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Throughout his career, György Ligeti (1923–2006) was known for creating distinctive sonorities, including the creation and use of micropolyphony and the incorporation of traditional Hungarian folk songs into post-tonal compositions. He combined unconventional rhythmic practices and compositional procedures from other composers with his own translations of mathematical and acoustic phenomena in order to manifest the “Ligeti style.”<sup>1</sup> Though he was heavily influenced by a variety of his contemporaries, especially serialists and those experimenting with electronic music, Ligeti did not strictly identify with any one sector of musical thought. By the late 1950s, Ligeti began to use more experimental styles and slowly moved away from micropolyphony. In my thesis, I explore Ligeti’s use of complex rhythmic structures and experimental techniques. I analyze three of Ligeti’s *Études pour piano* using and expanding upon John Roeder’s concept of pulse streams. This analysis demonstrates how the simultaneous pulse levels present in each of these works contributes to the overall tone of the work and defines formal boundaries. My analyses of these works will demonstrate the shift in compositional techniques Ligeti used to create these distinctive sonorities. This layering technique and amalgamation of experimental styles continues to be a significant influence on modern composers of art music.

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<sup>1</sup>György Ligeti, *Ligeti in Conversation* (London: Ernst Eulenburg Ltd, 1983), 13.

AN EXAMINATION OF RHYTHMIC PRACTICES AND INFLUENCES  
IN THE KEYBOARD WORKS OF GYÖRGY LIGETI

by

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Approved by

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Committee Chair

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## DEDICATION

This thesis is dedicated to my mother and father, Patti and Mark Halsey. You first introduced me to music and encouraged me to pursue my passion for music and the arts. You both continue to inspire me in all aspects of my career and my life. I cannot thank you enough for the faith and knowledge you have given me.

APPROVAL PAGE

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## CHAPTER I

### INTRODUCTION

The polyphonic and canonic structures in György Ligeti's compositions after 1972 far exceed metrical practices of the twentieth century. Throughout many of these later works, surface rhythms often seem erratic and continuously fluctuating. John Roeder explained similar surface irregularities in some of the works of Schoenberg and Bartók through the use of "pulse streams," or accent patterns, each of which contribute to different spans of continuous pulses that are simultaneously layered within a piece.<sup>2</sup> Ligeti uses these pulse streams to create aural illusions and convey the main theme of the work. Common analytical approaches of rhythm neglect to address the individual layers used in Ligeti's compositions and instead focus on the resultant polyrhythms. Therefore, Ligeti's method of rhythmic layers is often overlooked. In this document, I analyze three works from *Études pour piano* using a pulse stream analysis in order to explain some aspects of his compositional approach. Ligeti's works have been highly influential on art music composers ever since the late 20<sup>th</sup> century.

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<sup>2</sup> John Roeder, "Interacting Pulse Streams in Schoenberg's Atonal Polyphony," *Music Theory Spectrum* 16, no. 2 (Autumn 1994), 232–233.

## Ligeti's Early Years

Ligeti was born in 1923 in the small Transylvanian town of Dicsöszentmárton to Jewish parents. He often commented that many of his compositions stemmed from books he read and other early memories from his childhood.<sup>3</sup> Even as a young boy, Ligeti's active imagination created not only fantasy worlds, but also music:

I remember when I was very small, I was always imagining music. It was a sort of ritual when I got up or went to bed...there was morning music and there was evening music, it was all in my mind...I think that's how I became a composer. But back then I was unaware that this wasn't something normal.<sup>4</sup>

In his earliest years, Ligeti's only two exposures to music were from the radio and the family record player. After his family moved to Cluj in 1929, however, Ligeti attended operas and live orchestral concerts. He was allowed to receive piano lessons at the age of fourteen, and he practiced music extensively throughout his teenage years.<sup>5</sup> At the age of sixteen, only a few years after beginning his piano lessons, Ligeti composed his first work: a string quartet. Though his music teacher's reaction to the piece was not encouraging, he began working on his first symphony using the models of Beethoven and Strauss.<sup>6</sup> Despite growing Anti-Semitism, Ligeti was allowed to enroll in the Cluj Conservatory in 1941 to study with Ferenc Farkas.

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<sup>3</sup> Richard Toop, *György Ligeti* (London: Phaidon Press Limited, 1999), 11.

<sup>4</sup> György Ligeti in conversation with Reinhard Oehlschlägel, from Richard Toop, *György Ligeti* (London: Phaidon Press Limited, 1999), 9.

<sup>5</sup> Richard Toop, *György Ligeti*, 15.

<sup>6</sup> *Ibid.*, 17.

Ligeti's compositional studies came to an abrupt halt when, in 1944, he was forced into a labor camp for Jewish men. Both his father and brother were killed in concentration camps, while his mother narrowly survived because of her medical training. Ligeti returned to his compositional studies in 1945 at the Franz Liszt Academy of Music in Hungary to study with Sándor Veress. However, in 1948 modernist music was banned, and composers were forced to compose in the folk music idiom. Shortly thereafter, Zoltán Kodály secured a theory position for Ligeti at the Academy. During this time with restrictions on musical output, Ligeti secretly experimented in the instrumental idiom while publishing vocal works based on folk music. The goal of his secret experimentations was to move beyond the shadow and strict serialist style of Bartók. Ligeti commented that:

. . .the finer the network of operations with pre-ordered material, the higher the degree of leveling-out in the result. Total, consistent application of the serial principle negates, in the end, serialism itself. There is really no basic difference between the results of automatism and the products of chance; total determinacy comes to be identical with total indeterminacy.<sup>7</sup>

Ligeti's apparent disapproval of strict technique led to experiments with sound and textures. To create this new sound, he focused on the possibilities of manipulating a single note. This idea of growing out of silence developed into what he later termed micropolyphony. With this process in mind, Ligeti began to look to composers of the Renaissance period, especially Johannes Ockeghem, who layered and overlapped voices so that individual lines were no longer recognizable, but instead combined multiple layers

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<sup>7</sup> Richard Steinitz, "György Ligeti: Music of the Imagination," Northeastern University Press: Boston, 2003.

to create a “whole.”<sup>8</sup>In combining these layers, Ligeti applied less strict serialist techniques to rhythmic groups rather than pitch classes. While developing these ideas, Ligeti was invited to the electronic music studio in Cologne in the 1950s.<sup>9</sup> At the Cologne studio, he was exposed to concepts that would make possible his distinctive sound, as for example, the techniques of smearing and phasing that were used in his final compositions. It was through these experiments and his experiences in the electronic music studio that Ligeti developed the idea of micropolyphony, a layered compositional style that contains a multitude of voices in a canonic sequence. As the voices combine, no single line or melody is recognizable, but together they form one mass of sound that gradually develops throughout the piece. Ligeti stated that in his micropolyphonic works, “the overall form of the piece is to be realized as a single, wide-spanning arch—the individual sections melting together and subordinate to the great arch.”<sup>10</sup> He often combined this process with extremely soft dynamics and intricate rhythmic patterns to create his distinct, almost electronic, sonority. This technique can be heard in works such as *Atmosphères* for orchestra and *Continuum* for harpsichord. The distinctive sound mass created by his micropolyphonic compositional technique later became known as the “Ligeti sound.”<sup>11</sup>

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<sup>8</sup> Mark A. Radice, “Concert Music of the Twentieth Century: Its Personalities, Institutions, and Techniques,” New Jersey: Prentice Hall, 194.

<sup>9</sup> Benjamin Levy, “Shades of the Studio: Electronic Influences on Ligeti’s *Apparitions*,” *Perspectives of New Music* 47, no. 2 (Summer 2009): 61.

<sup>10</sup> György Ligeti. *Atmosphères für grosses Orchester ohne Schlagzeug*. 3 ed. Wien: Universal Edition, 1971.

<sup>11</sup> Steinitz, “György Ligeti,” 98.

## After Micropolyphony

Beginning in the late 1960s, Ligeti began to modify and abandon the idea of a sound mass created by his micropolyphonic method. Michael Searby explains that this change was likely because of the limitations of strict micropolyphony.<sup>12</sup> Some of these limitations include the extremely slow harmonic change in pieces with dense canonic motion. Also, there is a limited variation in sonority when using this strict micropolyphony, as no one line can be distinguished from another. Finally, there is little or no sense of a melodic structure created by this technique, as the canonic motion can only be seen on the score, not heard. Ligeti felt that his departure of micropolyphony was comparable to the deviation of serialism:

There pass through my mind interlinked parts of a melodic character, a polyphonic network in which not all the individual parts are submerged. On the contrary, the melodically shaped parts retain their individuality, they move simultaneously at varying speeds and possess a melodic and rhythmic line of their own, varying from and independent of the other parts. In this way melodic shape, that forbidden fruit of modern music, can to some extent be restored.<sup>13</sup>

Rather than using the chromatic “clusters” and his micropolyphonic technique as the center of his composition, Ligeti shifted his focus to harmony created by the multiple lines. There was also a noticeable change in the density of his compositions after this period: there was no longer a huge mass of sound, but distinctive melodies and timbres.

*Melodien* for orchestra (1971) was one of Ligeti’s first pieces that demonstrate his changing style. This work serves as an amalgamation of the old and new styles. This

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<sup>12</sup> Michael Searby, *Ligeti’s Stylistic Crisis: Transformation in His Musical Style 1974—1985*, (Maryland: The Scarecrow Press, Inc., 2010):91.

<sup>13</sup> *Ibid.*, 9–10.

piece differs from previous micropolyphonic works because of this new focus on perceptible melodic content. Ligeti claimed that:

I composed the orchestra piece *Melodien* in 1971. I attempted to loosen the thick “micropolyphony” of my musical language, to make it more transparent. I remained basically true to my earlier style: the musical form unfolds itself as an elaborately spun texture in continually flowing time—yet the individual voice no longer merge (as in my earlier music), but instead they are individually audible in their layering and interlacing. The voices turn into individual melodies with their own ductus, and their own tempo, rhythm, and interval structure. When one hears the work for the first time, it seems like a chaos of discrepant melodies—but when one knows the music better, the internal relationships, the hidden harmonic skeleton of the form become comprehensible.<sup>14</sup>

Though Ligeti claims to completely abandon chromaticism and his micropolyphonic writing, this idea can still be seen in *Melodien*: the musical structure is reinforced by organic combination of building upon and modifying his past micropolyphonic technique.

### The “New” Ligeti

One of Ligeti’s most significant stylistic changes occurred immediately following his opera *Le Grand Macabre* (1974–1977) with the works *Monument—Selbstportrait—Bewegung: Three Pieces for Two Pianos* (1976) and the Horn Trio (1982).<sup>15</sup> In these works, Ligeti demonstrates a new interpretation of traditional forms and tonal allusions. In this music, there is a wider, richer harmonic texture that is combined with layered

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<sup>14</sup> Janice Michel Macaulay, “Part I: Cosmic Landscapes. (original composition) (and) Part II: Aspects of Pitch Structure in György Ligeti’s “Melodien Fur Orchester” “(doctoral thesis, Cornell University, 1986), 145, quoted in Rudolf Frisius, “Tonal order postserial?” *Music und Bild* 7 (October 1975): 496.

<sup>15</sup> Michael D. Searby, *Ligeti’s Stylistic Crisis: Transformation in His Musical Style 1974—1985*, 87.

rhythmic structures and dynamics to form his new compositional style. To create these works, Ligeti relied on a variety of influences including the Hungarian folk tunes of his earliest style, inspiration from mathematical concepts such as fractals, and polyrhythmic structures. In *Monument—Selbstportrait—Bewegung*, Ligeti uses a slowly developing compositional process that is similar to American minimalists, such as Steve Reich and Terry Riley, which is combined with a layering technique he used in his micropolyphonic works.<sup>16</sup> In this piece, Ligeti states,

...we do not hear the various levels but something else, something like the three-dimensional impossible perspectives in Maurice [*sic*] Escher's pictures. In the same way there are rhythms and rhythmic formulae which neither pianist plays, but which emerge from the combination of the two pianos. What you get there is a complex acoustical illusionary rhythm, which I then extended to a type of melody also, and this I developed further, this is what is essential in it.<sup>17</sup>

This developing style not only allowed Ligeti to experiment with new sonic possibilities, but also allowed him to incorporate varying styles and influences, including works from the Renaissance and from other 20<sup>th</sup> century composers. He expanded upon this new style in his three books of *Études pour piano*, beginning in 1985. Three of these études are analyzed here: Etude 3: *Touches Bloquées*; Etude 12: *Entrelacs*; and Etude 13: *L'escalier du diable*.

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<sup>16</sup> This minimalist process is also seen in Ligeti's *Études pour piano*, described later in the introduction.

<sup>17</sup> István Szigeti, "A Budapest Interview with Ligeti," *New Hungarian Quarterly* 25 (1984): 210, quoted in Michael D. Searby, *Ligeti's Stylistic Crisis: Transformation in His Musical Style 1974—1985*, (Maryland: The Scarecrow Press, Inc., 2010): 94.

## Methodology for Analysis: Pulse Streams

*Touches Bloquées*, *Entrelacs*, and *L'escalier du diable* contain what Harald Krebs refers to as “interpretive layers,” or a series of regularly recurring pulses that move more slowly than the pulse layer.<sup>18</sup> In many of Ligeti’s works, these interpretive layers combine to form irregular accent patterns that do not fit within one meter. These seemingly fluctuating accents are often comprised of multiple, simultaneously occurring, regular accent patterns, or “pulse streams.”<sup>19</sup> This method explains surface rhythmic irregularities as a combination of multiple rhythmic regularities. A pulse stream is a series of repeated durations. A stream must consist of at least two consecutive pulses of the same length to be established, and these consecutive accents must be continuous in order to maintain the pulse stream. The longer equal consecutive accents within a pulse stream occur, the stronger the stream becomes. A pulse stream that is well established may be implied for a small time span even if no regular accent is present. Multiple pulse streams are layered, and occur simultaneously. Each accent in a piece of music contributes to a pulse stream, and the entrance and exit of these pulse streams, as well as their interactions with concurrent pulse streams, delineates the formal outline of the piece. Ligeti utilizes these pulse streams to express the topic of the work and to create an acoustic illusion.

Each of the etudes analyzed in this paper have underlying pulse layers made up of the smallest division of the beat over which pulse streams are layered. This pulse is generally made up of an ostinato figure that persists throughout each of these works,

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<sup>18</sup> Harald Krebs, “Metrical Consonance and Dissonance: Definitions and Taxonomy.” In *Fantasy Pieces: Metrical Dissonance in the Music of Robert Schumann* (New York: Oxford University Press, 1999): 23.

<sup>19</sup> Roeder, “Interacting Pulse Streams,” 233.

similar to the constant humming of a machine. Amy Bauer refers to this technique as “precision-meccanico.”<sup>20</sup>

In this document, I analyze three selections from Ligeti’s *Études pour piano* using and expanding upon John Roeder’s methodology of pulse streams. Unlike Roeder, I assert that the underlying meccanico layer does constitute a pulse stream. Though these meccanico layers do not feature an accent on each iteration of the contributing pitch, the entrance and exit of this layer is pivotal in defining the formal boundaries. Therefore, the behavior of this underlying pulse is crucial in a pulse stream analysis. Contrary to Roeder’s concept of pulse streams, I claim that pulse streams may indicate a sense of hierarchy in some works. This is especially true in my analyses of *Entrelacs*, supported by Ligeti’s notation of differing durations for each accent layer.<sup>21</sup> This analysis demarcates form in these highly complex keyboard etudes and describes multiple rhythmic intricacies that are often neglected by other types of analysis.

### *Études pour piano*

Ligeti composed three books of *Études pour piano* that contains a cycle of eighteen etudes. The first book, composed in 1985, contains six etudes that are widely varied in their texture and expressive character. The second book contains a total of eight etudes composed between the years of 1988 and 1994. These etudes demand more extensive technical ability and virtuosity than those of the first book. Ligeti composed the final book of piano etudes between 1995 and 2001. He intended to add more etudes to

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<sup>20</sup> Amy Bauer, “Compositional Process and Parody in the music of György Ligeti,” PhD Dissertation, 17.

<sup>21</sup> This is explained further in Chapter 3, Figure 2.

this book. However, due to his failing health, he resigned to ending the cycle with this set of four etudes. These etudes were composed as a result of his personal experiences playing the piano.<sup>22</sup> In this process, Ligeti tried to recreate the images and sounds from his imagination. However, he comments that the subsequent music that his hands played did not always align with his mental image:

The result sounds completely different from my initial conceptions: the anatomical reality of my hands and the configuration of the piano keyboard have transformed my imaginary constructs . . . .The criteria are only partly determined in my imagination; to some extent they also lie in the nature of the piano – I have to feel them out with my hand . . . . A well-formed piano work produces physical pleasure.<sup>23</sup>

Layered polyrhythmic structures are essential to the formal outline of each of these etudes. This is evident through Ligeti’s preliminary sketches of these works (Fig. 1.1). This layering of rhythmic durations contributes to the pulse stream analysis featured in each chapter of this document.

Many of these etudes, including the three studied in this document, are based on concepts of mathematics and science, especially fractals. However, Ligeti insisted that these elements only serve as a basis of construction: “In my music one finds neither that which one might call ‘scientific’ nor the ‘mathematical,’ but rather a unification of construction with poetic, emotional imagination.”<sup>24</sup>

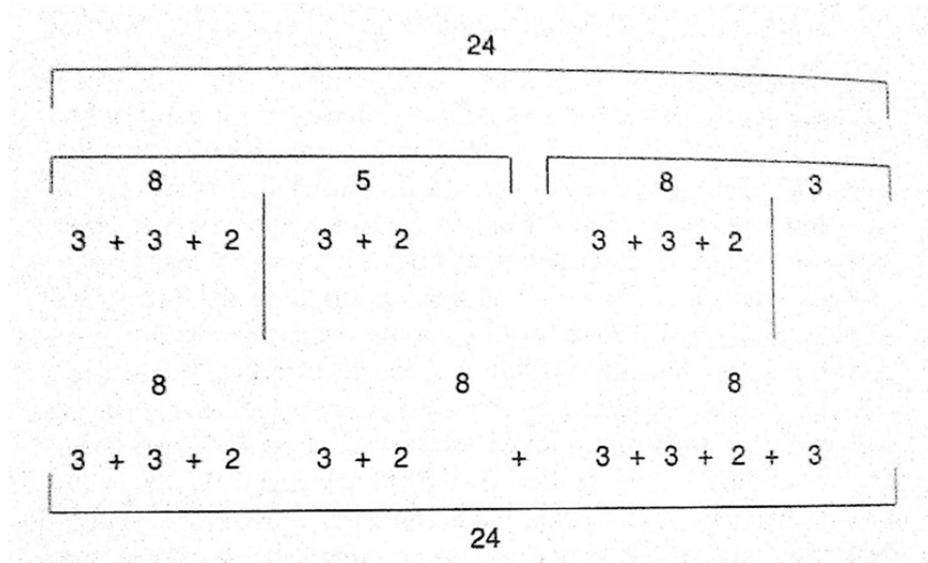
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<sup>22</sup> Richard Steinitz, *Music of the Imagination* (Boston: Northeastern University Press, 2003): 277–278.

<sup>23</sup> György Ligeti, Jacket notes to György Ligeti *Études pour piano*, Pierre-Laurent Aimard, CD (digital disk), SK 62308, 1996.

<sup>24</sup> György Ligeti, “On my Études for Piano,” trans. Sid McLauchlan, *Sonus* 9, no. 1 (Fall 1988): 4, quoted in Richard Steinitz, *Music of the Imagination* (Boston: Northeastern University Press, 2003): 277.

Figure 1.1. Rhythmic matrix for Etude 1: *Désordre*<sup>25</sup>



In the second chapter of this document, I analyze rhythmic structures and pulse streams in Ligeti's third etude, *Touches Bloquées* [Blocked Keys]. This work is based on Ligeti's earlier concept of the blocked key technique he used in the second movement of his three pieces from 1976 for two pianos: *Selbstportrait mit Reich und Riley (und Chopin ist auch dabei)* [Self-portrait with Reich and Riley, and Chopin is also there]. In each of these works, selected keys are depressed by one hand while the other hand plays a melodic figure, overlapping with keys that are already depressed. This results in irregular gaps in the melodic line. In the score, the sustained pitches are notated with a diamond-shaped note head while the blocked pitches in the melody are indicated by smaller note heads (Chapter 2, Fig. 2.1). In *Touches Bloquées*, the chromatic melodic line is comprised of constant eighth notes, and therefore acts as the meccanio ostinato.

<sup>25</sup> Sketched on February 2, 1985. From Richard Steinitz, *Music of the Imagination* (Boston: Northeastern University Press, 2003): 280.

However, some of the keys of this “meccanico” line are blocked by the depressed keys in the alternate hand, lending to the image of a malfunctioning machine. As the etude progresses, more eighth notes in the melodic line become blocked until the end when only the tapping of the pianist’s fingers upon depressed keys is audible.

The third chapter of this document features a pulse stream analysis of Ligeti’s twelfth etude, *Entrelacs* [Interlacing]. This work features the most extensive layering of pulse streams out of the etudes analyzed here. Like many of the other etudes, *Entrelacs* features pulse streams that are layered over a continuous ostinato figure. However, unlike many of his other works, Ligeti notates these layers with an extra stem of varying length and changing dynamic markings. This notation suggests a hierarchy of pulse streams with the longest notated pulse streams being the most prevalent (Chapter 3, Fig. 3.2).<sup>26</sup> As each layer continues to enter and suddenly exit, the result is similar to that of the phasing technique often used in electronic and minimalist compositions. This layering also results in the alignment and interweaving amongst accent patterns, which attempts to portray the title of the work.

The final chapter features an analysis of the thirteenth etude, *L’escalier du diable* [The Devil’s Staircase]. This etude is the longest of all eighteen etudes, and it was composed in 1993 while Ligeti was a guest artist at the Paul Getty Foundation in Santa Monica, California.<sup>27</sup> During his stay in this temperate climate, an unusually severe weather system caused by El Niño struck the coast while Ligeti was away from his apartment. He struggled for three hours to return to his residence. During his seemingly

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<sup>26</sup> This concept is discussed at length in Chapter 3.

<sup>27</sup> Richard Steinitz, *Music of the Imagination*, 307.

relentless battle to climb up the stairs, the idea for this etude emerged: “an endless climbing, a wild apocalyptic vortex, a staircase it was almost impossible to ascend.”<sup>28</sup> This etude shares the name and characteristics of the mathematical concept of a “devil’s staircase.” This phenomenon, based on Cantor Sets, involves the relationship of disproportional segments combining to create a self-similar group.<sup>29</sup> This concept is also used in the “mode locking” features of clocks and pendulums.<sup>30</sup> Ligeti expresses this concept with the inclusion of groups of two and three eighth notes that, when combined, create a self-similar rhythmic set. This grouping structure creates pulse streams and defines the formal boundaries of this piece. The structures seem to spiral infinitely up the piano, suddenly falling down to the lowest octaves.<sup>31</sup> Also influential to this work are the Catholic chant *Dies Irae* and the allusion to ringing bells in the final section of the work, evoking a sense of death.

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<sup>28</sup>*Ibid.*, 308.

<sup>29</sup> This concept is explained in detail in Chapter 4.

<sup>30</sup> Richard Steinitz, *Music of the Imagination*, 308.

<sup>31</sup> This concept relates to the Shepard scale, explained in Chapter 4.

## CHAPTER II

### *TOUCHES BLOQUÉES*

Following his monumental opera *Le Grand Macabre* (1974), Ligeti began to explore various ideas he “planted” within the opera. One such idea was inspired by Henning Siedentopf’s conception of “blocked keys” from his essay “Neue Wege der Klavier Technik.”<sup>32</sup> This idea of blocked keys is found in the second of a set of his three pieces for two pianos: *Selbstportrait mit Reich und Riley (und Chopin ist auch dabei)* [Self-portrait with Reich and Riley, and Chopin is also there]. In this work, some of the keys in the arpeggiated melodic line are already depressed by the chord in the other hand, leaving some gaps in the mechanical, moving texture.<sup>33</sup> Ligeti returned to this idea of blocked keys as a way to create asymmetry in his third etude *Touches Bloquées* (1985), dedicated to Pierre Boulez (b. 1925).

#### **Development of a New Compositional Style: Precision Meccanico**

In an attempt to move away from the harmonically constrictive aspects of his micropolyphonic technique, Ligeti began to experiment with multiple compositional methods in the late-1950s. Instead of a large, slow-moving mass of sound, individual

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<sup>32</sup>Translation from the Musical Score: György Ligeti, *Touches Bloquées*, Mainz, Germany: 1985, 13.

<sup>33</sup>Richard Steinitz, “The Dynamics of Disorder,” *The Musical Times* 137, no. 1839 (May 1996), 10.

melodic phrases and harmonies become distinct in this later style. However, the organic quality that was essential to micropolyphony is still present in these later works. In this new method of “precision-meccanico” approach, Ligeti layered rhythms rather than tones, as in micropolyphony.<sup>34</sup> Often in these pieces, “machine-like” patterns or layers move at a constant rate, forming an underlying pulse. Melodic gestures that form a separate rhythmic layer and a distinct pulse are layered over the “meccanico” pulse.

In an interview with Péter Várnai, Ligeti claimed that a fascination with faulty machinery and electronics had pervaded even his earliest writings.<sup>35</sup> This enthrallment with machinery began when, as a young boy, Ligeti read a work by Hungarian novelist Gyula Krudy about a widow living alone in a house filled with ticking clocks.<sup>36</sup> An image of “recalcitrant machinery [and] unmanageable automata” inspired by this story captivated the mind of Ligeti throughout his career. To achieve this image, Ligeti superimposed multiple rhythmic layers that moved at different times and at different speeds. This creates what Ligeti terms “rhythmical deviations” symbolizing machinery breaking down.<sup>37</sup> In Ligeti’s third etude entitled *Touchez Bloquées*, depressed chords and staccato interjections block a legato melodic line, composed of continuous eighth notes (Fig. 2.1). The irregularities caused by the blocked notes are made up of regular accent patterns, or pulse streams.

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<sup>34</sup>Amy Bauer, “Compositional Process and Parody in the music of György Ligeti,” PhD Dissertation, 17.

<sup>35</sup>György Ligeti, *Ligeti in Conversation* (London: Ernst Eulenburg Ltd, 1983), 13-14.

<sup>36</sup>*Ibid.*, 17.

<sup>37</sup>*Ibid.*, 108.

Figure 2.1. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 2—6.



The use of “meccanico” creates pulse streams within much of Ligeti’s music. This occurs as multiple melodic lines emerge over the underlying, autonomic pulse, creating simultaneously occurring accent patterns. Ligeti himself described this presence of pulse streams as independent melodic lines:

. . . my musical position following the abandonment of micropolyphony is similar [to the abandonment of serialism]: there pass through my mind interlinked parts of a melodic character, a polyphonic network in which not all the individual parts are submerged. On the contrary, the melodically shaped parts retain their individuality, they move simultaneously at varying speeds and possess a melodic and rhythmic line of their own, varying from and independent of the other parts.<sup>38</sup>

The entrance and exit of the simultaneously occurring pulse streams give form to the work. The precision-meccanico rhythmic technique is exemplified in Ligeti’s piano etude, *Touches Bloquées*.

### Origins of Blocked Keys

*Touches Bloquées* is built upon the presence of an underlying “meccanico” rhythm. However, unlike in his other meccanico works, some parts of the underlying

<sup>38</sup>Michael D. Searby, *Ligeti’s Stylistic Crisis: Transformation in His Musical Style, 1974-1985*, (Lanham, MD: Scarecrow Press, 2010) 9-10.

pulse are “blocked” by the alternate hand. Richard Steinitz suggests that Ligeti likely got this idea from Ernst von Dohnányi’s *Essential Finger Exercises for Obtaining a Sure Piano Technique* (1929, 1950) that utilizes “blocked,” non-sounding keys to strengthen the small and ring fingers.<sup>39</sup> Ligeti writes intermittent eighth notes in the blocking hand to help fill in the gaps left by the depressed keys in the chromatic melody. Throughout *Touches Bloquées*, the “holes” gradually increase from a single missing eighth note to multiple omitted eighth notes until the final measure where few notes actually sound. This use of the blocked keys relates to Ligeti’s previous micropolyphonic style of composition where the individual melodic lines are inaudible, forming a single, massive block of sound. In *Touches Bloquées*, most of the texture is heard but becomes increasingly more ambiguous as more tones become blocked by the held chord.

### **Pulse Streams Defining Form**

Within most of Ligeti’s works, the bar lines do not imply any sort of accent. However, *Touches Bloquées* contains irregular bar-line placement that is often concurrent with the accent patterns in the music. Analyses of pulse streams within this work help define the formal outline and reinforce the creation of asymmetry from symmetrical groups through blocking.

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<sup>39</sup>Richard Steinitz, “The Dynamics of Disorder,” 10.

Figure 2.2. Irregular grouping structures in Ligeti's *Touches Bloquées* mm. 1—3.

Right-Hand Grouping:  
 $15 = 7 + 8 = 7+7+1$

The first pulse stream in this work (PS1) is supported by the underlying eighth note-pulse (Fig. 2.1).<sup>40</sup> Throughout *Touches Bloquées*, this pulse stream becomes increasingly less supported as the alternate hand depresses more notes. Richard Steinitz refers to this sonority as a “quaver continuum” that becomes “perforated...like a moth-eaten cloth.”<sup>41</sup>

The creation of asymmetry from a symmetrical framework is demonstrated most obviously in Ligeti's grouping structures. Figure 2.2 demonstrates a group of fourteen eighth notes that move chromatically down seven semitones from Gb to B back up to Gb. To offset this “perfection,” Ligeti adds an extra eighth note (E-natural) making the pattern fifteen eighth notes. This pattern is further skewed by the insertion of silences created by keys that are obstructed by the left hand. The Gb as the highest note of the pattern creates the pulse stream while the repetition of this chromatic pattern strengthens the 15-note stream, PS2a (Fig. 2.3). Ligeti creates a rhythmic canon by applying this 15-note pulse stream to another accent point. PS2b emerges in the right hand and, like the

<sup>40</sup> The smaller notes in the right hand represent the tones that are already being depressed by the left hand.

<sup>41</sup> Richard Steinitz, “The Dynamics of Disorder,” *The Musical Times* 137, no. 1839 (May 1996), 10.

first stream, has a span of 15 eighth notes (Fig. 2.3). The first two notes of the first measure are played in quick succession and are followed by a “rest” as a result of the blocked key. The second eighth note of the group is heard as being longer than the first as a result of the following rest. This creates an agogic accent on the second eighth note of each measure, which forms PS2b. This pulse stream quickly disappears by mm. 13, coinciding with a shift in Ligeti’s notation of eighth note groupings. From the beginning until mm. 11, each odd-numbered measure contains 7 eighth notes and each even-numbered measure contains 8 eighth notes (Fig. 2.3). However, Ligeti notates mm. 13 with only 6 eighth notes grouped together rather than the expected 8. The anticipated reiteration of PS2b is replaced with silence in mm. 14, which signals a change in grouping (Fig. 2.4). This disappearance of PS2b also coincides with the occurrence of two adjacent blocked notes rather than one silent note.

Another iteration of this rhythmic canon is established by PS3 (Fig. 2.3). Though this pulse stream spans only five eighth notes, it aligns with a span of fifteen eighth notes starting in mm. 3 with the same left-hand accent. Throughout the *Touchez Bloquées*, Ligeti includes seemingly sporadic eighth notes in the blocking hand that both reinforce existing pulse streams and create new pulse streams. These notes also work to fill in the gaps of the blocked keys in the right hand. PS3 is established and maintained by these accented pitches in the left hand in the first section of this work.

Figure 2.3. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 1—11.

*Presto possibile, sempre molto ritmico*  
*sempre legato*

*senza ped. (sempre)*

PS1:

PS2a:

PS2b:

PS3:

PS1:

PS2a:

PS2b:

PS3:

Figure 2.4. Shift in grouping structure, *Touches Bloquées*, mm. 11–13.



PS3 continues to be supported throughout mm. 21, but it quickly dissipates as the chromatic melodic line moves down to the left hand. This disintegration of pulse streams and the change in register indicate a transition to a new section. There is an arrival of a fourth pulse stream that spans four eighth notes in mm. 24, signaling the new A' section (Fig. 2.5). This pulse stream shifts twice until it transitions to PS3, with a span of five eighth notes, in mm. 32 (Fig. 2.6). PS4 persists regularly until mm. 48–51, where there are multiple shifts in the pulse stream. This change indicates a transition to another formal juncture. First inversion minor triads, set-class [037], that are found within the right hand chromatic line, reinforce the propulsion towards a new section.

Figure 2.5. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 24—27

The musical score for Figure 2.5 consists of two staves. The upper staff is the piano part, featuring a melodic line with various dynamics including *f*, *mf*, and *ff*. It includes markings such as *cotta*, *legato (sempre)*, and a fermata. The lower staff is labeled "PS4:" and contains a series of notes connected by dashed vertical lines to the piano part. A "Shift:" marking is present at the end of the PS4 line.

Figure 2.6. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 31—34

The musical score for Figure 2.6 consists of two staves. The upper staff is the piano part, featuring a melodic line with various dynamics including *f*, *mf*, and *ff*. It includes markings such as *cotta*, *legato (sempre)*, and a fermata. The lower staff is labeled "PS4:" and contains a series of notes connected by dashed vertical lines to the piano part. Below the PS4 staff is a section labeled "PS3:" with notes connected by curved lines. A "Shift:" marking is present at the end of the PS3 line.

PS3 returns in the new section at mm. 52 (notated as A'' in Fig. 2.10), reinforcing this section as another variation of the opening. This section features a melodic line that descends chromatically down and back up 5 semitones, similar to the original A section's descent of 7 semitones. The chromatic line of this section gradually descends in dynamic

until mm. 72 (Fig. 2.7). There is a stark change in timbre, dynamic, and register as the chromatic line returns to the right hand in the highest register. These changes indicate a new section that is drastically different from any of the previous sections. Reinforcing the hearing of a new section is the disappearance of blocked keys and the appearance of octave doublings between the right and left hands (Fig. 2.10). Throughout this B section, Ligeti layers PS4 evoking yet another sense of micropolyphony from his earlier period. As the chromatic line descends, however, the supporting accents of the layered pulse streams become irregular as a result of the blocked keys. The layering of PS4 reappears in mm. 87 as the melodic line returns to the “obligatory register” of the beginning (Fig. 2.8).

Figure 2.7. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 68—74

The image displays a musical score for Ligeti's *Études pour piano*, Book I, etude 3: *Touches Bloquées*, measures 68–74. The score is written for piano and features a chromatic line in the right hand and a supporting pulse stream in the left hand. The right hand part is marked *diminuendo* and *pppp*. The left hand part is marked *non legato* and *tre corde*. Below the score, three pulse streams are identified: PS3, PS4a, and PS4b. PS3 is a chromatic line in the right hand. PS4a and PS4b are pulse streams in the left hand, with PS4b showing octave doublings.



Figure 2.9. Ligeti, *Études pour piano* Book I, etude 3: *Touches Bloquées* mm. 106—109

Handwritten musical score for Ligeti's *Études pour piano*, Book I, etude 3: *Touches Bloquées*, measures 106–109. The score is in G major and 3/4 time. The right hand has a melodic line with notes G4, A4, B4, C5, D5, E5, F5, G5, with dynamics markings *ppp* and *diminuendo*. The left hand has a complex rhythmic accompaniment with many notes and accidentals.

PS5: 

Shift: 

Handwritten musical score for Ligeti's *Études pour piano*, Book I, etude 3: *Touches Bloquées*, measures 106–109. This version highlights specific notes in the left hand with circles. The right hand has notes G4, A4, B4, C5, D5, E5, F5, G5, with dynamics markings *(dim)* and *b*. The left hand has a complex rhythmic accompaniment with many notes and accidentals, with two notes circled.

PS5: 

Figure 2.10. Formal outline of *Touches Bloquées*

Section:	A	A'	A''	B	A'''
Measures:	1–23	24–51	52–71	72–91	92–112
Characteristics:	Chromatic “melody” in right hand; blocking chord and “filler” notes in left hand; Dominance of PS2 → layered; PS3, which grows out of PS2, is also emphasized.	Chromatic “melody” and blocking is found in both hands; Appearance of PS4, dominance of PS3; blocked chords to emphasize a shift towards A'' section.	Emphasis of PS3; frequent shifting of pulse streams; descent to lowest register of the piano and increasingly softer dynamics.	Notated rests (first disappearance of PS1); doubling between the right and left hands (no blocked notes); extreme dynamic, high register; Prevalence of PS4.	Return to middle register; Blocking in Right Hand, chromatic “melody” in left hand; increase in adjacent blocked tones; Dominance of PS3 and appearance of PS5.

Ligeti’s transition from the indiscernible rhythmic canons of *micropolyphony* to the experimental style of “precision-meccanico,” where multiple rhythms with separate pulses are layered over a mechanical background, allowed for a wider range of sonorities and rhythmic variations. This automated style is emphasized in the third etude *Touches Bloquées*. In this work, a chromatic melody forms the meccanico pulse. However, chords that are already depressed by the non-meccanico hand block some of the pitches of the meccanico pulse. The frequency and length of blocked notes increase as the work progresses. Pulse streams throughout *Touches Bloquées* reflect the formal outline. PS2 and PS3 dominates each iteration of the A section while PS4 is used in the B section. The accents that support the pulse streams emphasize Ligeti’s application of layered micropolyphonic techniques to rhythm. These accents create simultaneous layers of the same pulse stream.

## CHAPTER III

### *ENTRELACS*

Following his micropolyphonic style, Ligeti experimented with multiple compositional techniques. One such technique is the phase-shifting process that was defined and developed by American composer Steve Reich. This process, developed from experimentations with electronic music: overlaying the same line onto itself, and shifting the layered line ahead of the original line, creating a canon. Ligeti uses a similar process throughout his *Études pour piano* that moves toward and away from a complete saturation of accent patterns, or pulse streams, to define the form. He also utilizes the “precision-meccanico” style that has an underlying, mechanical ostinato figure that represents his early fascination with “recalcitrant machinery.”<sup>42</sup> In several of these etudes, seemingly irregular accents develop throughout music that neither conforms to the notated meter nor to a single meter signature. In his twelfth etude entitled *Entrelacs*, simultaneously occurring melodic lines and rhythms are intertwined with a background of constant sixteenth notes (Fig. 3.1).<sup>43</sup> The surface-level rhythmic irregularities present throughout *Entrelacs* are actually concurrent regular accent patterns that form separate “pulse streams.”<sup>44</sup> In this movement, concurrent pulse streams contribute to the form of

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<sup>42</sup>György Ligeti, *Ligeti in Conversation* (London: Ernst Eulenburg Ltd, 1983), 17.

<sup>43</sup>*Entrelacs* is taken from the French term, literally meaning, “interlacing.”

<sup>44</sup>John Roeder, “Interacting Pulse Streams in Schoenberg’s Atonal Polyphony,” *Music Theory Spectrum* 16, no. 2 (Autumn 1994), 232-233.

the work and emphasize the interlacing of gestures, as implied by the title. This movement portrays the grinding sound of broken machinery. The incorporation of this idea into music creates a distinct compositional style.

Figure 3.1. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 1—6

The image displays a musical score for Ligeti's *Études pour piano*, Book II, etude 12: *Entrelacs*, measures 1 through 6. The score is written in 12/16 time and consists of two systems. The first system shows the right hand with a melody of eighth notes and the left hand with a similar pattern, marked with dynamics like *mf*, *pp*, and *con ped.*. The second system continues the piece, marked with *sim. al fine* and *sim.*.

### Development of a New Compositional Style: Phase Shifting

Following the uprising in Hungary in 1956, Ligeti moved west to escape the atrocities happening in his homeland, beginning his studies in the new trends of Western music. The main focus was the new art music based on serialism and the twelve-tone method of Schoenberg, which Ligeti had already begun to explore. However, Ligeti was searching to develop “static” music, which serialism alone could not create. Between 1957 and 1958, Ligeti was invited to work at the West Deutsche Rundfunk (WDR) in

Cologne, Germany, an electronic music studio.<sup>45</sup> Ligeti's colleagues at the WDR studio expressed the idea of "pairing...serial and electronic music to be the union of the most advanced compositional techniques of the day with the most advanced technology."<sup>46</sup> Theorist Benjamin Levy asserts that this experience with electronic music was the impetus for Ligeti's refinement of micropolyphony found in his major orchestral works.<sup>47</sup> In his later years, in an attempt to move away from the harmonically constrictive aspects of his micropolyphonic method, Ligeti returned to his experimentations with music using techniques he learned at the West German Studio. Such techniques include the application of using time durations, or "intervals of entry," rather than relying on the concept of measures and common-practice metrical structures.<sup>48</sup>

Many of Ligeti's works in the latter portion of his life, especially *Entre-lacs*, also show the influence of the electronic practice of phasing and phase shifting. Phase shifting is a technique where a repeated section of music is superimposed onto itself, slowly getting out of synchronization from the original repeated line. This shifting creates a multitude of polyrhythms, making this horizontally static music vertically complex. Steve Reich extensively explained this procedure in his essay "Music as a Gradual Process" (1968). Richard Cohn describes Reich's phase shifting music as starting with,

...the basic pattern in a single voice. After a brief time, the pattern issues a copy, which accelerates until it has advanced one beat ahead of the original voice. At this point, it locks back in at the original tempo, and the two voices engage in a canon

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<sup>45</sup>György Ligeti, *Ligeti in Conversation*, 8.

<sup>46</sup>Benjamin Levy, "Shades of the Studio: Electronic Influences on Ligeti's *Apparitions*," *Perspectives of New Music* 47, no. 2 (Summer 2009): 61.

<sup>47</sup>*Ibid.*, 60.

<sup>48</sup>György Ligeti, "Metamorphosis of Musical Form," trans. Cornelius Cardew in *Form—Space*, Vol. 7 of *Die Reihe* (Pennsylvania: 1965), 14.

at a transposition of one beat. Each composition essentially consists of a series of such progressions...and prolongations. The texture may become dense through addition of voices, either through further cloning or through resultant patterns....<sup>49</sup>

Cohn analyzes this music by using beat class sets and their movement toward and away from the “beat-class aggregate,” or towards and away from complete permeation of beat classes.<sup>50</sup>

Ligeti was well aware of Reich’s phase shifting techniques, and he incorporated them into a number of his post-micropolyphonic compositions. He first expressed his appreciation of Reich’s contributions in the second of his set of three pieces for two pianos: *Selbstportrait mit Reich und Riley (und Chopin ist auch dabei)*. He then modified and developed Reich’s phasing techniques for a number of his keyboard *Études*, including *Entrelacs*. In this work, Ligeti begins in the middle of the phasing process, as there are two simultaneously occurring lines, the top of which seems to be shifted ahead against the bottom line (Fig. 3.1). Like in the electronic studio in Cologne, Ligeti combines serial and phase shifting techniques of layering to create the desired sonority. Similar to Reich, Ligeti moves toward and away from complete saturation of accent patterns, or pulse streams, which defines the form of the work.

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<sup>49</sup>Richard Cohn, “Transpositional Combination of Beat-Class Sets in Steve Reich’s Phase-Shifting Music,” *Perspectives of New Music* 30, no. 2 (Summer 1992), 152.

<sup>50</sup>Richard Cohn, “Transpositional Combination,” 154.

## Experimentations with Precision Meccanico

In addition to experimentations with serialism and electronic music, Ligeti developed the idea of “recalcitrant machinery” that he discovered as a child in a process termed “precision meccanico.”<sup>51</sup> To achieve this image of dysfunctional machines, Ligeti superimposed multiple rhythmic layers that moved at different times and at different speeds.<sup>52</sup> This creates “rhythmical deviations,” symbolizing machinery breaking down.<sup>53</sup> For example, at the end of the A-section in Ligeti’s twelfth piano etude, *Entrelacs*, all eight-pulse streams of the piece are present (Fig. 3.2). The breaking down of the rhythmic mechanism occurs in the middle of measure 30 (circled in Fig. 3.2). After this brief absence of the “meccanico” pulse in the right hand, all but two of the pulse streams disappear. The full collapse of the “machine” begins in mm. 35 with a noticeable change in texture in the right hand.

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<sup>51</sup>Amy Bauer, “Compositional Process and Parody in the music of György Ligeti,” PhD Dissertation, 17.

<sup>52</sup>The process of precision-meccanico is explained to a greater extent in Chapter II about the etude *Touches Bloquées*.

<sup>53</sup>György Ligeti, *Ligeti in Conversation*, 108.

Figure 3.2. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 28—35

The musical score for Ligeti's *Entrelacs* (measures 28-35) is presented in three systems. The first system (measures 28-30) shows a treble clef staff with a complex melodic line and a bass clef staff with a rhythmic accompaniment. The second system (measures 31-33) continues the bass clef accompaniment. The third system (measures 34-35) shows a treble clef staff with a melodic line and a bass clef staff with a rhythmic accompaniment. The score includes dynamic markings such as *cresc. molto*, *pp*, *mf*, and *pp sub.*, and performance instructions like *sempre legato* and *poco f cantabile, in rilievo*.

The use of “meccanico” creates pulse streams within much of Ligeti’s music. This occurs as multiple melodic lines emerge over the underlying, autonomic pulse, creating simultaneously occurring accent patterns. The entrance and exit of the simultaneously occurring pulse streams give form to the work.

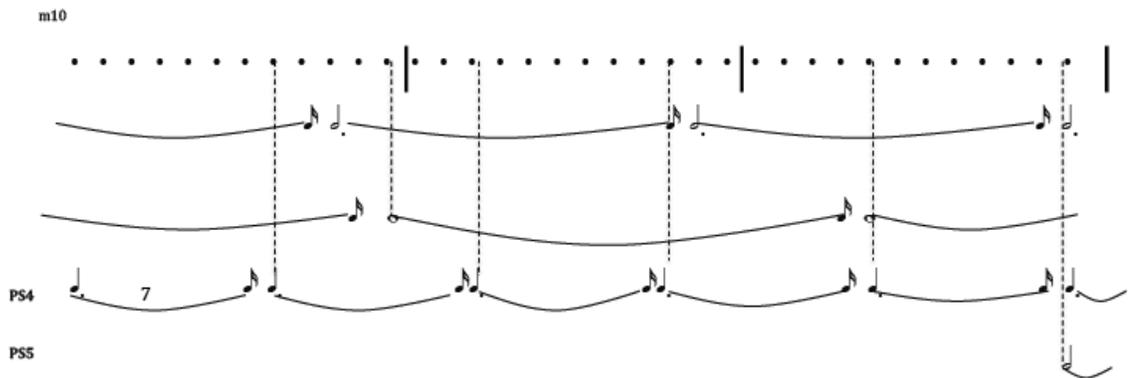
### **Pulse Streams Defining Form within *Entrelacs***

György Ligeti’s twelfth piano etude, *Entrelacs*, not only exemplifies many aspects of Ligeti’s experimental phase-shifting and precision *meccanico* styles, but also

the idea of pulse streams. Multiple pulse streams and an underlying “mechanical” ostinato reveal formal outlines and the “interlacing” of the piece. At first glance, the rhythmic accents between the right and left hand are noticeably unequal and would not fit within any one-meter signature (Fig. 3.1). Therefore, the half-note accents in the right hand and left hands, respectively, comprise a single pulse stream. This is demonstrated in Figure 3.3.

Figure 3.3. Rhythmic reduction and pulse streams in *Entrelacs*, mm. 1–12

The figure illustrates the rhythmic reduction and pulse streams in *Entrelacs*, mm. 1–12. It consists of three systems of musical notation, labeled m1, m4, and m7, representing measures 1, 4, and 7 respectively. Each system shows a dotted line representing a pulse stream, with vertical lines indicating the positions of notes. Below the dotted lines, curved lines represent the pulse streams for the right and left hands. The right hand pulse stream is labeled PS2 and the left hand pulse stream is labeled PS3. The right hand pulse stream has a period of 13, and the left hand pulse stream has a period of 17. The notes are represented by stems and flags, indicating their rhythmic values. The overall structure shows the interlacing of the two pulse streams over time.



- The abbreviation “PS” stands for Pulse Stream.
- The numbers between the slurs represent the number of sixteenth notes within each pulse stream.
- The numbering of the pulse streams is not necessarily an indication of hierarchy or importance, as the role of each pulse stream changes throughout each section of the work.

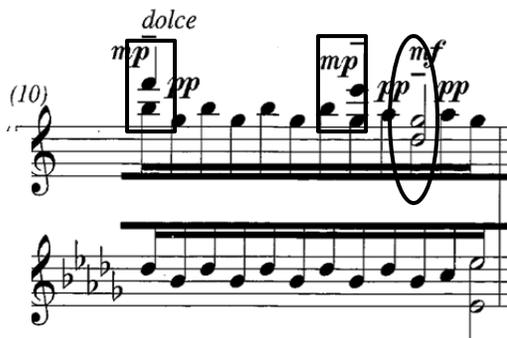
Contrary to John Roeder’s classification of pulse streams, I assert that the underlying sixteenth note pulse in *Entre-lacs* does comprise important stream of pulses. These sixteenth notes are not accented, and therefore do not fit Roeder’s definition of a pulse stream: regular accent patterns. The absence of this underlying pulse in the right hand beginning in mm. 35 and in both hands at the end of the work clearly denotes a new section in the work, and therefore contributes to the overall purpose of pulse stream analysis. In Figure 3.3, this underlying sixteenth note pulse is represented by the label “Pulse Stream 1” (abbreviated “PS1”). The bar lines in the score are indicated in this stream to show where they lie in comparison to the accents present in the piece.<sup>54</sup> Because the barlines only serve as an aid in the performance of the work, there is not an implied accent on the first beat of each measure.

<sup>54</sup>At the bottom of the score, Ligeti indicates to “Play very evenly: the barlines only serve as a guideline” (*Sehr gleichmäßig spielen: die Takte dienen nur zur Orientierung*).

Pulse stream two, represented by the abbreviation “PS2” in the figure, illustrates the half-note accents in the right hand. Each of these accents occurs every thirteen sixteenth notes, shown in the example as a dotted half note tied to a sixteenth note. Pulse stream 3, “PS3,” represents the accents present in the left hand. These accents span a length of seventeen sixteenth notes. These are the only three pulse streams present throughout the first nine measures of *Entrelacs*.<sup>55</sup>

In mm. 10, pulse stream four appears on the downbeat. A different reading may suggest that this pulse stream is a shift of pulse stream two. This is because the first occurrence of PS 4 shares the same pitch D6 that is heard in the previous iteration of PS 2. PS 4 can be seen as separate from PS 2 because it is notated in the score as a quarter note rather than a half note, as in previous occurrences of PS 2, and it is marked with a *mezzo piano* dynamic marking rather than the *mezzo forte* marking that occurs for PS 2 and PS 3 (Fig. 3.4).

Figure 3.4. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 10



<sup>55</sup>Because “Pulse Stream 1” does not fit into the definition of pulse streams presented by Roeder, I did not consider it in this context.

PS 4 first occurs in the right hand, and it consists of seven sixteenth notes, indicated by a dotted quarter note tied to a sixteenth note in Figure 3.3. In measure twelve, the fifth iteration of PS 4 coincides with the ninth occurrence of PS 3.<sup>56</sup> This is the first time since the first measure that two pulse streams are aligned. Similarly, the sixth event of PS 4 occurs on the final sixteenth note of the twelfth measure. This coincides not only with the twelfth entrance of PS 2, but also with the entrance of PS 5 in the left hand (Fig. 3.3).<sup>57</sup> The constant shifting and realignment of these layered streams recall Reich's phase-shifting processes.

In mm. 27 of *Entrelacs*, the eighth and final pulse stream enters, marking the first point where all of the pulse streams occur simultaneously (Fig. 3.5). This is building up to the climax of the section and movement towards a new section. All of the pulse streams continue at a regular rate until mm. 30 (Fig. 3.6). This is the first disappearance of the "meccanico" layer, signaling a formal juncture of the piece. Immediately after mm. 30, all of the pulse streams except for PS 2 and PS 3 are no longer supported, and therefore are absent in this small section. This sudden drop of continuous pulse streams suggests that mm. 30 is the climax of the section. This idea is supported by the dynamic of *fff*, the loudest dynamic heard in the piece thus far, as well as the eighth-note-long rest in the right hand, the only rests present in this entire movement.<sup>58</sup> This building of pulsestreams

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<sup>56</sup>This is indicated by the first arrow in measure 12 of example 2.

<sup>57</sup>This is indicated by the second arrow in measure 12 of example 2.

<sup>58</sup>The rests in Example 5 were circled by the author for emphasis.

and sudden disappearance of pulse streams is analogous to Richard Cohn's "beat class aggregate" theory in his analysis of Reich's phase-shifting works.<sup>59</sup>

Measures 31—34 are reminiscent of the beginning sonorities and act as a transition into the *cantabile, in rilievo* (song-like, in relief) section that begins at mm. 35 (Fig. 3.7). "PS 1," the constant sixteenth-note pulse, disappears for the second time in the right hand at the beginning of this measure, emphasizing the hearing of a sectional division. In this section, PS 2 is not as strongly supported as it is in the previous section. PS 3 continues as before, while PS 4 re-enters in mm. 37. The dichotomy between PS 3 and PS 4, both of which occur in the left hand, are heavily emphasized. Though the texture in this section is similar to the beginning of the movement, the faster accent pattern of PS 4 makes this section seem more frantic.

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<sup>59</sup>Richard Cohn, "Transpositional Combination," 154.

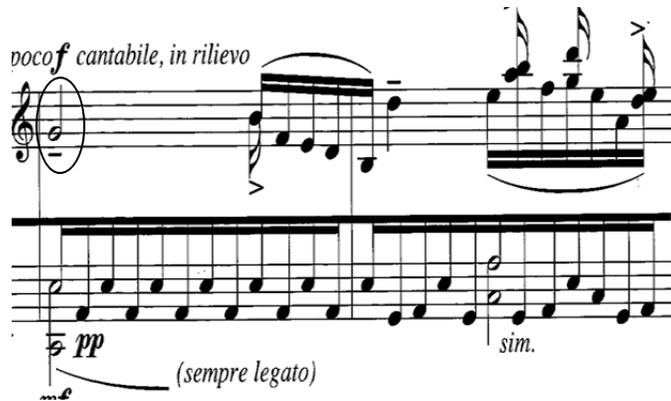
Figure 3.5. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 27

The image shows a musical score for eight piano parts, labeled PS1 through PS8. The top two staves contain the main melodic and harmonic lines. Below them, eight individual parts are listed. PS1 consists of a series of dots. PS2 through PS8 show various rhythmic and melodic patterns, with vertical dashed lines connecting notes across the parts to indicate synchronization.

Figure 3.6. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 30

The image shows a musical score for two piano parts. The top staff has a dynamic marking of *fff* and a circled section with the instruction *sempre legato pp sub.*. The bottom staff has a dynamic marking of *pp* and *mf sub.* below it.

Figure 3.7. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 35—36.



PS 7 enters in the left hand in mm. 43, thickens the texture and creates a more complex interplay of accents within the left hand. These voices build to mm. 46 where PS 2 strongly re-enters on a *fff* quarter note. PS 1 and PS 6 re-enter in the following measure in the right hand, creating a sonority similar to that of the end of the first section. However, PS 8 quickly re-enters in mm. 49, and it is highly emphasized with vertical accents. The entrance of this pulse stream functions as a re-transition to an A' section in mm. 54 (Fig. 3.8). This passage is supported dynamically with a crescendo leading up to a *ffff* dynamic marking in mm. 54, indicating a new section. Also in this measure are simultaneously occurring agogic accents, similar to the first measure.<sup>60</sup> Following this arrival point is an interplay between PS 2 and PS 3, as in the beginning section. PS 8 arrives in the left hand in mm. 59, emphasized by a tenuto marking. It is countered by the entrance of PS 5 in that enters in right hand in mm. 61, also emphasized by a tenuto marking.

<sup>60</sup>This is Roeder's term for durational accents: Roeder, "Interacting Pulse Streams," 238.

Figure 3.8: Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 54

The image shows a musical score for two staves. The top staff begins with a dynamic marking of *pp sub.* and contains a series of notes with stems pointing upwards. The bottom staff begins with a dynamic marking of *fff* and contains a series of notes with stems pointing downwards. The key signature has two flats, and the time signature is 4/4.

The exit of “PS 1” in mm. 64 and the increased dynamic level indicates a new section. This new section is marked by the entrance of PS 4 and the movement of PS 2 from the right hand to the left hand in mm. 65 and 66, respectively. This gives new meaning to the title “interlacing” as the pulse stream actually shifts hands rather than merely interacting with other pulse streams (Fig. 3.9).

Figure 3.9. Ligeti, *Études pour piano* Book II, etude 12: *Entrelacs*, mm. 64—66

The image shows a musical score for two staves, starting at measure 64. The top staff is in treble clef and contains chords and arpeggiated figures. It has a dynamic marking of *ff sempre* and a *non arp.* marking. The bottom staff is in bass clef and contains a continuous stream of notes. It has dynamic markings of *mf*, *f*, *ff*, *mf*, and *f*. A black oval highlights a specific note in the top staff, and an arrow points from this oval to another note in the bottom staff, illustrating the shift of a pulse stream from the right hand to the left hand.

A final return to the first section, or the A section, is marked by the re-entrance of PS 1 and PS 2 in mm. 71. This re-entrance is emphasized by a *fff* dynamic level, three accent markings, and the durational accent of PS 2. Pulse streams slowly die away, leaving only the original dichotomy between pulse streams PS 1, PS 2, and PS 3 in mm. 84. A short codetta occurs in the final three measures marked by the absence of all pulse streams. A chart of the formal outline in *Entrelacs* is indicated in Figure 3.10.

Figure 3.10. Formal Outline of *Entrelacs*

Section	A: section 1	Transition	B: <i>cantabile in rilievo</i>	Re- transition	A': return to section1	C: section 3	A': Final return	Codetta
Measures	1—30	30—34	35—46	46—54	54—63	64—71	71—88	88—91
Characteristics	Dichotomy between pulse streams two and three; entrance of all pulse streams	<i>fff</i> dynamic contrasted with <i>pp</i> dynamic; only pulse streams one, two, and three remain.	Absence of pulse streams one and two in the right hand; dichotomy of pulse streams three and four.	Dominance of pulse stream eight.	Arrival on <i>fff</i> dynamic; interplay between pulse streams two and three.	Absence of pulse stream one; movement of pulse stream two to the left hand; <i>ff</i> dynamic	Return of pulse streams one and two in the right hand; arrival on <i>fff</i> dynamic; interplay between pulse streams 1, 2, and 3.	Absence of all pulse streams

### Groupings, Hierarchy, and “Interlacing”

Throughout *Entrelacs*, different groupings of pulse streams influence not only the formal outline of the work, but also emphasize the idea of hierarchy and “interlacing” of voices. A hierarchy of voices is indicated in Ligeti’s notation of each pulse stream. PS 2 and PS 3 are both indicated throughout the movement by stemmed half notes and a *mezzo*

*forte* dynamic marking.<sup>61</sup> However, PS 4 and PS 5 are indicated by quarter notes and are to be played at a *mezzo piano* dynamic level throughout the first section. Furthermore, PS 6 and PS 7 are denoted by an eighth note and not given a separate dynamic level. Finally, PS 8 is only denoted by a doubly-stemmed sixteenth note. This notation suggests a hierarchy of importance within this section (Fig. 3.11). This hierarchy changes throughout each section with a change in dynamic emphasis and through the use of accent and vertical accent markings. As noted in figure 3.11, the pulse streams with the longest spans, especially PS 2 and PS 3, are often the most accented and dynamically emphasized figures in each section, while the pulse streams with shorter spans, such as PS 1 and PS 8, are generally less prominent.

Figure 3.11. General outline of hierarchy of pulse streams present in *Entrelacs*

Hierarchy	Notation	Dynamic
1—This most often occurs in PS 2 (13 sixteenth notes) and PS 3 (17 sixteenth notes).	h	<i>Mezzo forte—ffff</i>
2—This most often occurs in PS 4 (7 sixteenth notes) and PS 5 (11 sixteenth notes).	q	<i>Mezzo piano—Fortissimo</i>
3—This most often occurs in PS 6 (5 sixteenth notes) and PS 7 (4 sixteenth notes).	e	<i>Piano—Mezzo forte</i>
4—This most often occurs in PS 1 (“meccanico”) and PS 8 (3 sixteenth notes).	x	<i>pppp—fff</i>

<sup>61</sup>On the score, Ligeti indicates that the half notes in both hands should be held as long as possible.

The connection of voices is first introduced in mm. 12 where PS 2, PS 4, and PS 5 all intersect on the final sixteenth note (Fig. 3.2). As more pulse streams enter, the simultaneous occurrence of pulse streams becomes more frequent, further emphasizing their connections.

In the *cantabile, in rilievo* section (B section) beginning in mm. 35, PS 2 is given less emphasis than in the first section. In this section, PS 2 is indicated by a doubly-stemmed sixteenth note rather than a half note agogic accent it received in the first section. PS 4 re-enters in mm. 37 in the left hand, rather than the right hand as it did in the first section. This shift emphasizes the interweaving of voices that is suggested by the title. A similar interlacing of voices occurs in mm. 43 where PS 7 also enters in the left hand instead of its original position in the right hand.

The re-transition section is marked with a strong entrance of PS 2 in mm. 46 (Fig. 3.10). Here, PS 2 regains the agogic accent and is again emphasized dynamically. PS 6 re-enters one measure later in the right hand, rather than the left hand as it did in the first section. The dichotomy between these two voices is short lived as PS 8 strongly enters in the right hand in mm. 49. Though PS 8 is notated by sixteenth notes, suggesting that it is not hierarchically relevant, the registral position and emphasized vertical accents of the notes within this pulse stream override the agogic accents of the other pulse streams that are present.

In the third section, or C section beginning in mm. 64, PS 2 moves to the left hand, joining PS 3 and PS 4. PS 2 and PS 3 may be deemed hierarchically more superior to pulse stream four in this section because they are both indicated by half notes while PS

4 is indicated by a quarter note. However, pulse stream two is no longer reigistrally superior to either of these pulse streams, as it was in the first section, emphasizing the intermingling aspect of the piece.

In the final A' section beginning in mm. 71, there is an interplay between PS 7 and PS 8. Unlike in the first section, PS 8 is hierarchically equal to PS 7, as they are both indicated in the score by eighth notes. Though this could be considered simply continual shift of PS 8, the regular recurrence of PS 7 suggests an “interlacing” of the two pulse streams.

In the latter part of his career, Ligeti transitioned from the indiscernible rhythmic canons of *micropolyphony*, which he found to be harmonically restrictive, to multiple experimental styles that he was subjected to earlier in his career. In *Entrelacs*, Ligeti uses Steve Reich’s concept of phase shifting along with techniques he learned at the Cologne Electronic Music Studio to create the feeling of “interlacing” and layering throughout the piece. Ligeti also developed the technique of “precision-meccanico,” where multiple rhythms with separate pulses were layered over a mechanical background. This layering allowed the composer to use a wider range of sonorities and rhythmic variations found within *Entrelacs*. In this work, a multiple pulse streams are layered over an underlying background of sixteenth notes. The entrance and changes within these pulse streams indicate the formal outline of the movement and emphasize the idea of “interlacing” suggested by the title. Ligeti’s experimentation with phase-shifting and “precision-meccanico” allowed him to create new, unique sonorities that were impossible with the techniques of his contemporaries.

## CHAPTER IV

### *L'ESCALIER DU DIABLE*

Ligeti's thirteenth etude, *L'escalier du diable*, is based on the idea of *Dies Irae* [Day of Wrath]. This is evident through his use of the chant in the climax of the work. Ligeti was also influenced by the acoustical phenomenon of the "Shepard's scale," which changes the "chroma" of a tone to make it seem like it is continually moving when it is actually staying in the same register.<sup>62</sup> A more obvious reference to the mathematical phenomenon of the "Devil's Staircase" is also used in *L'escalier du diable*.<sup>63</sup> A Devil's Staircase is a type of Cantor Set that, when graphed on an axis, looks like a series of infinite series of unequal steps. A pulse stream analysis of this work can be used to mark formal boundaries and to portray a feeling of constant chase and/or of impending doom.

#### **Influence of *Dies Irae***

In his conversation with Péter Várnai, Ligeti expressed that, as a boy, he was haunted by a frequent sense of fear. He often found himself creating a world to escape his

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<sup>62</sup>This term was coined by cognitive scientist and psychologist Roger N. Shepard in 1964 during his experiments with electronic sound. More information about this concept is explained later in this chapter. Donald E. Hall, *Musical Acoustics: An Introduction*, Chapter 18: Harmonic Intervals and Tuning (California: Wadsworth Publishing, 1980), 436.

<sup>63</sup>The "Devil's Staircase" is a type of Cantor Set, developed by mathematician Georg Cantor, which contains specific, self-similar properties. More on this concept is explained later in this chapter.

imaginary terrors. Later in his life, Ligeti became enthralled with the “idea of hell and scenes of the Last Judgment.”<sup>64</sup> He was especially influenced by the visual portrayals of Death and the Last Judgment by painters Hieronymous Bosch (1450–1516) and Pieter Brughel the elder (1525–1569) (Fig. 4.1).<sup>65</sup> Earlier in his career, Ligeti expressed these ideas in some of his vocal works including *Requiem* (1963–1965) and *Lux Aeterna* (1966). In the piano etude *L’escalier du diable*, Ligeti musically expresses the concepts of fear and hell’s torture through the use of ordered intervals that mimics the ordered intervals of the Catholic chant *Dies Irae*.

The concept of the Last Judgment has been interpreted into music by a variety of composers throughout history, including Mozart and Berlioz, and is most notably used in the Catholic funeral service (Fig. 4.2). Ligeti incorporates the idea of the Last Judgment and the Catholic chant *Dies Irae* into this etude mimicking chants and church bells. Ligeti utilizes both the bells and the *Dies Irae* at the end of mm. 29 (Fig. 4.3A). Ligeti uses the right hand to mimic bell tones, indicated in the score with *wildes Glockengeläute* [wild ringing of bells]. Within this bell-like section, Ligeti uses the same ordered intervals (mod 12) as the *Dies irae* (Fig. 4.3B). Though the texture of the bell section is dense, the notes that emphasize the *Dies irae* are more accented than surrounding ones. This is accomplished through contour accent (lowest/ highest note in the texture), repetition (interval occurring in multiple layers), or agogic accent (Fig. 4.3A). Interval class 4, represented as a major third between Db and F, is repeated throughout mm. 31 and the

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<sup>64</sup>György Ligeti, *Ligeti in Conversation* (London: Ernst Eulenburg Ltd, 1983), 46-47.

<sup>65</sup>*Ibid.*, 46.

first half of mm. 32. The repetition the bell-like texture of this section evokes a sense of confinement and the inability to escape.

Figure 4.1. Triptych of the *Last Judgement* by Hieronymus Bosch. Akademie der Bildenden Künste, Vienna (not copyrighted, c. 1500).



Figure 4.2. *Dies Irae*, used for the Catholic funeral service, in modern notation.

Intervals: -1 +1 -3 +2 -4 +2



*Di-es i-rae, Di-es il-la*  
 (Day of wrath, Day of mourning)

Figure 4.3. György Ligeti, *Études pour piano* Book II, mvmt. 13: *L'escalier du diable*, mm. 29—32.

4.3A.

The image displays a musical score for three measures (29, 30, and 31) of the piece 'L'escalier du diable' by György Ligeti. The score is written for piano and consists of three systems of staves. Measure 29 features a complex texture with multiple voices. A box at the top right contains the text '(wild ringing of bells) wildes Glockengeläute'. Annotations include 'non arp.' and 'sempre non arp.' with arrows pointing to specific chordal textures. A circled area in the lower staff of measure 29 highlights a specific chord. Measure 30 continues the complex texture, with annotations 'sim.' and 'sempre non arp. (fff)'. A circled area in the lower staff highlights a chord. Measure 31 is marked 'tutta la forza, minaccioso e maestoso' and features a dense, sustained texture. Annotations include 'fff sempre' and 'fff'. A circled area in the lower staff highlights a chord. Pedal markings are present: 'haltepedal' at the bottom left, '+ sost. ped. / Tonhalteped.' at the bottom right of measure 30, and '(sostenuto pedal / Tonhaltepedal)' at the bottom left of measure 31.

(32)

sub. *ppp* \*)

sub. *ppp* \*)

senza ped.  
una corda

4.3B. Voice-leading reduction of *Dies irae* in B-section of *L'escalier du diable*

Contour: -1 +1 3 +2 -4 +2

(*pp*) (*b.o*)

### Spiraling Shepard's Scale

Ligeti's research in physics and acoustics influenced his compositions following micropolyphony. In order to imitate spirals in *L'escalier du diable*, Ligeti investigated the work in acoustics by Roger N. Shepard. Shepard's experiments change the "chroma" or color of a pitch while keeping the "tone-height," or placement of a pitch within an octave, constant. Shepard used a computer to create "sounds containing many members of a pitch

class together, or equivalently, harmonics 1, 2, 4, 8, 16, . . . of low fundamental frequencies.”<sup>66</sup> Shepard found that although the tones seemed to spiral up infinitely, changing “chroma,” the tones actually remained within a certain boundary.

Ligeti used this idea throughout *L’escalier du diable*. In mm.1, both hands begin in the bass clef an octave apart. Though the right hand rises above middle C to the treble clef in the second measure, as seen in Figure 4.4B. The left hand remains in the range of B<sup>1</sup> to A<sup>#3</sup>. As the right hand persists in the treble clef throughout the fourth measure, the left hand also ascends an octave, reaching just above middle C. In the seventh measure, the right and left hands switch clefs giving the illusion that the left hand is rising indefinitely (Fig. 4.4C). However, the right hand continues to descend to the original octave of the left hand in the beginning of the etude.<sup>67</sup> At the end of the eighth measure, both hands rise to the treble clef above C<sup>6</sup>. This continual rising lasts until measure ten where the left hand plummets to the lowest octave of the piano, playing the same chromatic segment as the beginning (Fig. 4.4D). The process of overlapping voices that both ascend and descend the chromatic scale continues throughout the piece. Though it seems that the voices are ceaselessly ascending, one voice usually moves down to account for the registral limits of the piano.

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<sup>66</sup>*Ibid.*, 460.

<sup>67</sup>This switching of hands also marks the point at which the rhythms of the hands are no longer in alignment, creating a complex hemiola affect. This will be discussed at length later in the paper under “Mathematical Relationships.”

Figure 4.4. Ligeti's use of the Sheperd's Scale in *L'escalier du diable*

A. mm. 1  B. mm. 2 

C. mm. 7 

D. mm. 10 

## Mathematical Relationships

The change in Ligeti's compositional techniques in the 1960s concurred with new theories on chaos and predictability in mathematics.<sup>68</sup> There was especially an interest in fractals and their relation to Cantor Sets.<sup>69</sup> In his thirteenth etude, *L'escalier du diable*, Ligeti translates the mathematical concept of a "Devil's Staircase," a specific type of Cantor Set, into music. Ligeti uses the concept of self-similarity of the "Devil's Staircase" to construct a sensation of endless spiraling and constant movement.

<sup>68</sup>Ligeti in a public conversation with Richard Steinitz (Huddersfield, 1993). Published by Richard Steinitz, "Music, Maths & Chaos," *The Musical Times* 137, no. 1837 (March 1996), 14.

<sup>69</sup>A Cantor Set is formed when a certain action continually recurs to an object or set. More information on Cantor Sets, and specifically the "Devil's Staircase," can be found here: Richard Steinitz, "Music, Maths & Chaos," *The Musical Times* 137, no. 1837 (March 1996), 14-20.

At the beginning of his career, Ligeti purposefully avoided the strict “academicism” and the systematic, mathematical style of many of his colleagues at Darmstadt.<sup>70</sup> Instead, he gave preference to the aural images created in his imagination. During the later part of his life, however, Ligeti became interested in the artistic possibilities of mathematics, especially the idea of mathematics translated into art to create an illusion:

Somewhere underneath, very deeply, there's a common place in our spirit where the beauty of mathematics and the beauty of music meet. But they don't meet on the level of algorithm or making music by calculation. It's much lower, much deeper—or much higher, you could say.<sup>71</sup>

This change in Ligeti’s composition style in the 1950s and 1960s was concurrent with a radical new thinking about chaos and predictability in multiple academic fields, especially mathematics. Though mathematics has long been an innate and crucial element of music, Ligeti used emerging concepts from the field and translated them into the musical language. Especially influential on his incorporation of mathematics, particularly fractals, within Ligeti’s music was mathematician and co-author of *The Beauty of Fractals*, Heinz-Otto Peitgen.<sup>72</sup> Throughout many of his *Études*, Ligeti explored the concept of creating the illusion of endless spiraling and unequal steps through the use of fractals.

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<sup>70</sup> Richard Steinitz, “Music, Maths & Chaos” *The Musical Times*, 137 no. 1837 (March 1996), 14.

<sup>71</sup> Ligeti in a public conversation with Richard Steinitz (Huddersfield, 1993). Richard Steinitz, “Music, Maths & Chaos” *The Musical Times*, 137 no. 1837 (March 1996), 14.

<sup>72</sup> Steinitz, “Music, Maths & Chaos,” 14.

Mathematician Georg Cantor first developed the idea of the Cantor Set in the 1883. It was later expanded upon by Benoit Mandelbrot who noticed the Cantor Set's relation with the concept of fractals based on his ideology that complexities are created through simplicities.<sup>73</sup> Fractals use the concept of self-similarity where the formation of each part resembles the structure of the whole. The Cantor Set is formed when a certain action continually recurs to an object or set. For instance, if we take a line and removed the middle third of this line, we are left with two separate thirds. We then repeat this process to each of the two thirds, creating four sixths. This procedure can be repeated *ad infinitum* resulting in "Cantor dust, an infinite number of points arranged in clusters, infinitely sparse, whose total length is 0."<sup>74</sup> This concept is presented below in Figure 4.5. The "Devil's Staircase" examines the relationship between the unequal proportions of the removed  $1/3$  to the remaining  $2/3$  in the Cantor Set. If this relationship were graphed onto an axis, it would appear to be a series of unequal steps with infinitely smaller steps between each point (Fig. 4.5).

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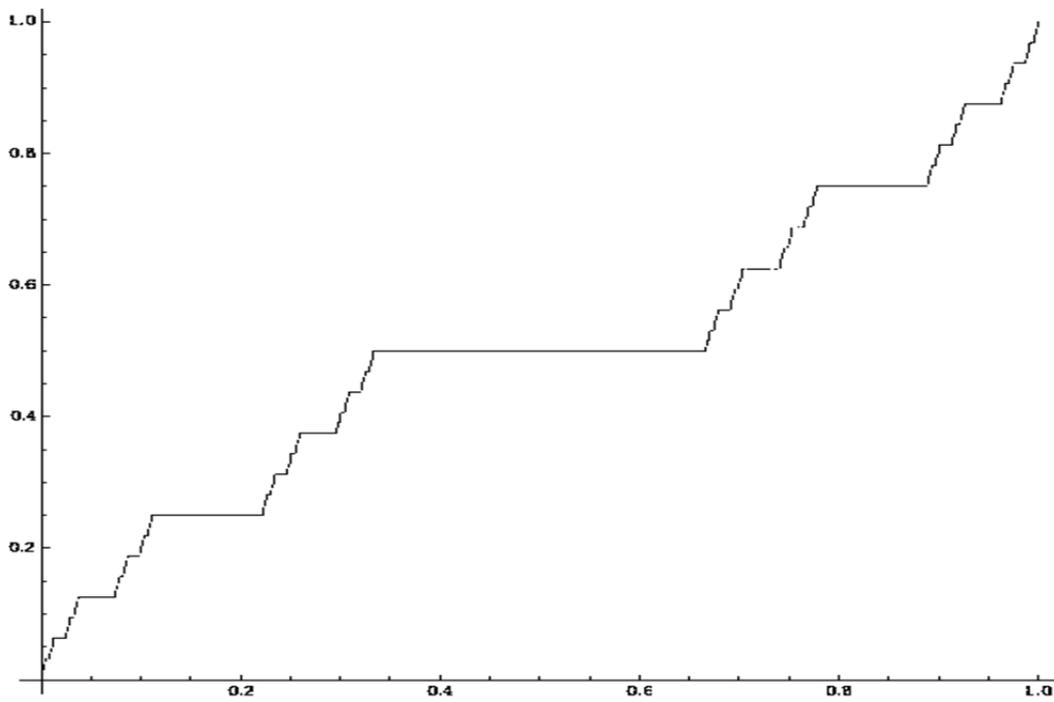
<sup>73</sup> Steinitz, "Music, Maths & Chaos," 18.

<sup>74</sup> *Ibid.*, 18.

Figure 4.5. Linear representation of a Cantor Set



Figure 4.6. Plot of the “Devil’s Staircase” on X, Y axis<sup>75</sup>



<sup>75</sup>Klaus Sutner, “Computational Discrete Math,” *Gallery* <http://www.cs.cmu.edu/~cdm/bilder.html>

Ligeti translated this mathematical concept into music by incorporating self-similar rhythmic groups. Throughout much of the piece, the rhythm is comprised of a dichotomy between groups of two and three that combine into larger groups (Fig. 4.7). This dichotomy of two and three is a direct reference to the ratios of 2:3 and 1:3 that comprise the mathematical concept named the Devil's Staircase. Ligeti first explored this idea of a 2:3 rhythmic ratios in the early experimental stages of his compositional shift when he used serial techniques to create rhythmic structures in his 1959 composition *Apparitions*.<sup>76</sup> In the first section of *L'escalier du diable*, Ligeti uses palindromic rhythmic groups comprised of subsets of twos and threes to create an unequal feeling that resembles the mathematical graph the Devil's Staircase (Fig. 4.7). The first group is comprised of 23 eighth notes whose sub-groups are 7+9+7. Each subsequent group in the first section, however, includes 34 eighth notes made up of the sub-groups 7+9+11+9+7. This lends the interpretation of the first group as a "false start."<sup>77</sup> Each subsequent rhythmic group overlaps by 7 eighth notes (2+2+3) in order to maintain the palindromic structure. This overlapping of rhythmic subsets recalls the mathematical concept of the Devil's Staircase as multiple subdivisions are embedded within each division of the original group.

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<sup>76</sup>Benjamin Levy, "Shades of the Studio: Electronic Influences on Ligeti's 'Apparitions,'" *Perspectives of New Music* 47, no. 2 (Summer 2009), 65—68.

<sup>77</sup>Steinitz, "Music, Maths & Chaos," 19.

Figure 4.7. György Ligeti, *Études pour piano* Book II, mvmt. 13: *L'escalier du diable*, mm. 1

**Group 1—“False start”      Group 2**

**Group 2'**

The image shows two musical excerpts from György Ligeti's 'L'escalier du diable'. The first excerpt, labeled 'Group 1—“False start”' and 'Group 2', is in bass clef with a 12/8 time signature. It features a piano part with a 'Presto legato, ma leggero, ♩ = 30' tempo marking. The music is marked 'una corda' and 'quasi senza ped.' with a 'cresc. poco a poco' instruction. The second excerpt, labeled 'Group 2'', is in treble clef and continues the piece with a 'sempre cresc. poco a poco' instruction. Both excerpts show complex rhythmic patterns with various note values and rests.

**Self-similar structures: Group 1 (False start)** = (2+2+3) + (2+2+2+3) + (2+2+3) = 7 + 9 + 7  
**Group 2 / 2'** = (2+2+3) + (2+2+2+3) + (2+2+2+2+3) + (2+2+2+3) + (2+2+3) = 7+9+11+9+7

The pattern briefly dissipates at the end of the sixth iteration of the pattern in mm. 7 (Fig. 4.8). This is a result of a misalignment of groupings between the right and left hands. This is similar to Harald Krebs’s “displacement dissonance,” which occurs when layers of equivalent cardinality are not aligned, usually perceived as a shifting of one or both layers.<sup>78</sup> At the beginning of mm. 7, the hands are synchronized as they finish the group of 11, sub-divided as a 2+2+2+2+3 pattern. In order to follow the previous pattern,

<sup>78</sup> Harald Krebs, “Metrical Consonance and Dissonance: Definitions and Taxonomy.” In *Fantasy Pieces: Metrical Dissonance in the Music of Robert Schumann* (New York: Oxford University Press, 1999), 23.

there needs to be a group of 9 (2+2+2+3) followed by a group of 7 (2+2+3). The left hand does follow this pattern, but the right hand reverses this pattern by forming a group of 7 followed by a group of 9. By momentarily displacing the right hand, Ligeti emphasizes the sixth iteration of the pattern. This signals the importance of the number 6 in relation to the ratio 2:3, as 2 multiplied by 3 is 6. This is also a reference to the Biblical number “666” which is said to be “the mark of the beast.”<sup>79</sup>

Figure 4.8. György Ligeti, *Études pour piano* Book II, mvmt. 13: *L’escalier du diable*, mm. 7

RH: ... 2 + 2 + 3      2 + 2 + 3      2 + 2 + 2 + 3 2 + 2 + 2 + 3      2 + 2 ...

(7)

*cresc. poco a poco* - - - - - *mp cresc.* - - - - -

LH: ... 2 + 2 + 3      2 + 2 + 2 + 3      2 + 2 + 3 2 + 2 + 3      2 + 2 ...

The first section ends in mm. 10 with a pattern of 23 eighth notes (7+9+7) rather than 34 eighth notes. (7+9+11+9+7), creating a large-scale palindrome, further emphasizing the embedded process of the mathematical concept the Devil’s Staircase.

The entire pattern seems to restart in the remainder of mm. 10 as the left hand plays the first measure of the piece a semitone lower. However, the reading of this section as a simple repetition of the first section is impossible when the right hand enters at the end of mm. 10 with a melodic line over the disjunctive pattern in the left hand.

<sup>79</sup>The Holy Bible, New International Version, Revelation 13:18.

The right hand no longer follows the pattern of the 2:3 ratio, but instead resembles the chromatic line of the left hand. Similarly, the left hand moves away from the self-similar 23- and 36-note patterns of the beginning when the right hand enters, signaling a movement away from the previous section.

Beginning in mm. 13, the right hand returns to a palindromic structure similar to the beginning (Fig. 4.9). However, in this iteration of the self-similar structure, each subset begins with groups of 3 eighth notes rather than groups of 2. This retrograde of the original pattern in the right hand is layered on top of the irregular 2+3 patterns in the left hand. This reference to the Devil's Staircase is emphasized by the unevenness of rhythmic accents between the right and left hands.

Figure 4.9. György Ligeti, *Études pour piano* Book II, mvmt. 13: *L'escalier du diable*, mm. 13—14.

(13) *fff* *p sub. cresc. poco a poco*

(14) *ff cresc.* *ff* *(cresc.)* *mf cresc.* *f cresc.* *ff*

RH: (3+2+2) + (3+2+2+2) + (3+2+2+2+2) + (3+2+2+2) + (3+2+2) = 7+9+11+9+7

### Pulse Streams within *L'escalier du diable*

John Roeder's concept of interacting pulse streams can also be used in *L'escalier du diable* to identify form and to emphasize endless spiraling (Fig. 4.10). In this etude, there are thirty-six notes in each measure that are divided asymmetrically into three hyper-measures. This notation is included to aid in the performance of the work, but no

accent is implied on any marked downbeat.<sup>80</sup> The underlying “precision-meccanico” pulse of constant eighth notes comprises “Pulse Stream 1” (labeled as “PS1”). Like *Entrelacs*, the absence of this underlying pulse later in the piece is crucial in the determination of formal boundaries within the work, and therefore can be treated as a pulse stream.

The second pulse stream, labeled PS2, follows *nadir* accent within *L’escalier du diable*. *Nadir* accents is a type of contour accent that occurs on a pitch that is lower than or equal to the lowest pitch that has occurred thus far in the piece. For this pitch to be accented, however, it must be lower than any immediately surrounding pitches.<sup>81</sup> In example 6, the first two instances of *nadir* accent coincide with this pulse stream, which spans 27 eighth notes. The third iteration of this pulse stream occurs on the same pitch class (pc 11) as the previous two occurrences, but it is displaced an octave higher. Though this pitch does not possess *nadir* accent, the accent is implied because the pulse stream is already established. However, after this iteration, the pulse stream dissipates because there is not an accent 27 eighth notes later to support the pulse stream. The *nadir* accent on B<sup>1</sup> occurs in the latter half of the following measure. The brief disappearance of PS2 gives the listener a greater sense of the instability Ligeti wants to convey. However, the constant return of pc 11 and PS2 at the end of mm. 3, and throughout this first section, reinforces the constant spiraling and ceaseless sense of falling within this work.

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<sup>80</sup> György Ligeti, *Ligeti in Conversation*, 14.

<sup>81</sup> John Roeder, “Beat-Class Modulation in Steve Reich’s Music,” *Music Theory Spectrum* 25, no. 2 (Fall 2003), 284.

The third pulse stream, PS3, is established and sustained by contour accents in the right hand. This pulse stream, which spans nine eighth notes, quickly dissipates and is replaced by PS4. This fourth pulse stream also dissolves rapidly after it is established. The rapid entrance and departure of these pulse streams initiated by the rising line in the right hand emphasizes the uneven “steps” of the Devil’s Staircase. The dichotomy between these and other pulse streams within *L’escalier du diable* help to further emphasize formal junctures and to reinforce the feeling of inescapable spiraling and lurking evil.

Figure 4.10. Pulse Streams in *L'escalier du diable*, mm. 1—2

The figure displays musical notation for the first two measures of *L'escalier du diable*. The top system shows the piano accompaniment in bass clef, marked with a tempo of 12/8 and a dynamic of *pp*. Circled notes in the piano part indicate the source of four pulse streams (PS1-PS4). Below the piano part, the pulse streams are represented as rhythmic patterns: PS1 is a continuous stream of eighth notes; PS2, PS3, and PS4 are longer, lower-frequency pulses. The bottom system shows the vocal line in treble clef, with circled notes corresponding to the pulse streams. Below it, the pulse streams are again represented as rhythmic patterns, with PS1 being a continuous eighth-note stream and PS2, PS3, and PS4 being longer pulses.

12/8 *pp*

“PS1”:

PS2:

PS3:

PS4:

“PS1”:

PS2:

PS4:

A new pulse stream emerges at the end of mm. 8, initiated by the upper notes of the right hand. The notes that contribute to this pulse stream also fall on a strong beat following a rhythmic sub-group of 3 eighth notes, further strengthening the stream (Fig. 4.11). The notes of this stream continue to climb higher in both pitch and dynamic until the beginning of mm. 10. The last eighth note of PS5 is accented, making it seem like the pulse stream has shifted back to one eighth note. However, when the left hand suddenly drops down to the bottom register of the piano at a *ppp* dynamic level, PS 5 is no longer supported. The entrance and abrupt exit of PS5 marks mm. 9—10 a transitional passage to sub-section “b” (Fig. 4.11).

The entrance of PS7 also indicates the beginning of sub-section “b”. This pulse stream is supported by the accents of the melodic line in the right hand (Fig. 4.12). The shifting of PS7, and other pulse streams, is prevalent throughout this section.

Figure 4.11. Pulse Streams in *L'escalier du diable*, mm. 8–10

(cresc.) - - - - - **ff** cresc. sempre, poco a poco

PS5: Shifted

(cresc.)

PS5:

(10) **fff** **fff** **p**

una corda

**ppp** sub. - - - - - cresc. poco a poco - - - - - **pp** cresc. - - - - -

PS5:

Figure 4.12. Pulse Stream 7 in *L'escalier du diable*, mm. 10—11

The image shows a musical score for two staves. The top staff is marked with *p*, *capriccioso*, *mp*, and *mf*. The bottom staff is marked with *(cresc.)* and *p cresc.*. Below the staves, a third staff labeled "PS7:" shows a sequence of notes, some of which are marked "Shifted". Vertical dashed lines connect the notes in the PS7 staff to the corresponding notes in the musical staves above.

The climax of *L'escalier du diable* occurs in mm. 26, coinciding with the beginning of the B section (Fig. 14). This section evokes the sound of thunderous church bells ringing, and it indicates the first time that PS1 is completely abandoned in both hands. Throughout the B section, the “ringing” gradually becomes quicker, resulting in a number of shifting pulse streams. The first instance of a stable pulse stream within this section occurs at the end of mm. 29 with PS11 (Fig. 4.13). This pulse stream, which spans 6 eighth notes, follows the strong entrance of *wildes Glockengeläute* (“wild ringing of bells”). This “ringing” speeds up to 5 eighth notes, indicated in Figure 4.13 by PS12. The gradual quickening of pulse streams and bell tones continue the idea of chase and inevitable doom from the previous section.

Figure 4.13. Pulse Streams in *L'escalier du diable*, Section B, mm. 29—31

The image displays a musical score for Section B of *L'escalier du diable*, measures 29 through 31. The score is presented in three systems, each featuring a piano part and a corresponding pulse stream (PS) part.

**System 1 (mm. 29-30):** The piano part begins at measure 29 with a treble clef and a key signature of two sharps (F# and C#). It features complex rhythmic patterns with many beamed notes and rests. The bass clef part provides a steady accompaniment. The score includes dynamic markings such as *fff* and *sempre non arp.* (sempre non arpeggiato). A pulse stream labeled **PS11** is shown below the piano part, consisting of a series of notes that correspond to the rhythmic pulses in the piano score.

**System 2 (mm. 30-31):** This system continues the piano part from measure 30. It includes the instruction *tutta la forza, minaccioso e maestoso* (with all force, menacing and majestic). The piano part features a prominent *fff* *sempre* marking. The pulse stream **PS11** continues, and a new pulse stream **PS5** is introduced at the bottom of the system.

**System 3 (mm. 31):** The piano part concludes at measure 31. The pulse stream **PS11** ends with a final note, and the **PS5** pulse stream continues with a series of notes.

Figure 4.14. Formal outline of *L'escalier du diable*

Section	A					B			Coda
	a	Transition	b	Re-transition	a'	c	c'	Re-transition	
Measures	1—8	8—10	10—13	13—17	17—25	25—32	32—35	35—43	43—54
Characteristics	Chromatic ascending line in left-hand; Constant presence of PS1 and dominance of PS2	Entrance of PS5; continued ascent to high register in both voices	Exit of PS5; exit of continuous PS1 in right-hand; prevalence of PS7	Exit of PS7; return of (mostly) continuous PS1 in right-hand	Frequent fluctuations pulse streams (PS9-10); ascent towards highest register of piano; building dynamic	<b>Climax</b> ; total abandonment of PS1 in both hands; <i>Dies Irae</i> ; bell-like; prevalence of PS5, PS11, and PS12	<i>subito ppp</i> ; exit of all previous pulse streams	Return of PS1; similar to a' section; gradual building to end of section from mm.41—43	Return of A section, later merged with B section; constant building until the end.

These pulse streams return after a re-transition into the Coda. The Coda serves as an amalgamation of each section of the piece that builds leading up to the final measure. A chart of the formal outline of *L'escalier du diable* is indicated in Figure 4.14. Throughout the work, the entrance and exit of pulse streams help to define formal outlines within the work and expand the feeling of unequal climbing within the work.

György Ligeti combined multiple styles of music and various disciplines of study in order to compose his unique works. His thirteenth etude, *L'escalier du diable*, is not only the longest of all of his piano etudes, but it is also the most dramatic, making use of drastic contrasts of pitch, dynamics, and texture. This etude was inspired by the *Dies Irae* as well as the visual art depicting the final judgment of mankind. Ligeti creates a feeling of continuous climbing through the amalgamation of spirals found in both physics and mathematics. To give the work a sense of ascending the Devil's Staircase, Ligeti used shifting pulse streams and self-similar rhythmic groups. Expanding on John Roeder's work, I analyzed *L'escalier du diable* using a pulse stream analysis. My analysis shows

that the central polyrhythmic structures, outlined by pulse streams, define the form of this work and contribute to Ligeti's goal of creating an image of relentless chasing and spiraling. This incorporation of emerging concepts in both mathematics and physics was highly influential on art music composers throughout the late 20<sup>th</sup> and 21<sup>st</sup> centuries.

## CHAPTER V

### CONCLUSION

The 1970s, in the period after his opera *Le Grand Macabre* marks a significant change in Ligeti's compositional style. This transition from the harmonically constrictive micropolyphony to various experimental styles led to the inception of Ligeti's *Études pour piano*. In these pieces, Ligeti not only incorporated Baroque and Romantic trends, but also serialism and electronic music techniques. These concepts united with evolving ideas from mathematics and science to form these unique works.

In many of his etudes, especially *Touches Bloquées*, *Entrelacs*, and *L'escalier du diable*, Ligeti uses an underlying "mecannico" ostiano figure that is layered underneath various melodic structures. These works contain complex rhythmic structures that cannot be analyzed through traditional rhythmic analysis. Though these melodic structures seem to be irregular accent patterns, they are actually composed of regular pulse streams that are layered to create a series of complex polyrhythmic structures. Through this analysis, I show that the entrance and exit of these pulse streams outline the formal structure of each of these works and emphasize the underlying idea that governs the piece. This examination also accounts for contour and agogic accents that are generally absent from other analyses of these works. Ligeti's experimental style was highly influential to his colleagues and composers of the 21<sup>st</sup> century, including Elliott Carter. Additional

research should be done on Ligeti's rhythmic practices in order to demonstrate his influence on later composers.

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