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**Neo-Riemannian Interpretation of the Tertian Triad: Perspective of Transformation into a Compositional System**

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**INTRODUCTION**

The well-known triads of a consonant nature which form the major-minor system have been the basis of the harmonic structures of music for several epochs. Although since the 20th century the possibilities of this probably the most popular chord in Western European music might seem exhausted, its acoustic properties (the consonant character) remain a value in contemporary compositional techniques, such as minimalism or *new simplicity*. However, the "perfect chord", considered to be a phenomenon of nature (Rameau, 1722), was chosen as the starting point for the study because of its other properties: in the late 20th century, theorists revealed the "second nature" of triads – non-functional triad relationships, based on mathematical group properties, which were studied by Neo-Riemannian theory. It has been a thriving analytical system for the past 3 decades, especially in North American musicology, which merged the ideas of the 19th century German theorists, with Hugo Riemann being the most influential of them, and the late 20th century analytical techniques (e.g. the set theory). Using a Neo-Riemannian analysis, i. e. interpreting the logic of a triad sequence as musical transformations of the mathematical group elements, the relationships became apparent that could not be seen in the usual functional (degree) harmony analysis. Characteristics of the internal structure of the triad were discovered, allowing consistent transformation through minimal voice leading, yet such potential of their systemic connections was masked by the methods of functional connection that dominated several epochs of music history. Neo-Riemannian theory, developed by David Lewin, Brian Hyer, Richard Cohn, et al., became a tool for studying non-functional triad connections and revealed the generative (algorithmic) nature of the triad. These aspects formed the core of the theoretical problem which can be defined by the following questions:

1. What are the characteristics of systemic connections of triads in the Neo-Riemannian context?

2. How can systemic connections of triads be applied in the process of composing music and what is the perspective of their transformation into a compositional system?

**Relevance of the paper.** Although triads are mostly associated with tonality or, more broadly, with tonality and functional harmony, in the 19th century, with the collapse of the functional relationships-based harmonic system, the search for "new tonality" and new systemic relationships between triads became **relevant,** which can be identified by means of Neo-Riemannian Theory. When the triads are "freed" from functional hierarchical relationships, linear voice connection becomes a factor of formation of the harmonic vertical and opens up the space of structured connection of triads, while the gradation of voice- leading consistency becomes a precondition for the development of systemic connections of triads. This historically capacious and theoretically specific topic is interesting and useful for the compositional practice, as the search for the generative code of triads opens up new possibilities for the systemic formation of harmonic strategies. A hypothesis is raised that, through its laws, changes in rhythm and timbre can be structured, thus the study can reveal new resources for music composing. The work is also relevant for musicologists, as the various branches of NRT, presented and compared in the paper, is a great tool for analysing triadic music, composed in accordance with the laws of other than functional harmony.

**Overview of the previous research.** In the19th century, systemic connections of non- functional relationships-based harmonic triads were studied by the dualist *Schritte / Wechsel* system, presented by Arthur von Oettingen (1866) and developed by Hugo Riemann (1880). In the 20th century, musical transformations as mathematical group elements were studied by David Lewin (1987) and Brian Hyer (1989). Richard Cohn (1996), (1997), (1998), (2012) wrote about PLR operations, *parsimonious* triadic systems, and their historical perspective. Parsimony and modes of limited transposition were graphically depicted by Jack Douthett and Peter Steinbach (1998). Julian Hook (2002) proposed the UTT (Uniform Triadic Transformations) theory of unified major-minor triadic transformations, applicable also to polyphonic chords or class "sets". Dmitri Tymoczko (2006), (2008) wrote about the conceptual voice-leading space and the non-Euclidean geometry of chords. Transformational theories have also been studied by Steven Rings (2011) and Edward Gollin (2000), while Henry Klumpenhouwer (1992) applied them to late Renaissance music. The texts of musicologists Alexander Rehding, Robert Cook, Daniel Harrison, Steven Rings, and others in *The Oxford Handbook of Neo-Riemannian Music Theories* (2011) discussed the relationship between Riemann's functional and NRT theories and also addressed psychoacoustic effects.

**Novelty of the paper**. Extensive research by foreign authors examining Neo-Riemannian systemic connections of triads through the analysis of compositions testifies to the relevance of the topic to contemporary music theory. Researchers into NRT, using mathematical group theory, analysed the LPR operation cycles, the resulting systems, and their properties. Their works featured a linear approach to triadic connections, related to parsimonious voice-leading, and their description in mathematical language. However, there is a lack of studies on the aspect of vertical triad juxtaposition; meanwhile, it is that particular discourse that would contribute to the refinement of compositional techniques (referred to in the paper as a multidimensional triadic harmonic system). It can be argued that the possibilities of applying Neo-Riemannian theories not in analysis, but in music composing, have not been sufficiently explored; therefore, the paper will examine the way that mathematical theories and algorithmisation of triadic sequences can be practically applied both in the analytical and compositional processes, including computer-aided generation programs. Finally, a lack of Lithuanian publications on the subject of Neo-Riemannian Theory encourages a more detailed presentation of this multifaceted theory, such as, e.g., Julian Hook's UTT system, through using it for the analysis of Lithuanian composers' works.

**The object of the research**: the Neo-Riemannian triad interpretation and the perspective of its transformation into a compositional system.

**The aim of the research:** to reveal the Neo-Riemannian triad intererpretation and the perspective of its transformation into a compositional system.

**The objectives of the research:**

1. To describe the triad concept in the Neo-Riemannian context.

2. To establish the concept of generative voice leading based on *Neo-Riemannian* ideas and to compare the syntaxes of the two types of music.

3. To present the categorisation and systematisation of Neo-Riemannian triad connections.

4. To reveal the relevance and potential of the triad in the 21st century music composition.

5. To cover the application of the versatility of the NRT system (different levels and aspects) in Žiūkaitė's compositions.

**The hypothesis of the research:** Neo-Riemannian Theory can be a precondition for making the triad relevant to music composition in our time.

**Research methods:** in order to achieve the set objectives, analysis of scientific literature, document analysis, and structural analysis and experiment (in accordance with the discovered models in the composition of musical works) have been used, as well as the descriptive, systemic, and analytical methods. A **qualitative type of research** has been applied, because the aim is to understand the nature and essence of the researched phenomenon and to focus on specific theoretical concepts.

**The structure of the paper:** the paper consists of an introduction, four chapters, conclusions, bibliography, and six appendices. Chapter 1, *The Triad Concept and the Trends of Development of Harmonic Tertianism before the Early 20th Century*, consists of three sub-chapters, in which the triad concept is introduced (1.1), the origin of the triad in music and the directions of conceptualisation of the phenomenon before the 19th century are presented (1.2), and a dualistic model of harmony, typical of the 19th century, as well as the *Klang* concept in the works of Hugo Riemann are overviewed (1.3). Chapter 2, *Fundamentals of the Neo-Riemannian Approach and Characteristics of the Analytical Technique,* presents the origin of the theory and the exposition of conceptual theses (2.1) with an excursus to mathematical group theory as well as the interpretation of the triadic generative voice leading (2.2); moreover, the systematisation of triad connections based on Neo-Riemannian transformations and an analysis of triad connections from the viewpoint of historical dynamics (2.3). Chapter 2 is supplemented by *Characteristics of the Neo-Riemannian Method of Analysis* (2.4) and the *Aspect of Musical Syntax in the Riemannian and Neo-Riemannian Theories* (2.5).

Chapter 3 is devoted to insights into the application of the Neo-Riemannian model in the 20th and the 21st century compositions. The nature of triad functioning in post-tonal music and its theoretical interpretations, such as, e.g., Arvo Pärt's *tintinnabuli* technique (3.1), are overviewed. Insights into the application of the NRT fundamental principles and the triad model in the harmony parameter (3.2) are analysed, and the possibility of computer-aided algorithmisation of triad connections (3.3) is tested. Ultimately, the above mentioned theoretical problems are illustrated through the practice of composition: the manifestations of the NRT compositional method are revealed in the works of Raimonda Žiūkaitė, author of the paper, in Chapter 4. These manifestations are theorised / classified in subsections: *Multidimensional Triadic Harmonic System* (4.1), *The Extravagant Transformations* (4.2), *Determination of Tone Purposefulness in Voice-Leading* (4.3), and *Insights into the Application of NRT Fundamental Principles and Triad Model in the Time, Timbre, and Other Parameters of the Composition and the Ratio of Musical Parameters Controlled* *by Triad Systems* (4.4).

The findings of the research have been summarised in the conclusions. The bibliography consists of 88 items, covering the publications of the period from 1894 to 2019 and of websites. The research paper has been supplemented with appendices. Appendix 1 provides a table of consonance-dissonance changes illustrating the establishment of the triad. Appendix 2 represents the study conducted by Raimonda Žiūkaitė: *Analysis of* *Triad Connections from the 4th through the Early 20th Century in terms of the Historical Dynamics of Music*. Appendix 3 presents an excursus to mathematical group theory, and Appendix 4, an analysis of Gavin Bryars' String Quartet using UTT system. Appendix 5 contains the score of Arvo Pärt's *Beatitudes* (1990) with marked triads. Appendix 6 is simulation of Arvo Pärt's *tintinnabuli* technique with PWGL software.

Thus, the new concept of the triad and its generativity, developed in the 20th century, revealed the theoretical and practical possibilities that will be explored in the current paper.

1. **THE TRIAD CONCEPT AND THE TRENDS OF DEVELOPMENT OF HARMONIC TERTIANISM BEFORE THE 20TH CENTURY**

## 1.1. The triad concept

A tertian triad is a chord consisting of two vertically stacked minor and major thirds (a monistic approach) or the tones of a third and a fifth from the given root tone, forming a sound phenomenon corresponding to the fourth, fifth, and sixth partial tones of the overtone sequence, 4: 5: 6 (a dualist approach). In the present research paper, in order to distance ourselves from the context and connotations of the functional-diatonic relationships of the tonal system, the term of *triada* (cf. Latin *Trias*, English triad), not yet fully established in Lithuania, shall be used.

The phenomenon of the triad stands out among other chords by its special consonant qualities and the role in the history of music. Reinhard Amon (2005: 58) named the triad as the most common, the most widespread, and the most important pitch class clump for tonal music both from the melodic and harmonic viewpoints, corresponding to, and preconditioning, the aesthetics in the period from ~ 1600 to 1900. The triad was associated with St. Trinity as a sign of perfection, equated with nature, regularity, or even an archetypal phenomenon. Such ideas were also established by the overtones discovered in the early 18th century and the correspondence of the first six ones with a major triad.

2. The origin of the triad in music and the directions of conceptualisation of the phenomenon before the 19th century

On the basis of the triad as the most important musical pattern, musicologist Willi Apel (1969: 372-374) identified three main periods in harmonic music:

• the pre-tertian harmony period (around 900-1450), in which the potential of the triad was not yet exploited;

• the tertian harmony period (c. 1450-1900), in which a third / triad predominated;

• the post-tertian harmony period (since 1900), in which, after the exhaustion of the triad, new harmonic patterns were desired.

The triad in the harmony of music emerged in the medieval polyphony. In 1558, Gioseffo Zarlino raised the idea that the constructive basis of all polyphonic music of that time was the triad, however, the term itself was first used by Johannes Lippius (1610, 1612): the term *trias musica* meant a chord of three different tones perceived as oneness. Jean-Philippe Rameau (1722) revealed the tonal-functional system of harmony encoded in the triad, while the discovery of the overtones made it possible to understand the phenomenon of chord inversion.

Thus, with the change of the harmonic system in the 12th through 17th century, a third from dissonance turned to consonance, the modal system was replaced by the tonal one, yet the triad, having established itself since the Renaissance, perceived first as a summary harmony and later a chord, remained the most important chord in professional European music until the 20th century.

**1.3.** **A dualistic model of harmony, the tertian *Klang* concept, and transformations in the works of Hugo Riemann and his contemporaries**

In the theory of Hugo Riemann, German musicologist of the 19th century, the concept of *Klang* occupied a central place, meaning both a musical pitch class with complementing overtones or undertones and a major or a minor triad.

The studies of harmonic relations by the 19th century theorists were reflected in the Riemannian theory of functions, the *Schritte / Wechsel* system (a system of direct connections of any two triads, introduced by Oettingen in 1866), and various *Tonnetz* [tone-networks], which were important historical forerunners for the depiction of NRT and the triadic transformation space. Those concepts in the 20th century Neo-Riemannian theory were separated from their tonally centered and major - minor dualism remnants and integrated into an analytical system, developed for the study of the repertoire of the 20th and the 21st centuries.

1. **FUNDAMENTALS OF THE NEO-RIEMANNIAN APPROACH AND CHARACTERISTICS OF THE ANALYTICAL TECHNIQUE**

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## 2.1. The origin of the Neo-Riemannian Theory and the exposition of conceptual theses

In North America, the revival of Riemann's ideas became an impetus for the development of a new paradigm of music theory. The ideas collected under the umbrella of the Neo-Riemannian theory first arose in the last decade of the 20th century from the works of David Lewin (1987) and Brian Hyer (1989). They interpreted certain functional triadic relationships in Riemann's works as mathematical transformations that affected triads, using them (and the accompanying group structures) for the modelling of structural relationships in the late 19th century music. Inspired by the ideas of Lewin's transformational movement, the works of Neo-Riemannians cover a variety of topics, such as: the 19th century harmony practice; the 20th century harmony and voice-leading practice; and transformational properties of diatonic and other scale systems. Edward Gollin (2005: 153-155) identified the following key features of NRT:

1. Triadic relationships are interpreted as transformations of elements of mathematical groups.
2. The privilege of transformations where there are as many common tones between objects as possible and simultaneously the shift of moving voices is as small as possible (**voice-leading parsimony**).
3. Spatial representation of transformational relationships by formal graphs or *Tonnetz* (tone-network).

The theory was developed due to the problems of analysis caused by the chromatic music of triadic origin, yet tonally non-unified; it became an alternative analytical system for the examination of those non-functional triads. The harmony of (late) Romanticism and early Baroque, popular music, and part of the 20th century repertoire (minimalism) allowed for the application of NRT.

In NRT, the transformational processes of each of the three triadic pitch-classes are assigned to three basic operations: the P (Parallel) transformation changes the triad mode by alternating a third of the chord by a semitone; The L (*Leittonwechsel,* or lead tone change) transformationalternates a prime of the triad a semitone down (in a major) or a fifth up (in a minor); and the R (Relative) transformation alternates a fifth of the chord a tone up (in a major) or a prime a tone down (in a minor). These operations maximally retain the correspondence of pitch-classes between the pairs of triads to be connected; each of them is involutional in nature (twice applied, returns to the original triad) and changing the mode. 24 triads and the PLR operations affecting them form a mathematical group.

## 2.2. The Neo-Riemannian interpretation of the triadic generative voice-leading

**Triadic cycles and compound transformations**

An interesting feature of triads and PLR transformations is their cyclical nature. On applying a series of repetitive transformations to triads (compound transformations of two or more PLR operations), the triad chain will return to the first triad after a certain time, thus closing the cycle.

The LP / PL transformation generates a maximally consistent (because one member differs from another by merely a semitone step) six-triad cycle. The LP / PL cycles divide 24 triads into 4 unrelated regions. Hexatonic pole transformations connect any two triads that are opposite each other in a cycle.

The PR / RP transformation generates an eight-triad cycle in which a semitone motion of one voice (P) alternates with a tone motion of one voice (R), dividing the entire 24-triad field into three unrelated regions.

**The RL / LR transformation** generates a cycle of all 24 triads. Once applied, RL / LR transposes by a fifth – a transpositional value that retains the maximum tone correspondence between diatonic sets (e.g. a circle of fifths) (Cohn 1997: 36).

**Ternary generators and LPR loops**

On performing the LRP compound transformation twice, we obtain a cycle of a ternary generator, an LPR loop, returning to the original chord (Cohn 1997). An important feature of them is that the six triads that make up the loop share one common pitch-class, and therefore, the sequence constantly maintains one unchanging melodic tone with a changing maximally consistent voice-leading harmony.

Those cycles combining two, three, or four basic operations could be examples of algorithmic composition and, from the viewpoint of mathematical group theory, the regularities of those cycles can be described in mathematical expression.

## Systematisation of triad combinations on the basis of Neo-Riemannian transformations

One of the goals of the research paper is to systematise and generalise all two-triad connections by classifying them according to the "distance" between them, measured by the number of tone shifts and transformations (PLR operations) performed. The voice-leading distance can be calculated by formalising and generalising intertriadic relatonships mathematically, expressing the intervals in numbers corresponding to the amount of semitones in a 12-tone system.

Upon the analysis of triad connections in specific examples of music of the 4th through early 20th century from the viewpoint of historical dynamics, in the evolution of harmony, an "arch" was observed between the linear harmony at the end of the Renaissance epoch (second half of the 16th century) and its return in the late 19th century. The findings suggest that Gesuald's work is characterised by the greatest diversity of triad combinations, and Mozart's by the least, moreover, an arch can be observed also between the dualistic approach in the Renaissance and the 19th century (Zarlino's harmonic and arithmetic proportions correspond to the 19th-century dualists' overtone and undertone rows).

## Characteristics of the Neo-Riemannian method of analysis

The NRT analysis has usually been applied to individual passages whose harmony sounds in an unusual way. After finding out the laws of harmony of the selected fragment (through marking PLR operations and calculating the voice-leading distance), a broader view is taken and a more detailed interpretation of the composition, a macro-system, is constructed.

As observed by Rings (2011), Neo-Riemannian Theory only reveals the order of voice-leading without explaining the psychoacoustic effect; therefore, in order to reveal the effect of music, it is more reasonable to use Riemann's theory of functions. In summary, it can be argued that it was specifically the NRT analysis that succeeded in the modelling of superficial features, important to the listener's intuition, thus, NRT is useful in places where chord interpretation is functionally complicated, while NRT reveals simpler voice-leading relationships and clarifies superficial details of music.

## Aspect of musical syntax in Riemann's and Neo-Riemannian Theories

The functional and Neo-Riemannian analyses represent two different types of musical syntax. The two natures of the triad and corresponding musical syntaxes can be expressed through the following table:

**Table 1. A dual nature of the triad (juxtaposition by Raimonda Žiūkaitė)**

|  |  |
| --- | --- |
| Riemann's Theory | Neo-Riemannian Theory |
| Musical logic | Structural logic |
| Cadence | Sequence |
| Hierarchical structures | Non-hierachical structures |
| Audiation in the process of music composing | Rejection of audiation |
| Functional relationships | Non-functional relationships, voice-leading |
| Classicism | Renaissance, Late Romanticism, consonant music of the 20th century |
| Diatonics | Chromaticism |
| Acoustic properties of the triad | Logic of the group theory principles |
| Objects are marked | Object relationships are marked |
| Principal operations: T, S, D | Principal operations: P, L, R |

1. **INSIGHTS INTO THE APPLICATION OF THE NRT MODEL IN THE 20TH AND THE 21ST CENTURY COMPOSITIONS**

The two different musical syntaxes, corresponding to the two triad potentials, are represented by two directions of logic in music composing: the musical logic, including audiation, and the structural logic, based solely on abstract thinking processes and seeking to find the internal logic of the syntactic structure elements without the assistance of audiation. The dual nature and potential of the triad also leads to dual compositional approaches: in the late 20th century, in the compositional techniques of spectralism and sonorism, they are based on the acoustic nature of the triad as a perfect chord and part of the harmonic spectrum, or a sound symbol boasting exclusive semantics among elements of music. Meanwhile, in some works of the compositional technique of minimalism or algorithmic composition, the second nature has influence – a triad as a mathematical group bound by consistent voice-leading relationships.

## The nature of triad functioning in the post-tonal music of the 20th and the 21st century and its theoretical interpretations

As noted by Russian musicologist Elena Tokun, the 20th century music development is characterised by regular algorithmisation of creative, including sonic, processes (Tokun 2011). In algorithmic theories of music composition, "as soon as certain variables detailed by theory are defined, a piece of music emerges" (Morris 1987: 3), since self-determination in precomposition determines many aspects of the score.

Although since the 20th century the period of post-tertian harmony has been prevailing, in which new harmonic patterns were already desired after the exhaustion of the triad (Apel 1969), in the late 20th and the 21st centuries, the triad has been found in the techniques / aesthetics of minimalism, post-minimalism, new simplicity, spectralism, and sonorism.

Pure triadic harmony, however, not necessarily governed by the principles of functional theory, is characteristic of the works of minimalist composers, such as Philip Glass, Michael Gordon, Gavin Bryars, Arvo Pärt, and others. Although the consonant sound of the triad is also important for that music (the triad often becomes a diatonic communality), the study of triadic connections focuses on the "structural nature" of the triad, and it is specifically Neo-Riemannian theories that promise assistance in writing and analysing triad-based music.

**3.1.1. Julian Hook's UTT analytical system**

Julian Hook in his work *Uniform Triadic Transformations* (2002) presented a universal system of formalisation of triadic transformations, the so-called Uniform Triadic Transformations (UTT). It is a simple algebraic structure by means of which the transformation is described by a three-component formula, specifying two parameters of change: the mode and and the distance between the leading-tones of the triads.

The generalising and simplifying formalism of the Uniform Triadic Transformations can express triad connections more concisely than clumsy compound transformations of NRT. In the analysis of Rytis Mažulis' composition *Clavier of Pure Reason* (1994), UTT enabled to write down a whole division of the work in one formula. In composition, the system can help generate triad sequences.

### 3.1.2. The triad as a structural unit in Arvo Pärt's *tintinnabuli* compositional technique

In the discussions on triad expression in the compositional techniques and aesthetics of the late 20th and the early 21st centuries, a unique compositional system *tintinnabuli* by Estonian composer Arvo Pärt is worth mentioning; its core element is the triad.

Tokun (2011) provides an important insight to the effect that the principles ("mechanisms") established in Pärt's *tintinnabuli* system to process diatonic or polymodal material lie in the algorithmisation of the musical form that arises from formal thinking: the formula could be defined as a reduced digital program containing an algorithm of development, yet simultaneously accommodating the sum of the pitch structure of the composition in its variants and diversity.

Upon comparison of the NRT and UTT analyses of Pärt's *Beatitudes* (1990), the latter helped to discover the structure covering the whole composition, an algorithm, moving from micro to macro relations: merely three triadic transformations, expressed by Hook's UTT formulas, substantiated the whole structure of the composition.

Both Neo-Riemannian and Uniform Triadic Transformation theories are important tools to substantiate the existence of the triad in the 21st century compositional practice.

## Insights into the application of NRT fundamental principles and the triad model application in the parameter of harmony

In a composition based on the mathematical properties of the triad, audiation (resting on our experiences and habits) should be automatically rejected, leaving the composer in the fields of rational, structural composing. Therefore, possibilities are analysed of using the triad in the generative, voice-leading-based aspect, in which the triad loses its connotation as an element of functional harmony and which represents the structuralist method of composition. Examples of manifestations of such use of the triad are compositions of Ričardas Kabelis, Richard Glover, and Raimonda Žiūkaitė.

In a composition of the non-functional triad syntax, several levels of triad expression could be identified. The first level, referred to in the paper as the **one-dimensional triadic harmonic system**, is identified when pure triads are heard as a result of harmony; the sound still remains consonant, however, the order of the change of harmonies is not characterised by the laws of the usual functional harmony and is not familiar to our music perception habits. At the second level of triad expression, referred to as the **multidimensional triadic harmonic system**, triads are no longer audible in the final outcome of harmony; they are hidden in multilayered material and serve only as building blocks to form more complex harmonic structures.

An example of a one-dimensional triadic harmonic system with a limited harmony-re-colouring field is Ričardas Kabelis' (b. 1957) trio *Cell* (1992) for violin, cello, and piano, where on the harmonic vertical solely triads sound, constantly rearranged in the process of connection (transformation). In the composition, the triads change at such a pace that the windings of harmony lose their connotations and turn into a certain state. Similar examples can be found in the works of Rytis Mažulis or Philip Glass.

Although Kabelis made his voice-leading choices intuitively, based merely on the himself-established rules for leading three voices (and being unfamiliar with NRT), the systemic totality revealed by the Neo-Riemannian analysis surprises by its consistency and demonstrates the projection effect of the local systemic aspect on the process of composing.

When exploring the possibilities of the multidimensional triadic harmonic system, it is useful to start by compiling a list of all variants of two simultaneously sounding triads and to sort them in terms of harmonic intensity.

These compositional approaches presented in the subsection presuppose the mathematical development of the triad in both the horizontal and vertical directions.

## 3.3. Possibilities of algorithmisation of triad connections. Analysis of pre-compositional music material and generation by PWLG software

Algorithmisation of triadic transformations points to the possibility of computer-aided generation of such structures. The generation and analysis of precompositional material can be performed by PWGL or OpenMusic software. It is a visual programming environment for computer-aided music composition and sound synthesis.

Since the triad is an archetype, a certain musical "constant", its transformations / sequences can be successfully described by formulas, and with the assistance of software, the transformations of triads can be performed extremely quickly. Arvo Pärt's *tintinnabuli* style, which works on algorithmic processes, can also be programmed / simulated by the same PWGL software.

1. **MANIFESTATIONS OF THE NRT COMPOSITIONAL METHOD IN RAIMONDA ŽIŪKAITĖ'S WORKS**

The aspect of the triad of interest for Raimonda Žiūkaitė is the potential for consistent voice-leading and systemic connections of triads, discovered by Neo-Riemannians. Žiūkaitė's works also reflect her own insights which expand and supplement the discourse of the NRT topic and help to understand how the ideas and techniques of the Neo-Riemannian Theory can be applied not only in the process of composing, but also in the search for a unique compositional style.

Ultimately, the use of triads in Žiūkaitė's compositions is distinguished by the fact that several layers of triads always sound simultaneously: a multidimensional triadic harmonic system is formed.

## 4.1. Multidimensional triadic harmonic system in the compositions *Chromatography* and *Orbifold*

Raimonda Žiūkaitė's composition *Chromatography* for eight accordions (2013) is based on the change in intensity in the vertical harmony of triad combinations, on the harmonic vertical of which more than two triads are combined. In the composition, the triads, like colours, are mixed and refined into mixes of different intensity, with harmony varying from an all-twelve-tone cluster to unison.

*Chromatography* uses methods to create triadic formations of different harmonic intensity, however, in it, the linear connections of triads and Neo-Riemannian operations and principles appear only in a fragmentary manner, without forming triadic sequences to extend throughout the work.

In *Orbifold* (2017) for electronics and the spatial sound sphere, transformations between triads having no common sounds are carried out in a slow-paced *glissando* manner, leading to the formation of "secret" triads on the horizontal and various polyphonic, constantly subtly changing, chords on the vertical. The composition simultaneously features two sequences of major triads moving at different pace. Different inverses of the triad are combined into the sequence so that each of the three pitch-classes moves at a different distance, and thus at different tempos. That differs from the NRT principles, as there triad inversions are ignored, and the triad is perceived simply as a three-tone set. Although we do not meet classical NRT operations in the *Orbifold,* which are characterised by the most consistent voice-leading and the retention of common tones, the composition deals with another important aspect of NRT, i.e. distance in space.

## 4.2. The extravagant transformations in the compositions *Glitchkitch* and *Salz ist mein Erbe*

In recent years, Žiūkaitė has been interested in the concept of transformation in a broader sense: the aesthetics of metamorphosis or visual *glitch* [literally, a sudden short-time failure]. In the composition *Glitchkitch* formixed ensemble (2018) and the short opera *Salz ist mein Erbe* (2020), in R. Cook's terms, extravagant voice-leading is used, where all the three triad tones move in the minimal - a semitone – voice-leading (the "hexatonic pole" transformation, denoted H). It expresses an imperceptible (in the least possible motion), however, total (with all three tones moving) change in the atmosphere and serves as a gesture of collision of two opposite worlds or the transition from one dimension to another, the opposite one. The composition *Glitchkitch* for ensemble (2018) features a cycle of H and T transformations of four triads. The excerpt from the opera *Salz ist mein Erbe* (2020) practically applies the three theoretical constructs discussed in the paper: Weitzmann region, where all the members (triads) are at a two-semitone distance, H transformation, and commutation of T / I and PLR groups.

## 4.3. Determination of Tone Purposefulness in Voice-Leading. An Integral Structure of the *Levitating Organza.*

In the construction of the basic sequence (the cell) of the composition *Levitating Organza* for string orchestra (2014), two rules were set: maximally consistent voice-leading allowing voices to move solely in semi-tones, and a purposeful (constantly rising or falling) sequence; consequently, the most consistent of all possible NRT sequences were chosen, and theory was subordinated to the needs of the composer.

Voice-leading and Neo-Riemannian operations are characterised by symmetry, and the micro-level (chord sequences in the cell) regularities unfold at the macro-level (in the composition): six triads are connected into a primary segment that, being sequentially repeated, forms maximally consistent and purposeful sequences, gradually building the tritone, a larger level macrostructural unit. Here one can see the projection effect of the system on the compositional process, i.e. the dissemination of systemic thinking over different levels of music and the hierarchy inherent in systems, where their elements are usually systems themselves, and the whole system becomes an element of some larger system.

**4.4. Insights into the application of the NRT fundamental principles and the triad model in the time, timbre, and other parameters of the composition**

Although the Neo-Riemannian interpretation of triads primarily predetermines the structuring of the harmony parameter, one can assume that it is possible to "translate" the triadic voice-leading systems and apply them to the structuring of other musical parameters. The laws of the triad system might indirectly determine the rhythm (durations, tempo), the change in the types of timbre and texture, and even the form of the composition, therefore it makes sense to study the possibilities of structuring their change and processuality. This requires dissociation of harmonic triads from the transformations being performed, so that transforming operations are performed on other objects.

In Žiūkaitė's composing process, triad sequences are reduced to the movement of individual tones in triad connections. It is the voice-leading (tone motion directions and steps in a triad combination) in each of the three lines (because the triad consists of three tones) that predetermines other choices when the relations between these tones are replaced by corresponding actions (e.g.one-tone step up is equal to duration deceleration/ acceleration). In *Virgo Rosa* for voice and electronics (2020), the relations between the voices in the triad sequence are "translated" into actions taken to structure the rhythm and timbre.

The structure of the LPR loop, which retains one and the same tone with harmony changing between six triads, could be similarly applied to the organisation of timbres or textures, when the composition features one predominant timbre / unchanging texture, while other timbres / textures around it systemically change (Žiūkaitė's composition *Wormholes in the Mind* for five electric guitars (2019)). It is important to note that the three voices that make up a triad predetermine the texture of the three layers, the interaction of the three timbres, or the polyrhythm and polytempos on the time-structuring plane.

To sum up, the triad models and Neo-Riemannian ideas in Raimonda Žiūkaitė's compositional prctice range from the total control of the NRT triad model (*Levitating Organza*) to a fragmentary touch. In earlier works (*Chromatography, Levitating Organza*) focusing merely on the structuring of the harmony made up solely of triads, in recent works she tests the application of transformation laws to other musical parameters (*Virgo Rosa),* transformations as a semantic gesture (*Glitchkitch*), and sometimes rejects triads as an object of harmony and tries to treat these systems more freely, in a fragmentary manner (*Wormholes in the Mind*).

**CONCLUSIONS**

Upon summarizing the accumulated historical and theoretical knowledge about the development of the triad, its expression in compositions of various epochs, and the practical application of Neo-Riemannian principles in compositional practices, moreover, upon overviewing the historical development of tertianism and searching for the possibilities of triad functioning in the 21st century musical composition, **the concept of triad has been extended from the triad as a harmonic chord in the context of functional harmony to an abstract triad model applied to other musical parameters.** The topical and multifaceted problem has been explored by studying Neo-Riemannian literature, mathematical group theory, and triad connections that prevailed in Western European music of different epochs. The research discussed the advantages and disadvantages of analytical techniques for tritonal harmony; the results of the analyses of compositions by means of functional, tone series degrees, NRT, and UTT methods were compared. The research revealed how, obviously on the basis of the NRT principles, the triadic compositions of Lithuanian composers Ričardas Kabelis and Rytis Mažulis were related. For the first time, Julian Hook's UTT system and algorithmisation of triadic sequences with PWGL software were presented in Lithuanian. The compositions of Raimonda Žiūkaitė, the author of the paper, demonstrated how mathematical transformation theories can be practically applied in analysis and music composing, and the versatility of NRT was revealed.

The research resulted in the following findings:

1. The triad played a key role in Western music and theoretical systems of various epochs. Upon overviewing the functioning of the triad in the history of music, we note the establishment of the triad as the most important perfect chord in the Renaissance and the return of the Renaissance linear paradigm in the 19th century music, which became a precondition for the emergence of NRT. If the works of Rameau and Riemann assume that functional harmony is inherent to the triad, then Neo-Riemannian Theory (NRT) reveals the second nature of the triad: the triad is inclined not only towards functional-tonal harmony, but also towards consistent voice-leading between the triads themselves. Due to the tertian structure, triads are distinguished by the possibilities of extremely consistent connection; however, the potential of their systemic connections was masked by the methods of functional connection that dominated several music epochs and the evaluation of the triad as acoustic perfection. For the formalisation of the triad, which is characteristic of NRT, the chord arrangement and melodic position become irrelevant, the leading tone of the chord also loses its weight, and finally, the triad is translated into a set of numbers. Thus, the Neo-Riemannian approach becomes a great tool to use the triad in a post-tonal context, having exhausted the potential of the triad in tonal music (functional harmony).

2. Two ways of harmony formation (triad connection) can be distinguished: functional and generative, forming the respective syntaxes. If the interval / vertical structure, the fifth, and the thirds of the triad predetermine functional harmony (Rameau and Riemann's ideas), then the system of relationships between triads (PLR of Neo-Riemannian transformations) can lead to non-functional, generative harmony and alternative (non-classical) syntax. Thus, parsimonious voice-leading is simultaneously a possibility of a new syntax, and such examples have already been demonstrated by the structural basis of the late Renaissance, early Baroque, late Romanticism, and the 20th century minimalism, consisting of the same matter \_ triads \_ which are associated with a non-functional-narrative syntax. These styles are united by the common aesthetics of sound and technological principles: the music is consonant, and the most important element of the harmonic structure is the triad. Although the sound is woven from triads, we do not hear their functional attraction, and this type of music does not contain other later or earlier elements of the classical syntax, such as sentences or periods. There is also no hierarchy of musical elements (it exists in functional harmony: without a tonic, there would not be any dominant or subdominant, as they exist only in relation to the tonic). Thus, hierarchical structures create the syntax and gravitation of classical music. From the NRT perspective, voice-leading here becomes a harmony-generating factor and a presupposition of generativity that determines the systemic nature of harmonic connections.

However, the absence of musical attraction is considered to be a shortcoming of NRT, because PLR transformations are just movements in space that do not affect us psychologically, thus, a tendency is observed of also looking for semantic meanings in Neo-Riemannian theory and considering them from the hermeneutic or semiotic perspectives. Retaining the power of musical attraction or creation of new meanings is important even after breaking free from the boundaries of functional harmony.

3. The voice-leading distance can be calculated through the formalisation and generalisation of the intertriadic connections mathematically. Thanks to mathematical formalisation, we can group triads into cycles and systems, and this helps to find new relationships, coherence, and spatial representations that have not been offered by other analytical techniques. This makes it possible to organise hierarchies of NRT elements at a higher level. Coherence is sought by marking PLR operations, UTT formulas, and measuring voice-leading distances: Neo-Riemannian theory is not homogeneous, and it attaches importance to both the most consistent voice-leading, and transformations, and the expression of a triadic relationships system through geometric tone maps (*Tonnetz*). The theories are united by the transformational approach, the metaphor of movement, and the concepts of space and distance, but there is no agreement on the aspect to be used for measuring distance in voice-leading. However, such versatility also allows for more flexible application in the analytical and compositional processes.

4. In the compositions of the 20th and the 21st centuries, the dual nature and potential of the triad give rise to dual compositional approaches. In the 21st century, the possibilities of using the triad are applied in a specifically generative, voice-leading-based aspect. Here the triad loses its connotation as an element of functional harmony and represents a structuralist compositional technique in the composition of a nonfunctional triadic syntax (the triad is treated as a structural unit). The mathematical resources of the triad revealed in the compositional sphere show that the triad is perhaps the most exclusive element in music conducive to programming. This insight is supported by the mathematically conceptualised notion of the triad itself: a triad (a 3-tone sub-set in a 24-tone set) is a specific object that, upon defining the voice-leading rules (consisting of P, L, and R operations), can be transposed to another object in the same family through the most minimal step (by changing one of the three tones) and thus generate various triadic sequences and cycles. These transformation operations, applied to tones (the parameter of pitch), could also be applied to other musical objects, e.g. the durations of sounds, or the position of the sound in time (in a bar), in other words, to the parameter of rhythm.

In the analysed compositions, we notice a common trend, namely the projection effect of the triad system on the compositional process, the cyclicity of the non-functional triad connection variants, and the limits of possibilities of the twelve-tone harmonic system, predetermined by the triad internal intervallic structure. The structure enables the most consistent voice-leading / generativity / algorithmisation, but it also has a limiting effect. The strict application of NRT to triadic sequences on the plane of harmony limits, and does not respond to, other topicalities of composition, especially in the 21st century (time structuring, timbre, and the concept of a composition), thus, Neo-Riemannian Theory is merely a technological tool that enables the understanding of triad relationships without reference to the centre of harmony and the voice-leading-based perspective. In order to achieve an original artistic result, the use of the NRT resources can become an important composing tool.

5. In Žiūkaitė's works, several layers of triads always sound simultaneously: a multidimensional harmonic system of triads is formed. When composing, the significance of the harmonic aspect is restored, and attention is paid to the verticals formed by layering the triads. Layered triad sequences and consonant formations result in chords of different density and intensity, and often of a dissonant character. By leading simultaneously sounding triad sequences in one direction or another, these chords can either become more transparent or thicken.

The most important conclusion: the heterogeneity of Neo-Riemannian Theory also provides an opportunity for the diversity and flexibility of compositional techniques / approaches. Raimonda Žiūkaitė's compositional system is not strict, limited, or stagnant. She aims to find a new approach to each composition, a new aspect of the distribution of triads, while simultaneously fostering a unique compositional style and combining the aspects arising from Neo-Riemannian Theory with other compositional ideas; however, her works are united by the ideological axis of NRT.

Further research into the issue might develop in the following directions:

1. Application of NRT at the level of sound synthesis in the formation of sound timbre (a sound wave form).
2. Development of the concept of spatiality. It would make sense to implement models of the representation of sounds and relationships between them in space through spatial sound.
3. Development of systemic connections between triads in systems larger than twelve tones (microtones) and algorithms generating triadic sequences and cycles.
4. The teaching of Transformation and Neo-Riemannian Theories could be included in the curriculum of contemporary courses in the theories of musicology.

While wondering how much the compositional system is relevant to the art of the 21st century, a need arises to try to treat the triadic compositional models in an abstract way and to transfer the principles of their operation to other musical parameters, such as, e.g., timbre. We can assume that the Transformation Theory in a broad sense becomes increasingly relevant, tearing away from the triad as an acoustic object.

Perhaps important here is the shift of NRT and Transformation Theory from the object to the relationship between objects and the metaphors of motion and path.