Figure 4.1:** *Les Yeux Clos II* Spectrogram Overview.

The analysis says a few things about the general design of the piece by indicating figures implying different formal sections via dynamics and frequencies.

These implications, though, offer nothing more than the common view regarding the formal designs of these pieces. If this view is adopted to determine the formal organization of the piece, one might only say that there are structures at random order and they can also assert that the order of these structures can be changed resulting in no alteration in the identity of the piece. Listening to the piece and looking at the spectrogram visual are similar in terms of formal identification. In the Figure 4.2, certain frequency bursts and frequency clusters are observed. Therefore, the only significant result we obtain out of the spectrogram is the general design based on energy levels. As a result, it might be concluded that the spectrogram is not capable of showing more than the existence or absence of frequencies on the X axis. An analysis depending on this data might be acceptable as illustrated below, but if more is said based on the visual, that will be overinterpretation. Similarities might be found in the Y axis but one needs an algorithm for that as depending on the eye only will not suffice in this kind of repertoire if the graphs turn out to be like the one below.

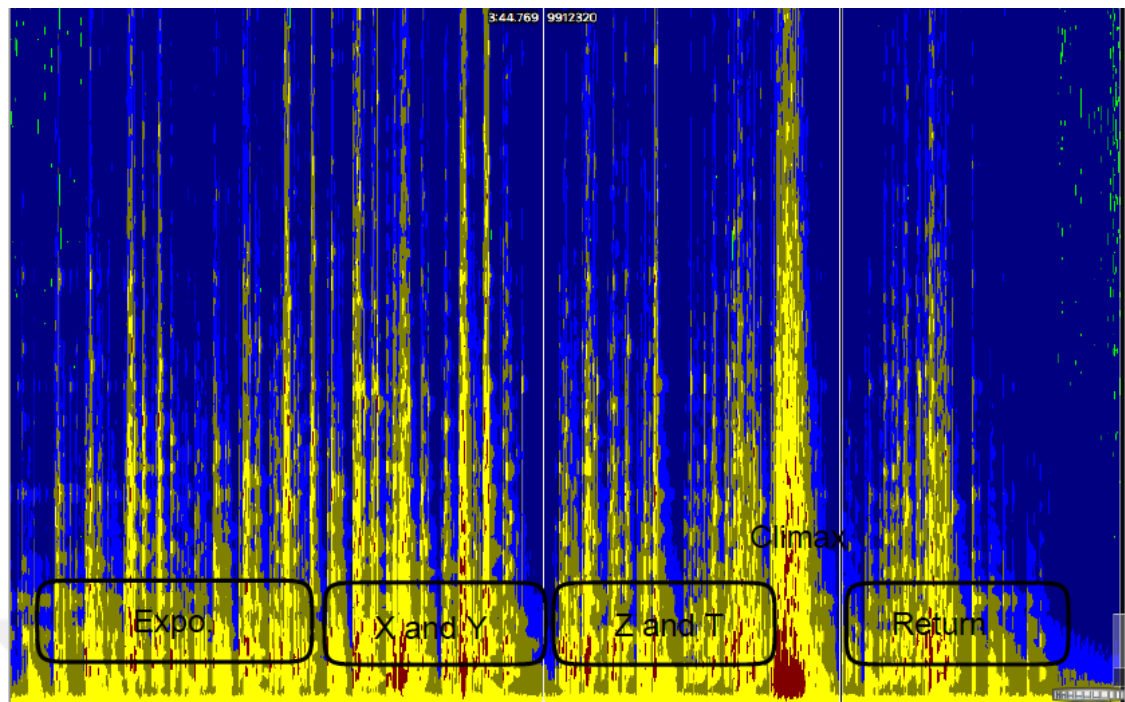


**Figure 4.2:** *Les Yeux Clos II* Formal Interpretation.

The pitch content, dynamics and setting of structures might define a design. The first section identified as expo. is defined by an insistent tone in the background. All the materials are diminished to that tone in the end and one could consider this as a form defining element. The second part, X and Y, is particular in that they lack the background tone encountered in the previous section. This section ends rather like an arch and is followed by the climax whose dynamics and frequencies are obtrusive and reflect the ordinary climax traits. The final section brings back the background tone as observed in the visual representation and therefore could be identified as a return or recapitulation in conventional terms. The overall formal design, whose information is provided not by listening but by spectrogram analysis, could therefore be identified, with letters, as A(Bc)(De)FA'.

## 4.2 Spectral Music Under Spectrogram: String Quartet No. 2 by Haas

Spectrogram analysis could also be used to analyze spectral music and the idea to look for formal elements in spectral music sounds promising as the creation process of such pieces involves spectral dimensions of sound. There are a number of spectral techniques to compose such music but as it is out of context for the scope of this paper it is enough to say that spectral music basically tries to re-synthesize spectral qualities of any given sound and uses the re-synthesis as its basic compositional

material (Anderson, 2001). Spectral qualities of sound are inspected by means of different tools, one of which is spectrogram. Let us now reverse the creation process of a spectral piece and inspect it under spectrogram. The piece to be analyzed is George Friedrich Haas's String Quartet No. 2. Born in 1953, Haas is an Austrian composer who favours irrational nocturnal resonances. His early works employ intricate mathematical techniques while one might observe bits of early music elements and tonality use in later works (Wiesmann, 2001).

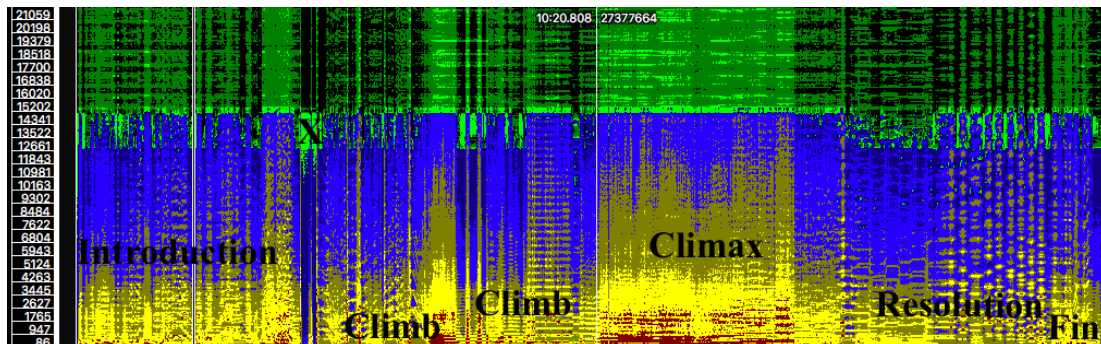


**Figure 4.3:** Haas String Quartet No. 2 Spectrogram Overview.

The piece is a twenty-minute long one and therefore it is not easy to follow it with a concern to understand its formal design just by listening. Following the score might provide a little help but due to the length of the piece it is again very difficult to have an overarching view on the piece. Fortunately, the spectrogram enables us to see the piece with all its sections in a nutshell. As one might see above, it becomes easy to make comments regarding the design of the piece. When listening accompanies the visual representation above, understanding the form becomes even easier. Asserting that the piece has a prolonged introduction with long pitches and then an abrupt caesura, which is marked with X in the visual and which might be claimed to have a unique semiotic significance due to repetitions, then a burst aiming to bring about the climax, a fail in the ascent, another ascent, climax as indicated by intensification of frequencies as a consequence of dynamics, resolution with silence points at intervals and the finale. It seems that the piece has a parabolic form rather than the arch form as the section after the climax is not derived from the one before it.

It is also observed in the visual representation, when zoomed in, that elements that cause change in design separate sections very clearly. In this piece, the first and

foremost design change comes with exaggerated *glissandi* and below one might find how these sliding tones are reflected in the visual representation.

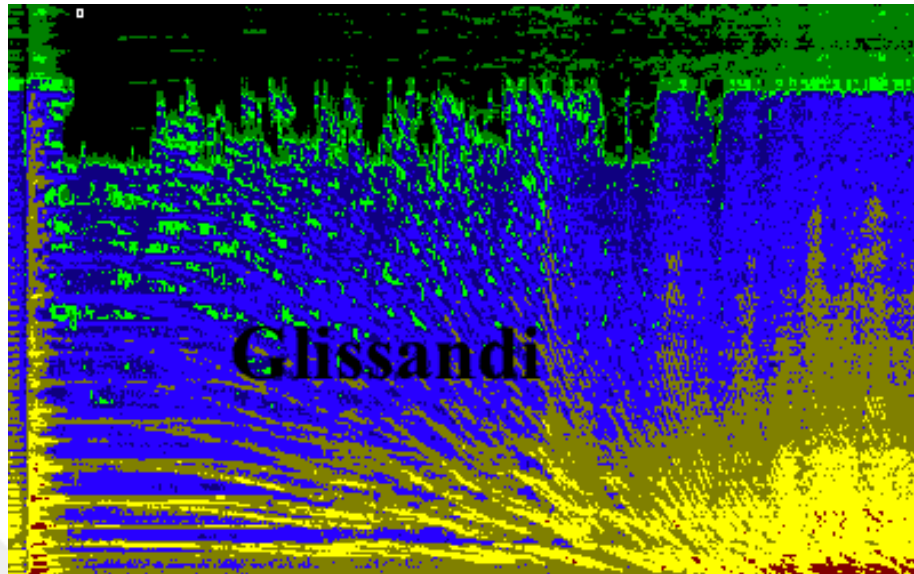


**Figure 4.4:** Haas String Quartet No. 2 *Glissandi*.

It is also possible to observe in the shapes that *glissandi* become faster later in the section as the slope of the shapes increases in the right side of the visual. This might be used to support the claim to label this section as ‘ascent’, as the frequency of occurrences increases. Just before the ‘ascent’ begins, there we hear sudden stops that nearly stupefy the listener. Even the first occurrence of the stop has a special place in the design of the piece. That would be wrong if one claims that this moment of silence is no different from any rest that could be found in many pieces. The material is the same, silence, but the way the composer puts it and the elements surrounding it together with repetitions make the abrupt stop significant.

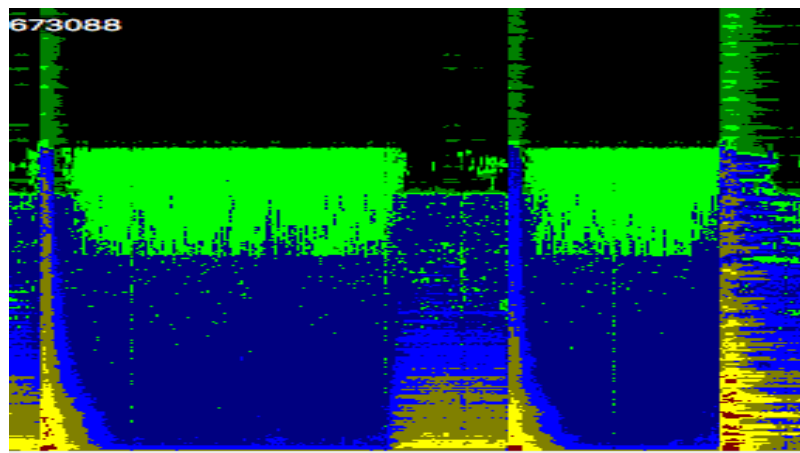


**Figure 4.5:** Haas String Quartet No. 2 Abrupt Stops.

Such meaningful structures could be considered to have important roles in terms of formal design. What might occupy measures or pages in another repertoire as transitions or other game changing agents could be a mere silence point as witnessed in the piece.

### 4.3 Arvo Pärt's *Cantus in memoriam Benjamin Britten*

Looking for different parts of a piece under spectrogram yields results but in this repertoire we encounter pieces incorporating limited compositional material in the creation process. Arvo Pärt's *Cantus in memoriam Benjamin Britten* would be a case in point for this as the whole piece is based on a *cantus firmus* repeated many times throughout the performance. Analyzing such a piece based on repetition sounds promising, too, like the spectral music but this time due to different reasons. Repetitions are easily seen in the visual representation of the sound and therefore they are suitable for this method of analysis. What one might expect from the analysis is to see similar if not exact shapes with descending contour differing in terms of dynamics and rhythm whenever the *cantus* is exposed to transformation in these regards. There are rhythmic and dynamic differentiations of the *cantus* in the piece, other than that the compositional material is identical. Let us now look at the visual representation obtained by the analysis method.

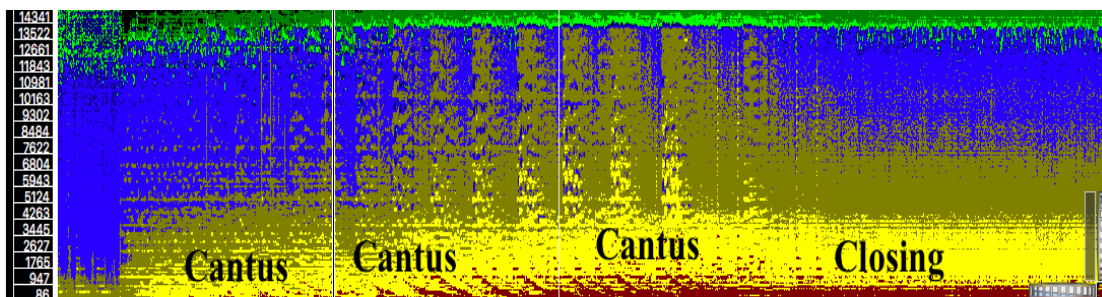


**Figure 4.6:** *Cantus in memoriam Benjamin Britten.*

As expected, the analysis provides shapes where repetitions are clearly seen and therefore one could make meaningful inferences out of the shapes. However, it is important to see the early occurrences of the 'cantus shapes' as they might be ignored if one does not look carefully due to the vague character of the shapes as a consequence of dynamics. As mentioned above, dynamic differences might play a

role in failing to see the similar structures in the visual. The piece opens with campana, which is an idiophone formed by a hollow material, in short a bell (Price et al., 2001). The bell sound, which is particularly significant for Arvo Pärt's music, is then followed by strings playing the melody. In Pärt's music, bells play a big role as the philosophical approach behind his compositional practice depends on the idea of associating the resonance of triad to that of bells (Hillier, 2001). Because of the importance of bells in the music, it might be true that the bell at the beginning of the piece provides hints about the formal design of the piece as it is heard at certain intervals as if it wished to indicate the returning frequency of the *cantus*.

The image displays a musical score for 'Cantus in memoriam Benjamin Britten'. The score is arranged in a system with six staves. The top staff is for the Campana (Camp.), which has two marked sections, 2 and 3, and a 'p' dynamic. The second staff is for Violins I (Vl. I div.), the third for Violins II (Vl. II div.), the fourth for Viola (Viole), the fifth for Violoncello (Vc. div.), and the sixth for Contrabass (Cb. div.). The string parts (Violins, Viola, Violoncello, and Contrabass) play a melodic line with dynamics ranging from 'pp' to 'mp'.

**Figure 4.7:** *Cantus in memoriam Benjamin Britten* Repetition of the *Cantus*.

The formal design of the piece might be claimed to incorporate an opening, a middle section where the *cantus* is heard *piano* and *forte* respectively and a closing section with a climactic character. Probably because of the purpose of the piece, the music is interrupted at a point of climax, aiming to create a feeling of upheaval in the listener. Silencing the strings at a high moment is further enriched by the final resonance of the bell, which might be associated with the effect of decease over those who are left behind. Going beyond hermeneutic or semiotic remarks, we might claim at this point that such considerations of composers, alleged of course, might have an effect over the formal design of pieces due to the fact that formal designs are directly connected to the affective content of the music. To ascertain this claim, one might ask whether the final effect would have been the same if the composer had added a recapitulation

at the end of the climactic closing section. Listening to the piece, looking at the score and also spectrogram analysis provide the same result. However, scores cannot reflect the final resonance of the bell as the other two methods. In the spectrogram and therefore in the sound we can observe and hear, respectively, the prolongation of the bell sound but the score tries to indicate that with its own facilities, which means there might be a decline in the semiotic inferences we could make out of the score.

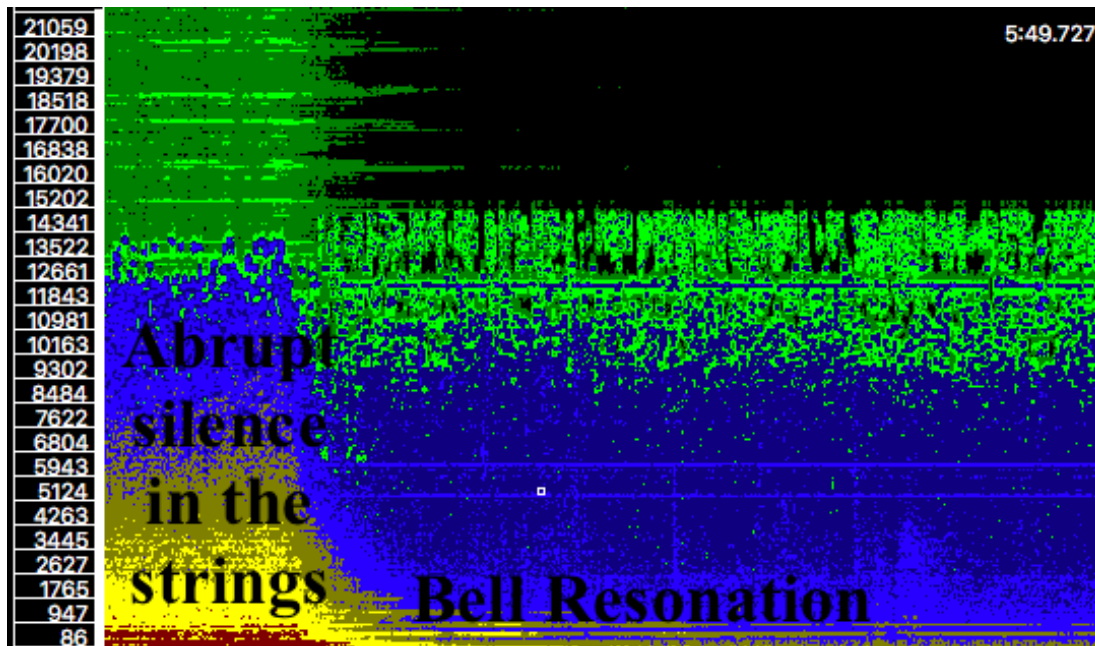


**Figure 4.8:** Finale of *Cantus in memoriam Benjamin Britten*.



**Figure 4.9:** Final Measures of *Cantus in memoriam Benjamin Britten*.

Taking the sections, other than the finale, of the piece into consideration, it is easy to suggest labelling, either (x-A-A'-B) or (x-A-B). However it must be kept in mind that such formal designs with an agenda regarding the affective content of the music cannot be expressed in terms of labelling and an analyst should devise a way to do

so. Shapes or mathematical analogies could be a good point of source. To express what happens in the final moment of the piece, we would like to offer using the term fracture point, a mechanic and automotive terminology incorporating the contradiction of resistance and force, in favour of the latter.

#### **4.4 Boulez's *Eclat* and Berio's *Sequenza VI***

Speaking of affective content and the role of perception on the form, now let us analyze Pierre Boulez's *Eclat* and Berio's *Sequenza VI* on which a cognitive trial regarding the perception of the pieces' forms is conducted. The article by Deliege, which tries to find whether musicians and non-musicians could determine formal sections based on Gestalt principles of sameness and difference, states that musicians and non-musicians have been successful in determining the major sections of the pieces just by listening to them. As the formal sections of the pieces are identified by taking the performance at the center, it would not be wrong to assert that the spectrogram would yield similar results in that it, too, is performance bound. The formal sections of the pieces are taken as stylistic or textural unities in the study. Therefore, whenever a change was in question in the pieces, it was assumed that the form changed.

The other principle on which the formal considerations were based on in the paper is Gestalt principles regarding similarity and proximity incorporated into music theory by Lerdahl and Jackendoff (1983). Deliège also discusses that *indices* or *cues* make one discern between different structures. As a musical element at the surface, indices denote other objects and in progress of time they transform to those objects they denote (Peirce, 1974: 2.248, p. 140).

The listeners identified thirty seven sections in the ten minute long piece, *Eclat* and thirty two sections in *Sequenza VI*. This might be because of the frequently changing textures of the pieces. The question whether such an analysis could be taken as form identification or not will remain for now but the approach here is to see in the spectrogram analysis different sections as many as in the paper, or as close as possible to the number in the paper.

The first digit being the minute and the other two being the seconds elapsed, the listeners in the trial identified sections at 0.09, 0.25, 1.15, 1.26, 1.45, 2.10, 2.35, 2.50,

2.60, 3.05, 3.25, 3.30, 3.35, 3.50, 3.60, 4.15, 4.25, 4.30, 4.35, 4.50, 5.15, 5.25, 5.35, 6.02, 6.17, 6.41, 7.00, 7.16, 7.40, 7.45, 8.05, 8.25, 8.35, 8.50, 9.12, 9.35, 9.40 in *Eclat* and at 0.15, 0.20, 0.34, 0.40, 0.46, 1.02, 1.22, 1.30, 1.48, 1.58, 2.10, 2.30, 2.49, 3.04, 3.26, 3.38, 3.52, 4.06, 4.36, 5.05, 5.45, 6.26, 6.36, 6.50, 7.32, 8.04, 8.17, 8.26, 8.35, 8.52, 9.21, 9.53 in *Sequenza VI*. Spectrogram analysis and these numbers might not match exactly as the performance recordings on which the two analyses conducted are not the same but an approximation, too, would be enough to indicate textural changes and in turn changes in formal design taking the theoretical approach of similarity and difference into account as proposed by Lerdahl and Jackendoff (Deliège, 1989).

Now let us look at the two pieces under spectrogram and try to see sections and associate them with the ones perceived by the listeners.

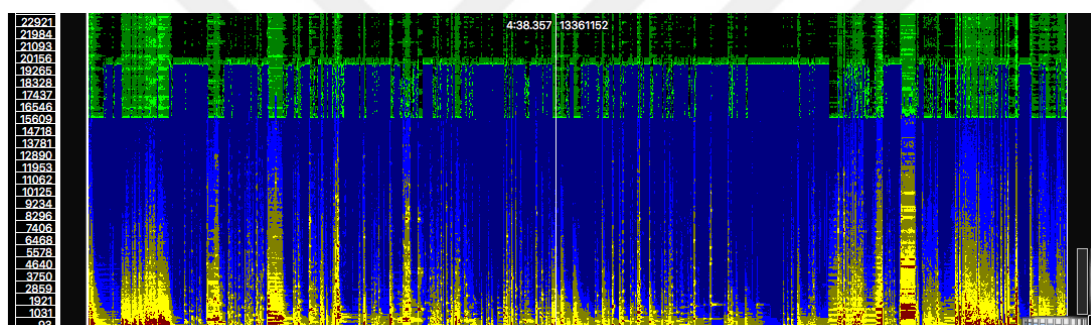


**Figure 4.10:** Boulez *Eclat* Spectrogram Overview.

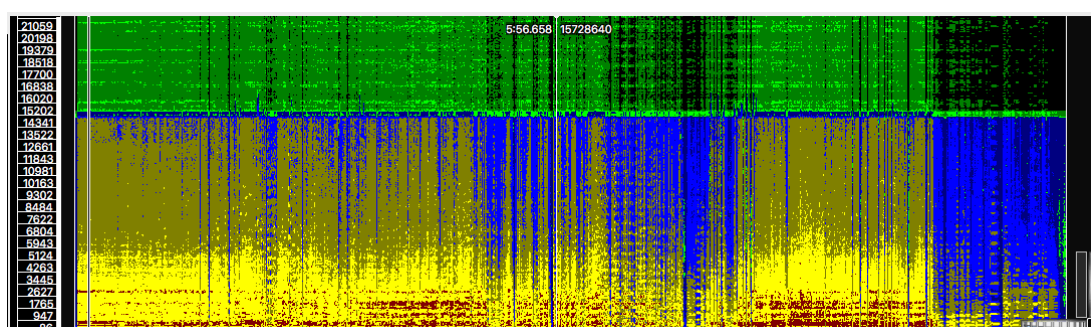


**Figure 4.11:** Berio *Sequenza VI* Spectrogram Overview.

The first thing observed in the two visual representations is the fact that the shapes are not prolonged or they do not exhibit an integrated character. Rather they resemble fractures or cracks. This might explain why listeners showed a tendency to identify too many sections in both pieces. The fact that identification of too many

sections not only in one piece but also in the other one asserts that the trial does not reflect coincidental results especially because of the stylistic similarities shared by the two pieces. There we also observe many areas of silence and this might be perceived by the listeners as final points syntactically and whenever sound followed silence, listeners might have been guided to identify such musical syntagmas as unique formal elements. Analyzing lower, middle and upper frequencies might bring us results regarding whether all these structures with cracks are really idiosyncratic formal units or not but it is obvious that perceptually listeners are guided by silence as much as sound or maybe more than sound. That might establish an experimental setting for those who work in the area of form from the perspective of perception.

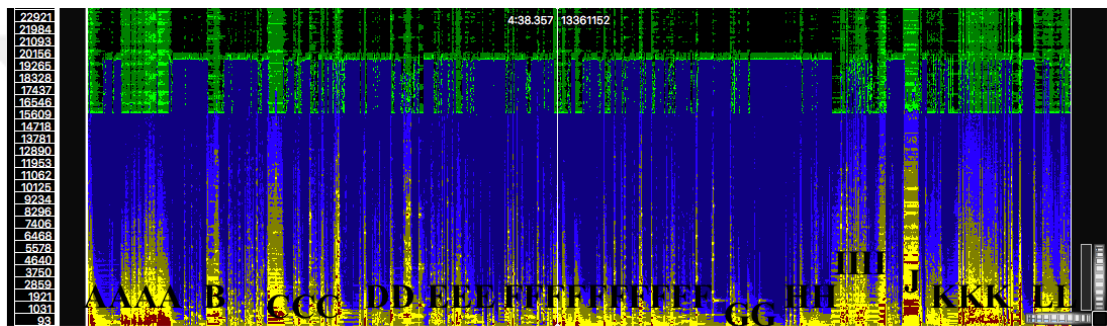


**Figure 4.12:** Frequency Clusters in *Eclat*.

In terms of continuation of the frequencies, ignoring the fractured texture, one might observe thirteen major sections, still based on the principle of similarity of frequencies and dynamics. However, recognizing the identical sections if any without or even with the score seems quite difficult by means of spectrogram analysis. This analysis, thus, helps us identify fewer sections compared to the article claiming to be based on the cognitive processes and have an opinion of the form in favour of through-composed form. Such a claim could be supported by Boulez's composition approach as he, following developing serial techniques, became interested in the concept of 'open form', which basically means that idiosyncratic pieces could be considered to be parts of a larger work that is in the process of creation, and these pieces might be revised at later times (Hopkins & Griffiths, 2001). We must give enough consideration to the concept of form in a piece that could be changed in any way. This is what I, personally, believe to be a befitting example of the organic or evolutive form. We could therefore claim that in this

repertoire we might find pieces that bear a resemblance in terms of formal design to the pieces composed in the Renaissance and Baroque period.

Frequency clusters, which could be defined as similar frequencies grouped together, indicate another perspective in terms of form in the other piece, *Sequenza VI*, as well. Unlike the article, in which the listeners identified thirty two formal sections, spectrogram analysis offers eight major sections, one fourth of the former one. The theoretical framework of the paper, the principle of similarity and difference, is much better reflected in the spectrogram analysis than the cognitive approaches as listeners might be misguided by many factors including silence as mentioned above, transformations in dynamics and memory as the piece is rather long to associate final sections with the former ones and so forth.

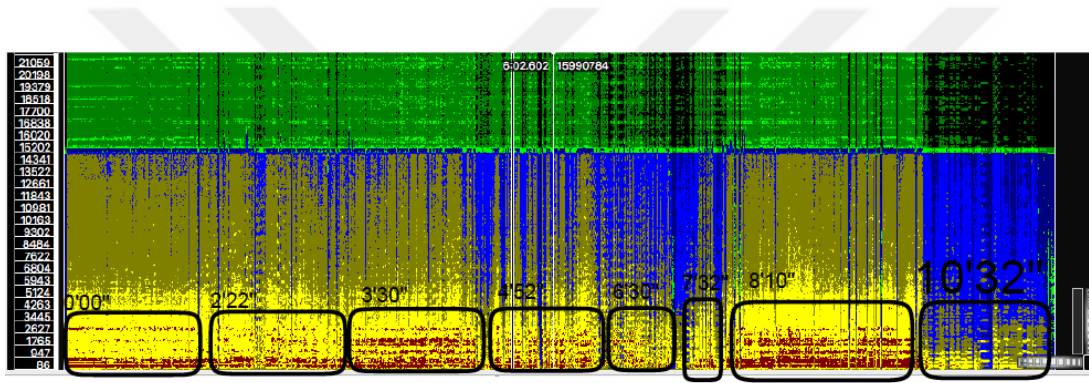


**Figure 4.13:** Frequency Clusters in *Sequenza VI*.

Sound similarity in the piece might be detected by means of frequency clusters observed in the spectrogram analysis and this could help us identify formal sections based on the Gestalt principles mentioned above. In the visual representation above, one could see where frequencies heap together and where they dissociate. Both association and dissociation of the frequencies are significant in formal design interpretation as they represent compositional materials that are used in similar manner. In the visual representation of *Sequenza VI*, we observe eight sections. The first one is dense in the lower frequencies, the second one again dense in lower frequencies losing its upper frequencies to some extent, the third one dense both in the lower and upper frequencies, fourth one more with more fractured texture, fifth one losing the dynamic power of the previous section, sixth one a rather small section with contrasting elements to the previous and next sections that could be considered to be a transient area, seventh one with the loudest frequencies and the

eighth one that could be seen as a final section. Sections begin approximately at 0.00, 2.22, 3.30, 4.52, 6.30, 7.32, 8.10, 10.32 respectively, the first digit being the minute and the last two ones being the seconds.

Because spectrogram analysis provides us with the visual material in which we could observe tangible results regarding the output of the compositional processes in these pieces, we could assert that this analysis method could be preferred to cognitive methods especially in contexts where identifying thirty or so sections is not fruitful. In pragmatic settings, as well, this analysis method could be more beneficial for instance for rehearsal practices of an orchestra. Therefore, Deliège's paper remains to be an experimental effort in the area of music cognition rather than an effort to identify formal sections in contemporary music, which requires more than just listeners' perception of certain pieces.

Last but not least, one might observe a parallelism between the third and the seventh sections in terms of frequencies and their density. At this point we might be motivated to ask if these could be taken as similar or identical sections put there with a formal approach that is reminiscent of recapitulation. In order to answer such a question we need to listen to these sections and look at the score if it is available. If this parallelism is also supported by a score based analysis, then the success of this method would firmly be proven at least in this repertoire.

Now let us look at the related sections on the score and try to see similarities if any between the two sections as a final endeavour for these two pieces.



**Figure 4.14:** A portion from the Section 3 of *Sequenza VI*.

In the third section, whose shapes are similar to the seventh section, we observe multiple stops on viola mostly and between the multiple stops there are tremolos and very fast lines. The section is therefore dominated by multiple stops on a string instrument. The density we observe in the frequencies is probably due to the multiple stops. If, in the seventh section, we encounter such a texture, which utilizes multiple stops mostly, then we could assert that the composer brings back the idea we find here. This claim could be further supported by the fact that we do not observe a return of a compositional material anywhere else in the piece. Although recapitulation is not a strictly necessary terminology to describe the interplay between the third and the seventh sections, using it here will cause no harm. Nevertheless, if one claims that recapitulation requires the use of exact compositional materials, the terminology fails to label the seventh section. Still we would like to use the term ‘recapitulation’ to denote the section as we observe multiple stops not only in the third section but also at the very beginning of the piece, therefore it might be asserted that this is a point where the composer re-capitulates.

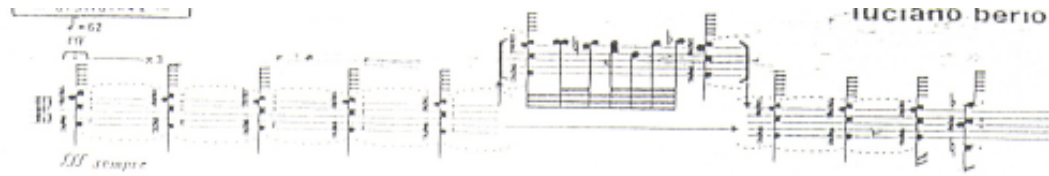


**Figure 4.15:** Opening of *Sequenza VI*.

We have found a formal similarity between the third and the opening of the piece, or at least a formal similarity that depends on or is brought about by compositional material. Now let us look at the seventh section which seems similar to the mentioned parts according to the spectrogram.



**Figure 4.16:** A portion from the Section 7 of *Sequenza VI*.

It is very clear that in this section, as well, we encounter multiple stops. There are also tremolos and quickly played lines that seem subordinate to the other elements. Rhythmic ideas of the portion are also similar to the third section. Although we assert that the similarities are mainly found in the third and the seventh sections, we also find the same rhythmic utilizations in the opening of the piece. Therefore, another approach to the formal design might claim that there are actually three similar sections with contrasting sections played after them, in which case the formal design would be A -B - A' – C – A'' – D. This formal design might probably be supported by the visual representation unless one takes into account the absence of the upper frequencies in the first section. In either case spectrogram analysis yields more than conceptual methods as we read in the paper that no one mentions the returning of a

particular section either by mentioning the returning sections by the term recapitulation or using other terms.

#### 4.5 Polystylism Under Spectrogram: *Concerto Grosso No. 1* by Schnittke

Because style could be observed in the spectrogram in the previous examples we could proceed by analyzing a piece that is polystylistic. When polystylistic music is mentioned it is necessary to discuss Alfred Schnittke's music as polystylism is attributed to the composer who created the concept by mixing modern compositional techniques with rather conventional rhythms and gestures. Schnittke's polystylism especially developed during the last years of 1960s. While this decade witnessed the coining of the term, 'polystylistic music', the next two celebrated the peak of the pieces in this style (Fanning, 1992).

It has been claimed by some scholars that in Schnittke's music, for instance, in his *Concerto Grosso No. 3*, there are structures whose materials are borrowed from different composers such as Bach, Webern etc. (Sullivan, 2010). However, such stylistic borrowings might not be observed in the spectrogram as composers usually expose these borrowed materials to transformations and put these materials in such contexts that it becomes virtually impossible to observe the structures as we observe them in their original contexts.

In this study, *Concerto Grosso No. 1* will be put to spectrogram and the six major sections of the piece will be analyzed with a historical perspective as the names imply styles that are significant in the history of Western music. The names of the sections are Preludio – Andante, Toccata – Allegro, Recitativo – Lento, Cadenza – with no tempo indication, Rondo – Agitato and Postludio – Andante, Allegro, Andante, respectively. In order to understand the concepts, historical insight is necessary. Therefore, we need an understanding covering the concepts such as *concerto grosso*, *preludio*, *toccata*, *recitativo*, *cadenza*, *rondo* and *postludio*. Brief definitions of these concepts will suffice considering the scope of this paper.

To begin with *concerto grosso*, the most important characteristic of this type is that a large group in the piece alternates with a small group. Alternative names of the groups are *ripieno* or *concerto grosso* and *concertino* respectively (Grove, 2001). *Preludio* or *Prelude* basically means a piece preceding another one and introducing its musical traits with the purpose of getting the attention of the audience.

Improvisation is also a characteristic of preludes (Ledbetter and Ferguson, 2001). *Toccata* is a piece composed with the intention of indicating finger dexterity. These pieces are usually composed free of form and from the view of etymology the word comes from Latin *toccare* which means ‘to touch’ (Caldwell, 2001). *Cadenza* is a virtuoso section coming towards the finale of the movement of a concerto. These sections are triggered by an indecisive chord, usually cadential six- four. *Cadenza* sections might be written out by the composer or might be improvised by the performer. *Rondo* has been explained above and finally *postludio* is similar to *preludio* in terms of function. It brings the piece to a finale. In *Concerto Grosso No. 1* we also observe *Tango* and thus we need to explain it before looking at the score. Tango is a song and dance genre with Latin American origins. Although the origin of the genre is debated, it is mostly associated with Latin America. Tango mostly has a duple meter character. Historically, tango genre has a three-part form but from the early years of 1910s two-part character started to permeate the genre. Rhythmically syncopation is a significant trait of tango (Béhague, 2001).

As we have formed a theoretical and historical background regarding the structural elements of the piece, we could proceed by looking at the score to see peculiar commonalities of the sections.

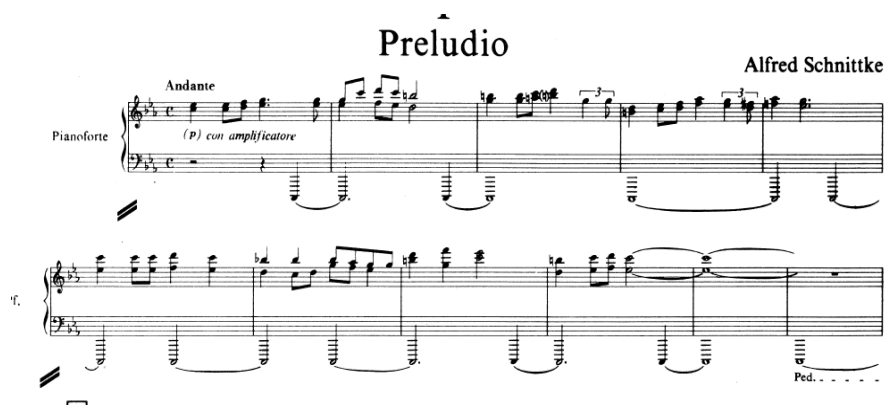


**Figure 4.17:** *Preludio* from *Concerto Grosso No. 1*.



Because *Rondo* cannot be understood just by looking at the beginning of the section, the score is not provided at this stage. For the recording used in the analysis, sections begin at 00.00, 05.01, 09.27, 16.22, 18.54, 26.00 and it might be concluded that sections are more or less of the same length, the first being five minutes long, the second four and a half, the third seven minutes, the fifth one two and a half and the final one seven minutes. Initially let us try to see what the individual sections look like under spectrogram, with a general overview.

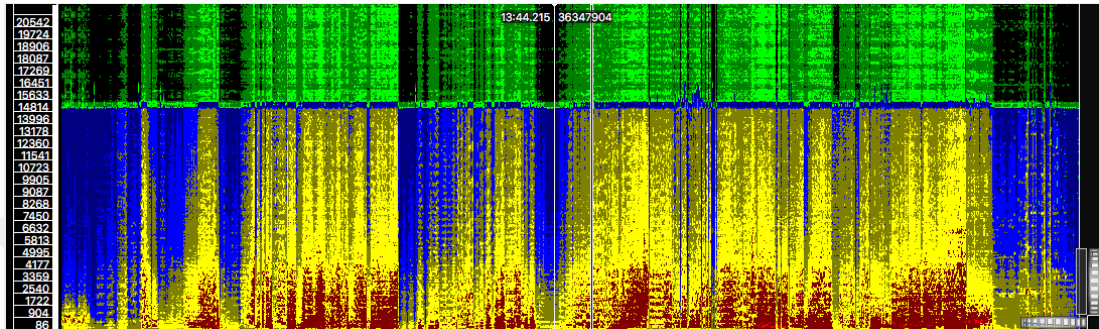


**Figure 4.21:** *Concerto Grosso No. 1* Spectrogram Overview.

The visual representation of the whole piece does not indicate stylistic manipulations of the compositional material due to the length of the piece but it is promising that shapes seem to be grouped in six different sections. The first section is from the beginning till the second group where frequencies are intertwined, the third one is the one coming after the second group with dense frequencies. Due to the fractured structure of this section, it is probable that the third section represents the *Toccata*. Taking the length of the *Toccata* section we could estimate that the third and the fourth groupings belong to this section. The next two sections obviously grouped together are probably the sections *Recitativo* and *Cadenza*. When the dynamic quality of the *Postludio* is taken into account, one might assert that the final part of the visual representation, where blue is prevalent, stands for the *Postludio* section of the piece. The length of the final section also supports this claim as the *Postludio* section is a rather short one compared to the others. When checked with the times of the sections on the spectrogram, it turns out that the sections are mostly estimated accurately only with small deviations in the *Cadenza* section.

As the next step, we can try to identify formal and stylistic peculiarities of the individual sections by zooming into them.

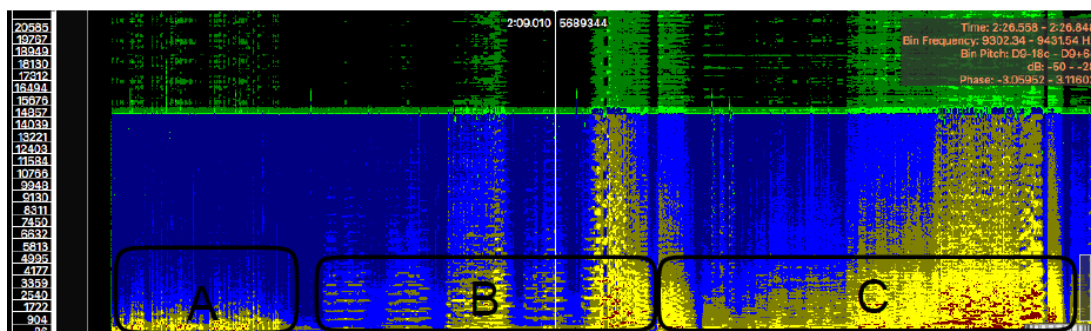


**Figure 4.22:** *Preludio* from *Concerto Grosso No. 1*.

The *Preludio* section opens with prepared piano, with a pedal C below and a very simple melody putting across the main motive we would hear throughout the piece. The main motive is then played by the violins and it comes with dynamic transformations in different manners in the strings. Then the harpsichord plays the main motive in a stylistic manner that we hear again in later sections. It is obvious that there is a historical accuracy in the composer's approach to the section and nomenclature. The formal design of the section is pretty straightforward. The part where prepared piano opens the piece is marked with A, the part where the main motive is played mostly by strings is marked with B and the part that is opened by harpsichord and taken over by ripieno strings is marked with C. In these three formal structures, compositional materials are submitted in different settings although there is a motivic relationship between them, notably between B and C.

At this point it might be useful to indicate what the main motive looks like under spectrogram. Consisting of only two notes the main motive is encountered at early or later points of the piece either in descending or ascending mode. *Recitativo*, in particular, depends mainly on this motive and therefore identification of it is significant in order to be able to identify the formal design of the section.

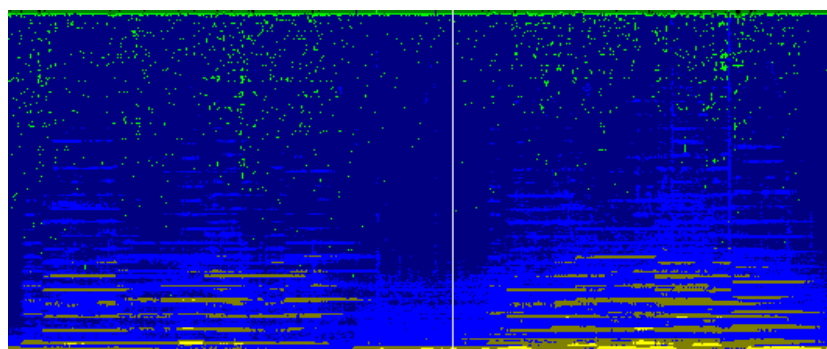


**Figure 4.23:** Main Motive in *Preludio* of *Concerto Grosso No. 1*

The *Toccata* section is interesting in that one could observe structures that are reminiscent of sonata form. Surprisingly, there is a theme, then a part of transition character and then another section with a new theme that has the characteristics of a subordinate theme. The following sections are also similar to the sonata design although there are some differences such as the absence of a recapitulation consisting of exact material from the exposition. Nevertheless, we encounter transformed versions of these themes in the sections that follow the closing. In one setting transformations incorporate rhythmic differentiations and in another we encounter sequential manipulation of the themes, the subordinate theme in particular.

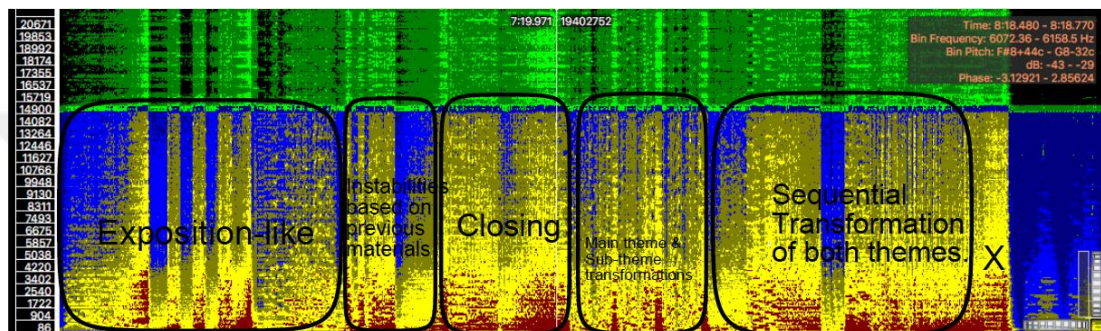


**Figure 4.24:** *Toccata* from *Concerto Grosso No. 1*

In the exposition-like section we encounter a main theme then a very symmetrical transition and a subordinate theme whose mode is more spirituelle than the former one. This section is followed by unstable ripples which is followed by the closing section. In terms of sonata form we need a recapitulation but the composer does not provide us with a proper one. Instead we hear transformation based on the main and the subordinate themes. These themes, in the next section, are heard in sequences with transformations again. The part that is marked with X closes the section, which might mean that it could be a codetta or syntactically we could make an analogy by asserting that X is a full stop.

Even if it is not considered appropriate to claim that there is a sonata form most probably due to the absence of a proper recapitulation, it is possible to see the formal design of the section in the visual representation and it is also possible to infer similarities between the design of this section and parts of a first movement of a sonata. As a final remark on alleged sonata reminiscences, it could be said that returning materials from the so-called exposition might be seen as a quasi recapitulation although these materials are in a context full of transformations of different natures.

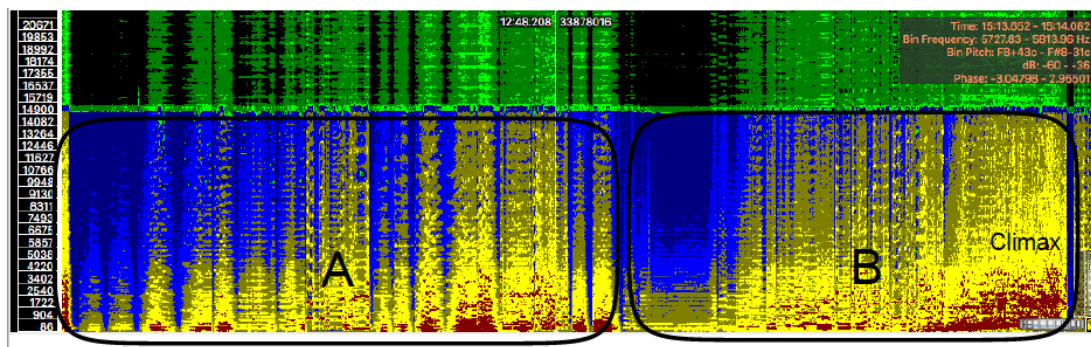


**Figure 4.25:** *Recitativo* from *Concerto Grosso No. 1*.

The *Recitativo* section does not provide an intricate formal design but a simple one with two main parts. The first part is based on the main idea whose visual representation is provided above and one could see similar shapes representing the main motive and indicating its prevalence in this part of the section. The second part, though, is based formally and compositionally on the transformation of the main motive. The evolution of the motive carries the part to a point where we observe climactic properties such as an increase in the number of players (as a climactic property peculiar to orchestral pieces), intense dynamics, high frequencies etc. The section comes to an end with the climax and the next section, *Cadenza*, begins with the same motive but with a contrasting texture as this section begins with the solo violin, a contrast to the full orchestra playing the climax point of the previous section.

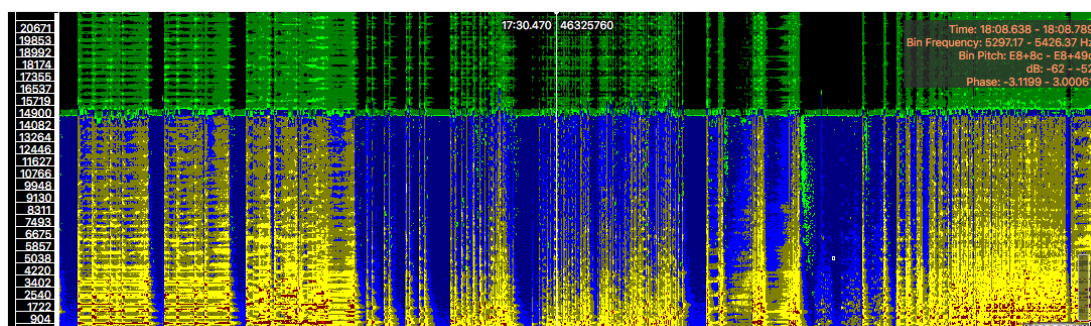


**Figure 4.26:** *Cadenza* from *Concerto Grosso No. 1*.

This section also lacks a tight-knit formal design but structurally it is also based on the main motive. Pizzicato parts might have caused the peaks that we observe in the shapes throughout the visual. There is a frequency density towards the end of the section but it would not be appropriate to assert that this density denotes an idiosyncratic part within the section. Nevertheless, this helps us see that the

composer has a tendency to finalize the sections with climactic behaviours in the compositional process, at least for this piece. The next section is a promising one as it is named *Rondo*. If the formal design of a rondo is preserved in the piece, we will observe repeating sections and contrasting sections between them.

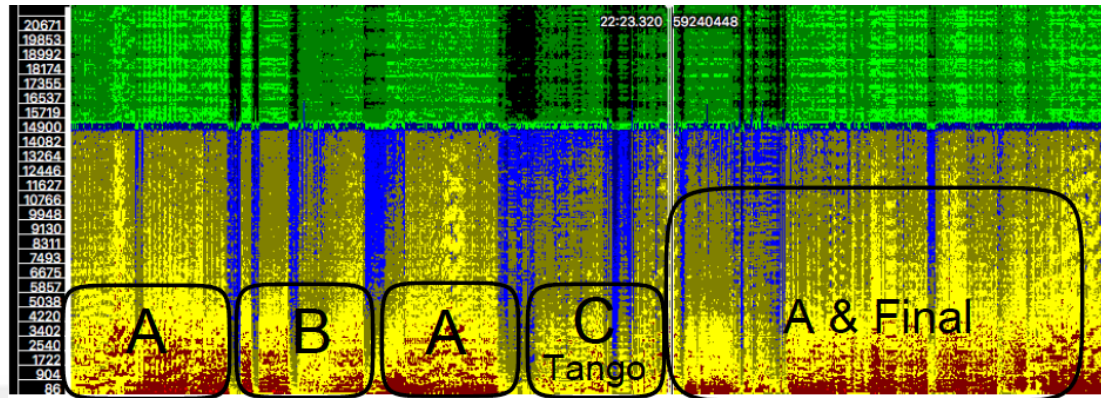


**Figure 4.27:** *Rondo* from *Concerto Grosso No. 1*.

Listening to the section does provide an idea about the formal design when the repeating parts are noticed. There are also other parts put in between the repeating portions, which proves the idea that the historical connection between rondo and the title of the section still exists. A, in which the main theme is heard, is a fast section in the solo violin and there is also accompanimental texture behind fulfilled by the orchestra. B section incorporates the harpsichord and we hear the main motive in this instrument. The harpsichord actually sounds very similar to its first appearance in the *Preludio*, as mentioned in the related portion of the text. There are repetitive elements in the B section, as well. Therefore one might assert that these repetitive elements are reminiscent of minimalism in terms of material manipulation. The first repetition of A is followed by *tango* section and the tango is prolonged by different playing techniques in the strings and alternations between the full string orchestra and solo strings.

The final A is very long and again there is a climactic approach towards the end of the section. Rhythmic synchronization and desynchronization are significant here in that they form contrasting textures and such a difference carries the piece on. The overall formal design of *Rondo* could be claimed to be ABACA, a five part rondo design.

The finale is very straightforward. There are long-held strings below and above we hear prepared piano. The main motive comes in the piano or in the strings. The piece sinks into silence and comes to an end.

As it could be witnessed in the analyses, spectrogram helps us a lot in this process. Together with listening to the piece, spectrogram provides us with the analytical tool which enables us to identify major formal sections and designs of a rather long piece in a relatively short time, which might not be possible all the time when it comes to score-based analyses.

#### 4.6 Ravel's *Bolero*

As another example, now let us analyse Ravel's *Bolero* under spectrogram. *Bolero* is a Spanish dance or song which enjoyed its peak in terms of popularity from the last third of the eighteenth century on in both court and theatres. *Bolero* is typically moderate and in triple meter and it is performed by one or more couples. It consists of three equal sections. Musically, however, bolero consists of an AAB design. A similar rhythmic quality is shared with polonaise rhythm. Ravel's *Bolero*, too, has these traits. It is in triple meter and it is in rather uniform form. We observe a repetitive underlying rhythm, on which the entire piece is based. The piece has a moderate tempo and it does not change throughout the piece. Melody and harmony, which we encounter in the piece also comply with the prevalent rhythm, although there are transformations in these elements, we observe that such transformations are temporary and they are overwhelmed by the recurrent rhythm that is given in the figure below (Kahl and Katz, 2001).



**Figure 4.28:** Underlying Rhythm in Ravel's *Bolero*.

With these traits in mind, what we expect from the spectrogram analysis might be a fractured structure due to rhythmic characteristics prevalent throughout the piece, similar shapes due to recurrent melodies, difference in dynamics, no clear differentiation in formal syntax etc.

Now let us look at the piece under spectrogram and see if our assumptions are valid or not. Similarities in low and high frequencies could be the most significant recognition mark of such pieces with uniform design and transformations in different musical elements.

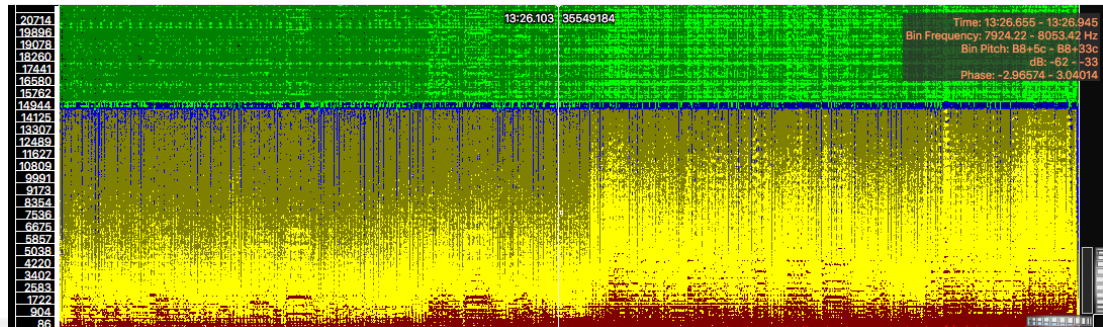


**Figure 4.29:** A portion of Ravel's *Bolero*.

As observed in the visual representation, Ravel's *Bolero* yields expected results mentioned above. Fractured structures are most probably caused by rhythmic motivations of the piece and we observe them from the beginning to the end. Although the frequencies are more intense in the second part of the visual representation, one could not and actually would not assert that this is an idiosyncratic section which could be labelled as a part different from the first one considering the formal design of a bolero. Historical knowledge regarding the formal designs or even the names are important in recognition or interpretation process of a piece with or without spectrogram. It helps us identify the major sections, if any, or it stops us from being misguided by differing frequencies as a consequence of differing dynamics. The second part of the visual representation represents the finale of the piece and that's why we see an upsurge there. If red shapes are analyzed with caution, one will observe similarities that are caused by the recurrent melodic themes. In addition to the repetitions of the themes, instrumentation and/or orchestration might be another contributing factor to the similar shapes that group together and catch the attention of an analyst.

Upper frequencies could also be used in the analysis of pieces of this sort. In this case, for example, upper frequencies also maintain an attitude very similar to those below. In addition to using frequencies, we could also assert that the unvarying form of the piece might be observed by the bounds, as well. For instance in this case the

boundaries between green, blue, yellow and red areas are very clear and they do not change. Ignoring the slight difference in the red shapes, one could see that the blue shapes form a quasi-line structure and the line is quite straight, which might be taken as another proof of unchanging setting. The other parts of the piece are also in this shape. There is no part that we could interpret as a divergence from the main pattern. Such pieces do not provide an analyst with enough *donnee* to make formal interpretations but if it is sufficient to see the fixed structure of such pieces, spectrogram analysis could be utilized easily and it would yield fast and sound results on which one might work. It might be said that rhythm and X axis are the most important agents in determining the formal designs in such pieces and one needs to incorporate the Y axis into the analysis processes by means of some kind of digital procession that will manipulate the data provided by the spectrogram and come up with quantitative and objective measurements upon which formal or any other claims could be established with certainty.

#### **4.7 *upa.naxturušu* by Onur Yıldırım**

As a future study suggestion, it might be possible to say that there are pieces whose scores are very difficult or almost impossible to follow with a consideration to identify formal sections. Onur Yıldırım's piece, called *upa.naxturušu*, is just suitable for such classification. Because such pieces are thought to be free of form or because it is difficult to conduct a score based analysis on them, they are often ignored in terms of formal design quests.

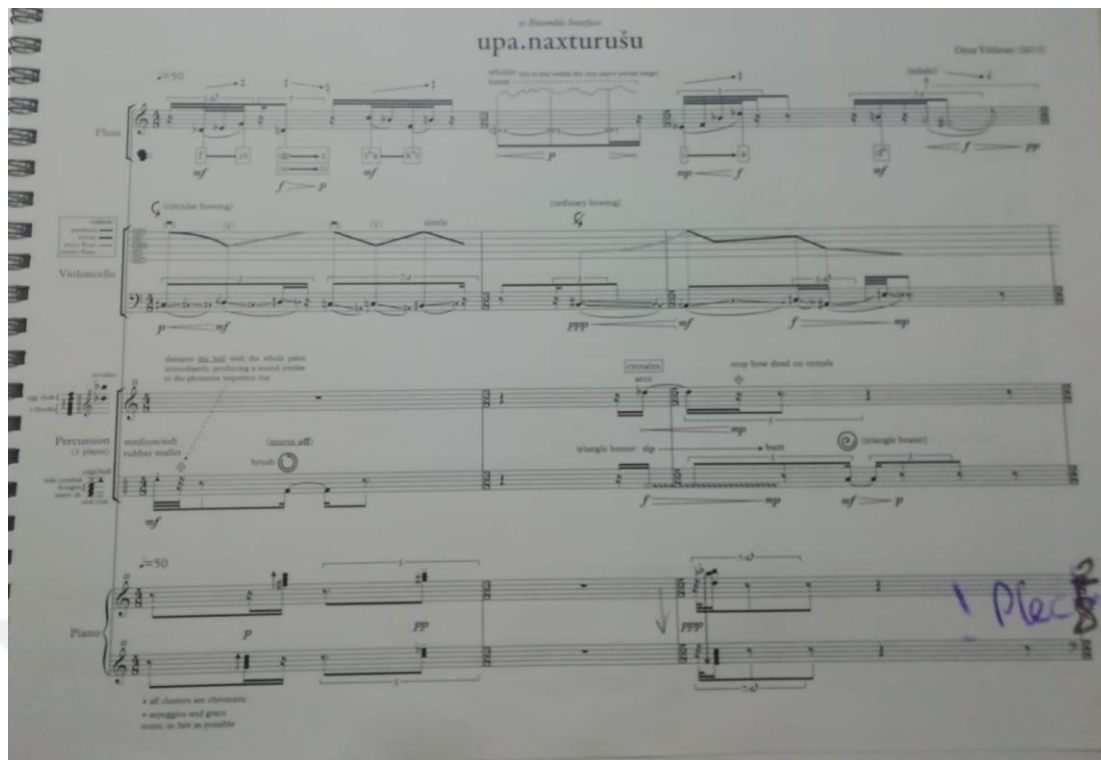


**Figure 4.30:** Opening measures of Onur Yıldırım's *upa.naxturušu*.

The first page of Onur Yıldırım's *upa.naxturušu* proves that it would be virtually impossible to conduct a score based form analysis for this piece. However, spectrogram could be used to see what this piece looks like and for some, actually, spectrogram visual might be more meaningful than the score if a certain level of proficiency is accomplished with such scores. Let us now put the piece into spectrogram and see what the performance of this score looks like.

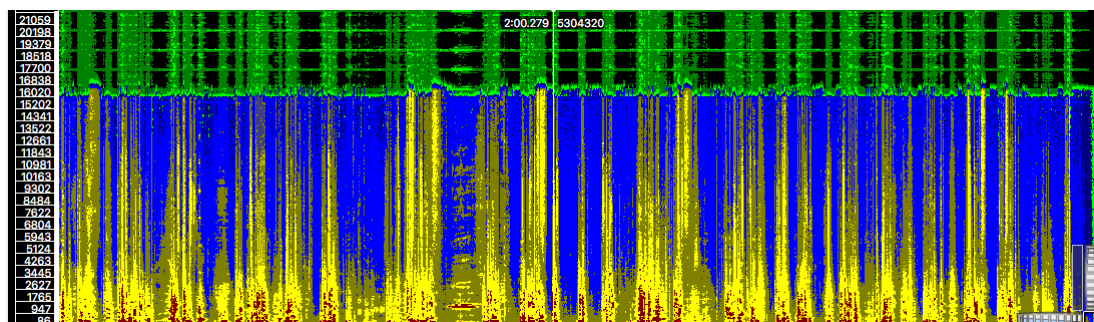


**Figure 4.31:** *upa.naxturušu* Spectrogram Overview.

There are frequency groupings as observed in the visual representation. The formal hints might be inferred from the shapes but it is necessary to define the frequency shapes first as the shapes seem very similar to each other while the sound is different.

This might be taken as a future study suggestion. This piece looks quite similar to *Les Yeux Clos II* in terms of the shapes observed in the spectrogram. Therefore, similar principles might be accurate for this piece, as well. Most importantly, it is essential to come up with an algorithm to catch the digital connections, if any, between what we see as energy bursts on the Y axis. Without such an agent, depending on the eye will only enable us to say there are consecutive energy rises and neither the X axis nor the Y axis will be able to provide us with the proper shapes to make comments on.

I would like to put Onur Yıldırım's *upa.naxturušu*, whose spectrogram analysis has not yielded sufficient results, into another spectrogram software. The software I am going to use now to show if there are differences between softwares in terms of analyses is Spear, which is also a freeware. Because Spear does not run MP3 files, I have converted the same file into WAV and used it in order to avoid any differences between analysis materials.

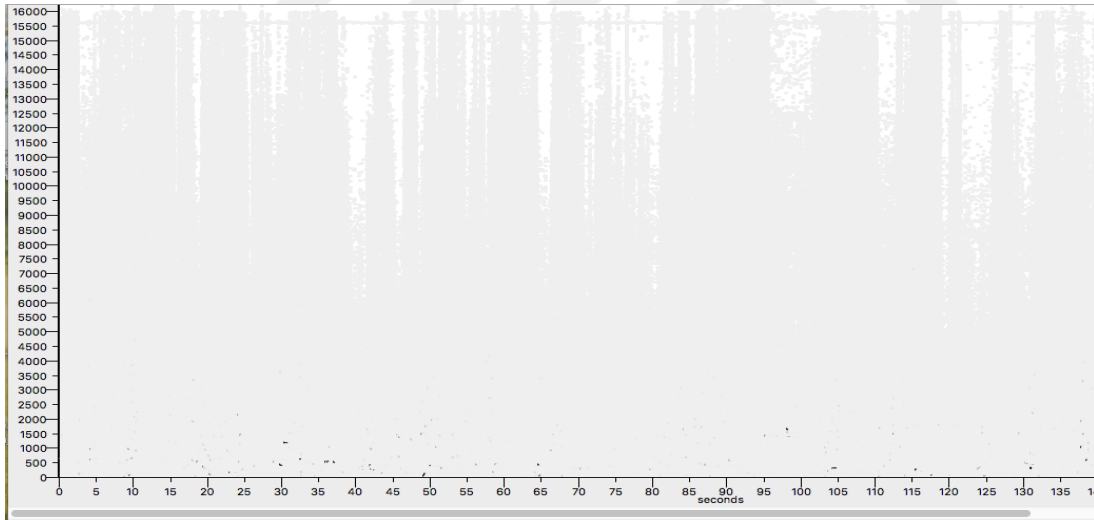


**Figure 4.32:** *upa.naxturušu* in Spear.

Because visual hints are very important in this method of analysis, Spear does not prove to be effective as a software to show formal designs. If colour is ignored, shapes look similar and therefore we are not provided with extra data by this software. It is revealed, thereby, that without an algorithm it is not possible to discover formal relationships between these frequencies whose energy level and ordering we observe in the X and Y axes respectively.

As in the examples discussed above, the spectrogram might yield good but improvable results in formal quests depending on the musical cases. Although in some cases spectrogram does not provide us with proper material to make bold comments, it might be incorporated to different analysis processes such as historical considerations, score based analyses, performance analyses, cognitive trials and so forth.

Pieces from the nineteenth century might be suitable for spectrogram analysis in terms of form due to the fact that they might obtain their formal structures from the common practice period ideas. For instance, sonata form ideas in Liszt's pieces such as *Lamento* might be checked with spectrogram to establish or support such claims. For pragmatic settings, classical pieces could even be analyzed with spectrogram and commentaries regarding their forms could be created based on these analyses. However, in cases where tonality is very important for definition of formal structures, this analysis method could be inadequate as the shapes could only give slight idea about the tones and they cannot reflect the full-fledged tonal structures of a piece. In such cases spectrogram analysis could still be utilized as a verification tool after score based analyses. One could practice score based analysis and in order to verify their ideas they look at the visual representation, as well. Contemporary pieces, to repeat the bottom line, need algorithm to be analysed properly by the spectrogram.





## 5. CONCLUSION

In this study, formal designs of selected pieces from both Renaissance/Baroque and Modern/Contemporary repertoires have been analysed and in the process of formal design quests, spectrogram has been used as a tool to identify formal structures or elements. In the study, *Sonic Visualiser*, which is a freeware provided by the University of London, has been used as the spectrogram. The purpose of the study is

to incorporate spectrogram into form analysis processes and to make it easy for those, who work in the area of form, to analyse pieces whose form is not so straightforward as in the cases of pieces from Renaissance, Baroque and Contemporary repertoires, and whose score-based analyses are difficult or even impossible to conduct. It has been found out that spectrogram could be used in certain pieces with precision and might cause some problems in others especially when the piece does not provide proper visual representation due to intensity of frequency or recording quality.

In the first chapter, the theoretical framework of the study has been put across and in order to provide examples and to make the concept understood, a few pieces with very clear and familiar formal designs have been analysed with spectrogram and the process of analysing music from formal point of view has been explained with figures and commentaries. Because form is an indispensable part of classicism, we have obtained fruitful results in this repertoire. A rondo by Beethoven and a piano sonata by Mozart have been analysed and we have observed these familiar forms in the visual representations which are provided by the spectrogram analysis and which are used to concretize the sound before our eyes. We also analysed different pieces such as an invention by Bach and in order to understand if we could observe transformations under spectrogram, we have analysed a piece by Liszt. The visual representation of D minor two-part invention has turned out to be very surprising as the shapes have been very organized and aesthetic given the circumstances of a spectrogram visual. For Liszt's example, though, we have not been able to observe thematic transformations under spectrogram satisfactorily, but there we have observed similar shapes on which further studies could be conducted. Zooming in and zooming out have turned out to be significant parts of this analysis method.

In the third chapter, analyses from Renaissance and Baroque periods have been provided and these have also been put into spectrogram to see their formal designs. First analysis has been conducted on Monteverdi's *Lamento della Ninfa* and one of the most important structural elements of music, descending fourth or lamenting fourth has been observed in the spectrogram. However, due to the fact that the frequencies were weak in the recording, it was necessary for us to re-master the track in order to make the frequencies more observable in the spectrogram. This could be a requirement in cases where recording lacks audible frequencies due to recording

processes. Other pieces from the beginning of the seventeenth century have been analysed and promising results have been obtained by means of spectrogram. *Toccata no. 5* by Kapsberger has been analyzed and for the piece it has been found out that historical accuracy could also be observed in the spectrogram as the toccata style has been associated with the shapes created by the frequencies. Fugues might also be analysed in the spectrogram but as we have provided a two-part invention in the previous chapter we have not put a fugue into the chapter as it would yield similar results. In this chapter, we have experienced problems regarding the methodology due to the fact that the frequencies in the recording of a piece by Frescobaldi have turned to be very intense from the beginning to the end and therefore we have not been able to see meaningful shapes in the spectrogram visuals. The organ piece have been written again in a notation software and therefore a piano transcription of the piece has been created. Although we have not been able to yield results out of the analysis of the actual recording, analysis of the piano transcription has provided us with shapes upon which we have been able to make comments regarding the form primarily based on the energy levels. Depending on the energy levels that we have encountered in the shapes, we have been able to suggest a formal design and it has also been possible for us to see the harmonic rhythm of the piece taking the energy levels encountered in one of the formal units of the piece into consideration. In conclusion, transcriptions have proved to be useful in cases where frequencies cannot function due to timbral qualities of instruments.

In the fourth chapter contemporary or modern pieces have been analysed by means of spectrogram and in this chapter, we have obtained some issues on which debates could occur. Takemitsu's *Les Yeux clos*, Haas's *String Quartet No. 2*, Arvo Pärt's *Cantus in memoriam Benjamin Britten*, Boulez's *Eclat*, Berio's *Sequenza VI*, Alfred Schnittke's *Concerto Grosso No. 1*, Ravel's *Bolero*, Onur Yıldırım's *upa.naxturušu* have been put into spectrogram and I have tried to find formal structures with Gestalt principles. Frequency groupings have been observed and together with listening to the groupings 'a formal labelling suggestion' has been provided for the pieces for which it might be difficult to come up with a formal design labelling. Nevertheless, it has been concluded that mere observations are not sufficient for determining the formal designs of such pieces and a computerized intervention is needed to see if any true relationship exists within the frequency clusters. As another analysis in this

chapter, Onur Yıldırım's *upa.naxturušu* has been put into another spectrogram software to see if software difference is a variable affecting the methodology. No difference has been found in accordance with software types and it has been concluded that spectrogram softwares using colours at different frequency levels are more effective in the process of indicating the formal design hints depending on the energy levels.

As observed in the analyses, formal design information could be obtained by means of spectrogram. Being an alternative to the score based analyses, spectrogram analysis could also be utilized in cases where score analysis and listening are not sufficient. In this study, different pieces have been exposed to spectrogram analysis and a number of findings have been obtained such that the effect of materials used in compositional process could be observed in the analyses, as well as the main formal structures. Conventional form information could be further supported by means of spectrogram and this kind of analysis could also be used to analyze 19th century repertoire that is claimed to use sonata form in pieces with no conventional movements. Motivic content of a piece might be observed in the analyses and it might also be possible to observe thematic transformations unless the musical texture is crowded in terms of elements other than the transformed theme. For such quests, an algorithm is absolutely necessary as observation alone is not sufficient. Certain conventions in Baroque and Renaissance music could be identified although these analyses will not always be dependable. One of the most significant drawbacks encountered in the course of the analyses conducted in this study is the fact that analyses depend on sound and mixing and mastering have a direct influence on the result. Sometimes it might be necessary for the analyst to take on the task of adjusting the frequencies. Melodic and tonal content of the pieces cannot be identified, either, but main tonal areas could be identified with a cautious look at the frequency range.

The spectrogram might be incorporated into the analysis processes but before that a systematic approach like the one we find in speech analysis must be established in the area of music. For instance, depending on the repertoire, phoneme-like structures must be defined and their spectrogram visuals must be learnt for proper identification at a later point. Tonal music is a good area for such an effort. This endeavour would be about the material or maybe vocabulary of the music regarding harmony, syntax,

colour, timbre and so forth. A certain period's music and its traits could be exposed to the spectrogram analysis and as in speech analysis by spectrogram, experienced analysts could look at the visuals and immediately identify what they see in the spectrogram. This would be an extensive study but collecting the vocabulary or idiomatic structures of a certain music style and looking at them under the spectrogram might be another way of exploring different repertoires. Form analysis with the spectrogram, on the other hand, works for certain repertoires as expressed above. Mere observation is effective for common practice period pieces and for some of the works from the Renaissance and Baroque periods. More is necessary to depend on the spectrogram in terms of form analysis but it might work in the future when the method is improved by necessary interventions regarding computerization.

As a result in light of the whole discussion, we can assert that what we can or cannot obtain does not depend on the software that is used in the process of form analysis and the issues of the methodology mentioned above remain to be handled or solved in order to improve this analysis method to incorporate it into well accepted analysis methods. Improvements or ideas to improve the methodology occur to people during the actual analysis processes. In other words, what should be done will be found while actually dealing with the issues. Therefore, it is necessary for an analyst to use this method, encounter a problem and try to look for ways to eliminate the issues. Although there are and there will be issues like in all analysis methods, spectrogram analysis could be integrated with other analytical perspectives and when an algorithm that will free us from our dependence on observation is made possible, the method could then be used more easily and more effectively. For all the repertoires, it would be best to define spectrogram shapes of idiosyncratic structural elements that could be considered to be idiomatic elements of a certain repertoire, and the first step to begin such an endeavour could be choosing appropriate pieces from the repertoires in question. This study might hopefully provide a perspective for those who wish to conduct studies in the area of form.





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