MONO

In previous works, I have sought to develop compositional systems that allow me to produce audible polytemporality in acoustic works without recourse to technological aids such as headphones and click tracks. My 2018 composition *Cascades* employed a system drawn from the techniques used in the 1977 Harrison Birtwistle composition *Silbury Air*—in which a series of calculated metric modulations allow for a pulse to remain at a constant audible rate as the surrounding tempo changes—to create a compositional plan in which proportion is used to derive sectional durations, employing the inverse of Birtwistle's technique to keep durations consistent as pulse increases. Though this produced a frame within which I was able to produce some interesting rhythmic events once pitch material had been derived, ultimately, the term 'polytemporality' was somewhat of a misnomer, as the audible effect was of three solo instruments playing in varying tuplet ratios, which is reproducible by any number of compositional systems.

Elsewhere, my work has used Cage's short 1949 article *Forerunners of Modern Music* as a launching point for experiments on means of organising form that are not harmony-based.[1] Though Cage for his own reasons proposes that duration is the organisational means most in accordance with the natural properties of sound, I have found the loose question 'what means other than harmony might be used to organise music?' to be creatively rewarding. My interests are very much informed by the Minimalist notion of audible process, and as such the question for me has narrowed over time to become a pursuit of surrogates for harmonic consonance and

[1] John Cage, *Silence* (London: Calder and Boyers, 1968), p. 63.

dissonance. The most striking of these for me—informed somewhat perhaps by the works discussed in the previous paragraph—was the effect of decelerating and/or accelerating pulses falling into alignment. This effect, heard most starkly in the latter stages of Ligeti's 1962 *Poème symphonique* for one hundred metronomes, allows for a signposting of structure similar in its legibility to the harmonic resolution, and I sought ways of employing it structurally.

My 2019 solo-piano composition *Construction 1* used as its basis a twelve-note all-interval chord, which I transposed and applied basic serial transformations of inversion, retrograde, and retrograde-inversion to to produce a bank of 48 chords. At the centre of the chord was the interval of a minor second, which I found I was able to employ as an organising element due to its discernibility. It became clear upon review, however, that my process wasn't quite involved enough to allow for exploration of the fairly extensive bank of pitch material I had produced, and once I discovered that a further transformation of my prime chord was possible—by displacing the intervals to begin the chord with each in the interval series—to which I could then apply the 48 transformations, the number of total possible chords in my process grew massively to 528 and I realised that I would need a new system if I were to begin a composition that could encompass more of the material.

It was with these ideas in mind that I began work on what was to become *MONO*. My challenge was to devise a compositional scheme that would allow all of these concerns to operate dependently and address what I felt to be the shortcomings in my previous attempts. I began by expanding the transformations of *Construction 1*'s prime chord to include all 528 possible iterations, and decided that, since I had

insufficiently explored its potential in that piece, the chord would form the basis of the new work. I then returned to the canon of pan-intervallic music to familiarise myself with the format.

Perhaps the first aspect of Carter's string quartets to strike an observer, since it forms the basis of much of the scholarship on the topic, is the use of time and rhythm in the pieces. Though much is written of the composer's use of metric modulation, of more interest for my purposes was the use of tempi in design at the formal level, and, more specifically, the ways in which this allows Carter to achieve what Jonathan W. Bernard terms 'simultaneity'. In the Second String Quartet, for example, Carter begins the piece with four tempi in the ratios 1:1, 1:3, 3:4 and 4:5, which, through careful preparation, instruments are able to modulate in and out of as either unity or disunity are required.[2] With the addition of a number of textural and gestural devices, separation between parts is reinforced, and, therefore, simultaneity achieved.

Though certainly partly a result of the constraints of the string quartet medium, it was my feeling that Carter's strict rhythmic frameworks often leaves little room for gestural variation. Where Carter left it to subjective 'characteristics' assigned to each instrument to provide variation, I conceived of a sound world in which combinations of intervals would contribute to variations in texture. Partly the result of an encounter with Jürg Frey's 2009 orchestral composition *60 Pieces of Sound*, I envisioned a process that would be sufficiently aleatoric to produce vertical sonorities of varying timbral characters, without sacrificing separation of parts into individual tempi. In Frey's *60 Pieces of Sound*, a series of chords are presented sustained and

[2] Glenn Gass, "Elliott Carter's Second String Quartet: Aspects of time and Rhythm," *Indiana Theory Review* 4, no. 3 (Spring 1981), pp. 13–18.

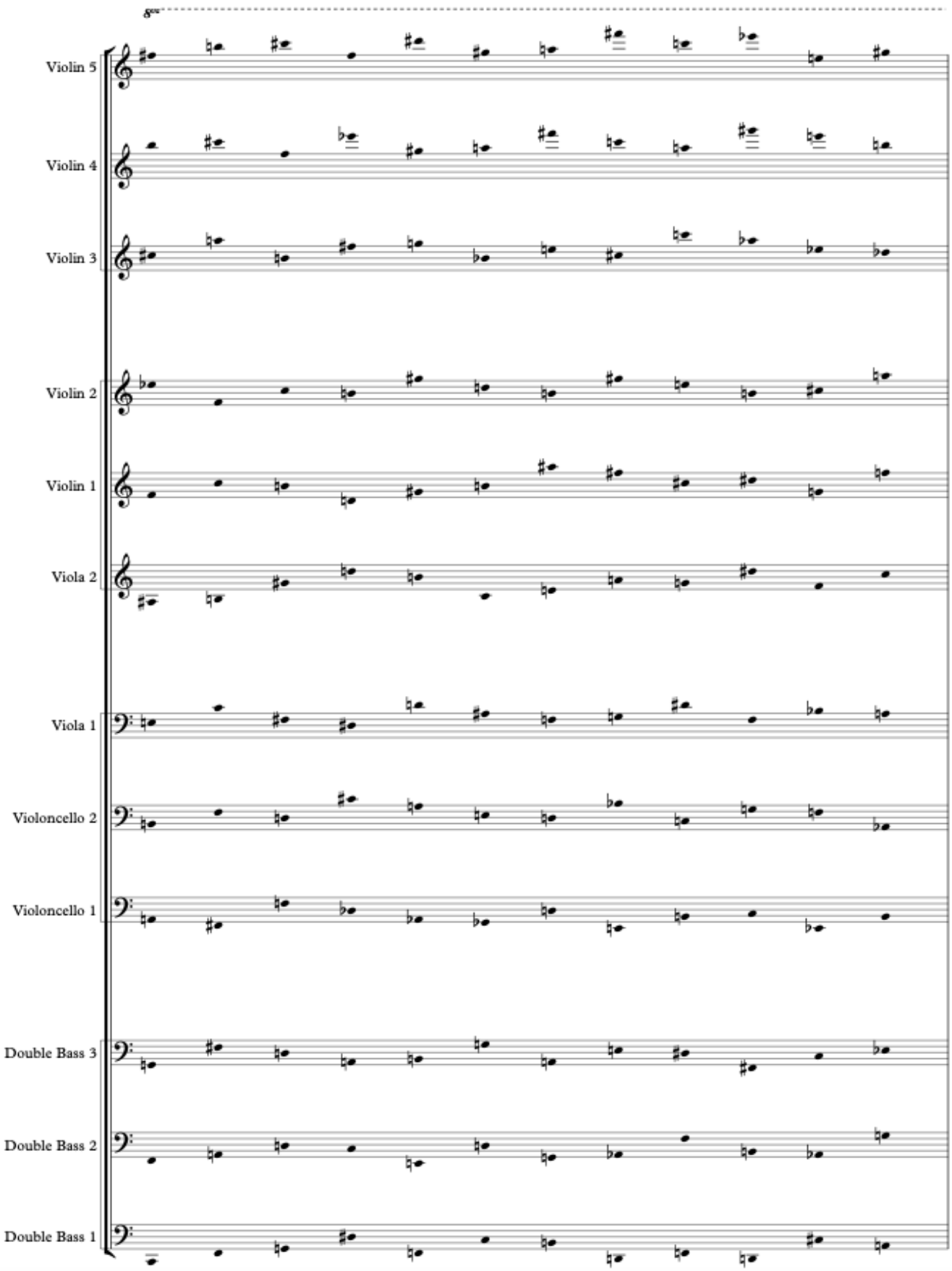
separated by periods of silence, with the intent that the listener have time to investigate the quality of each. Working pan-intervallically seemed to me to afford a similar opportunity to treat sonorities in this exhibitional manner—with so much chordal material generated, as a listener I wished for the opportunity to consider the differences in quality between, say, my chord in its prime form and its fifth transposition in retrograde form.

The reasons for my choice of the medium of string-orchestra were twofold: first, to emphasise the textural aspect of the piece, I wished for instruments timbrally similar enough that I could merge them into a single texture at points of my choosing. Second, my chords span the range of five octaves and a fourth, and so I needed an instrumental family capable of playing across all registers. Instrumentation was further determined by my pitch material: to accommodate my twelve-note chords, the orchestra consists of twelve instruments, each with its own sequence of intervals. Both the highest and lowest instruments are assigned the intervals of the prime chord (P). Moving down from the highest, the next instrument's sequence begins on P's second interval (P_1), with this process continuing until all 11 transformations have been assigned.[3] To accommodate my metric and temporal plan, described later, the ensemble is divided into four trios. Each trio in turn has its own set of intervals, one of either the prime chord, its inversion, retrograde, or retrograde inversion, (P, PI, PR, PRI, henceforth P-variant chords). The starting notes for each instrument correspond to that instrument's position in its trio's assigned P-variant chord.

Example 1 shows the pitch series for each instrument once its sequence of intervals has been applied. As well as each instrument following its own intervallic

[3] 'Transformation' here refers to the process of changing the ordering of intervals, numbered P_1, P_2…, whereas transpositions are changes to the starting pitch, numbered P_1a, P_1b…

Example 1: Pitch series for intro section



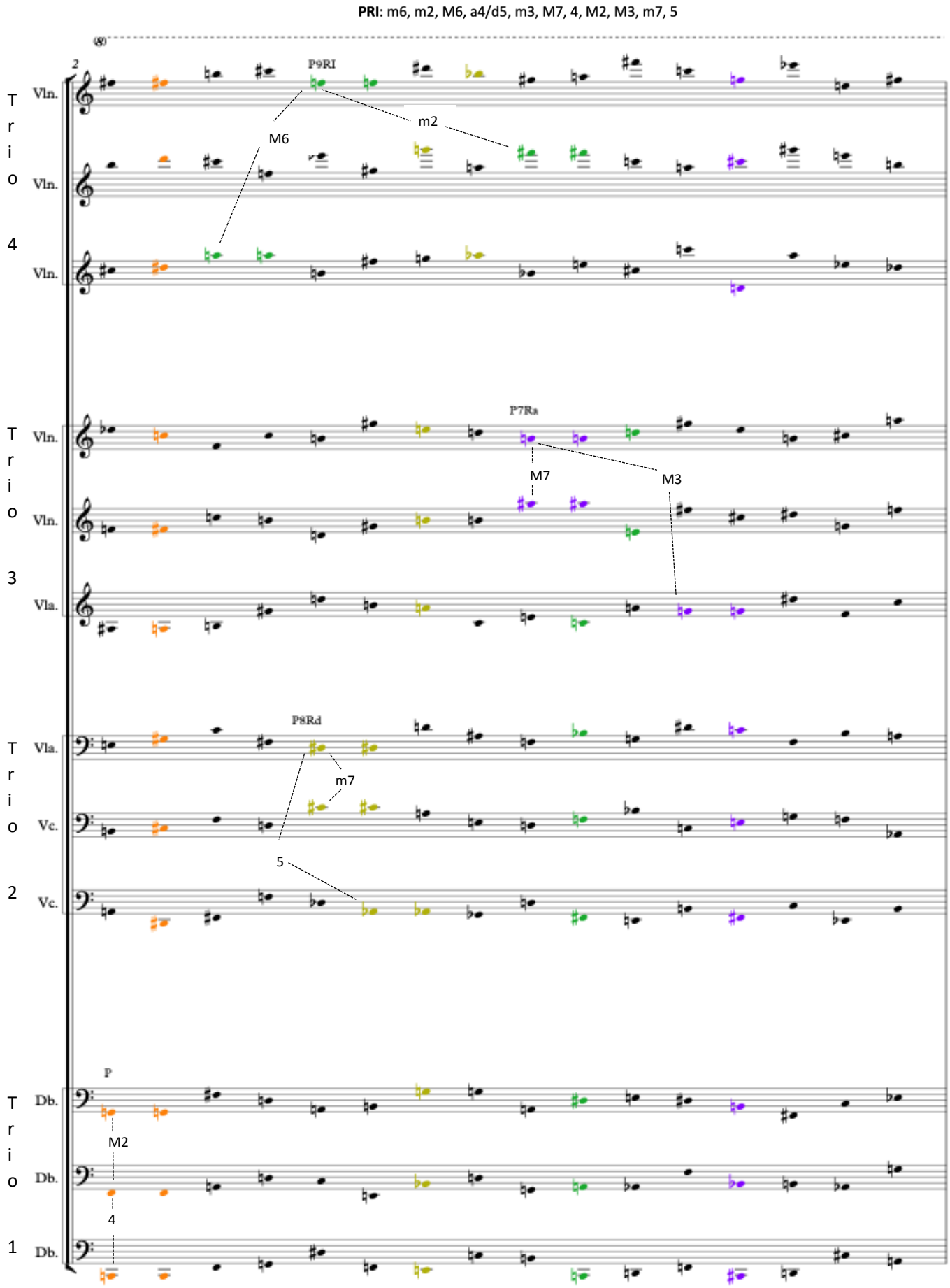
series, those of each trio form triads that follow the intervallic sequence of their P-variant chord. The resultant triad occurs in several chords within my chord bank. In each case, I select one of these twelve-note chords and then one instrument from the triad to determine the position of the chord in the score. The twelve notes of the chord are then cascaded throughout the rest of the ensemble, and the notes of the triad repeated. Example 2 shows the first application of this process. The new, amended sequence is then carried over to the next section, where the process is repeated, the result being that each sequence has two notes more than the sequence of the preceding section.

I completed a number of short tempo studies in preparation for work on the piece. Example 3 shows an excerpt of the second of these pieces, wherein the pitch series determines note values. It can be noted that passages of pulses are either diminished or augmented proportionally to accommodate alignments between parts at set points. In the pitch series above, for example, the notes of the triad P9RI in trio 4, coloured green, are to occur simultaneously in each instrument. The pulses of the upper and lower violins will therefore have to be augmented to accommodate this. Yet I found that simple adjustments in note value did not yield the audible effects that I desired—to make changes in tempo apparent to the listener, I sought a way of accurately notating deceleration and acceleration. Example 4 shows the calculator I developed, based on the formula:

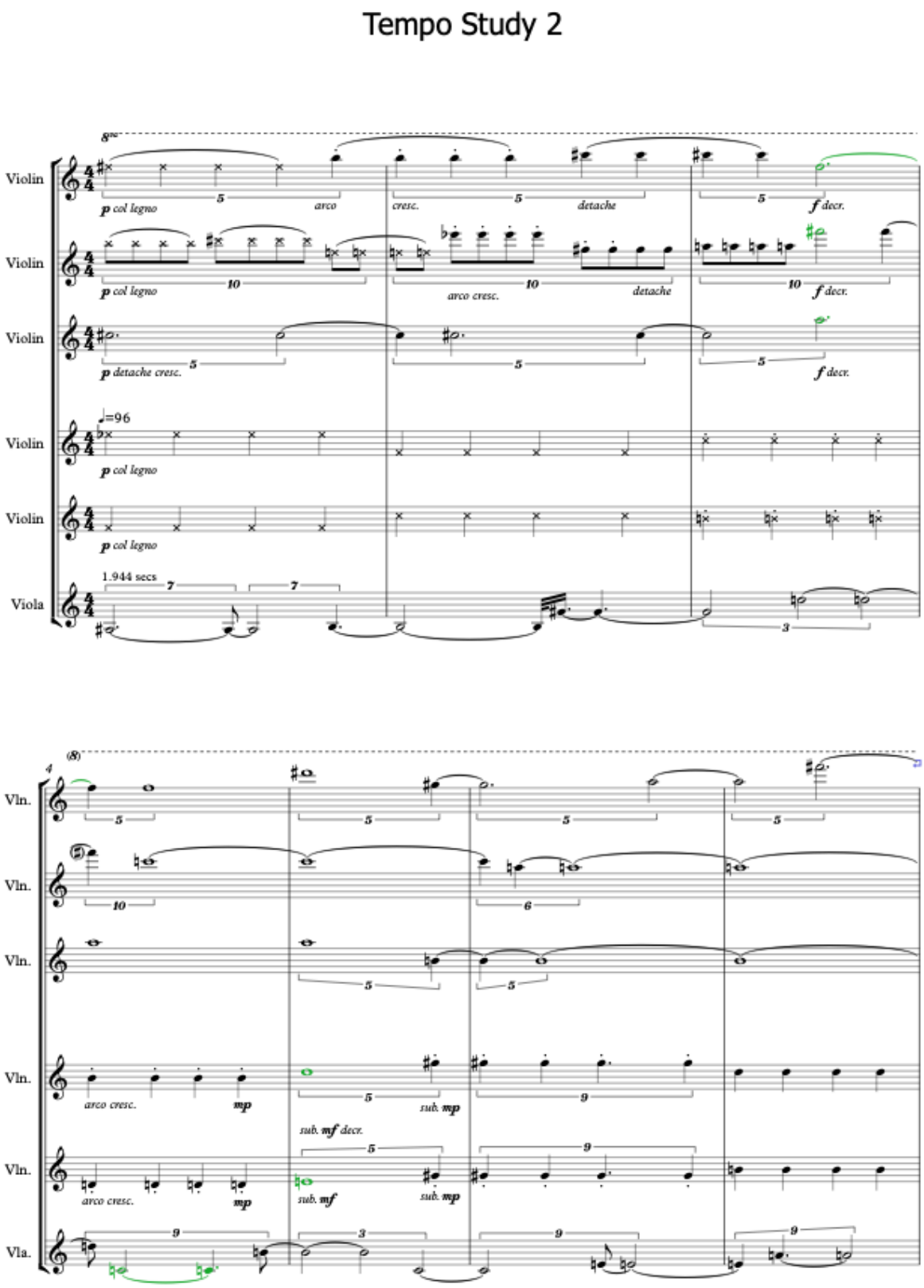
$$x^{(n-n)}{}_y, x^{(n-(n+1))}{}_y, \ldots x^{(n-(n+n))}{}_y$$

where x is the rate of acceleration/deceleration, y is the length of a beat in seconds, and n is the number of values to be calculated. Notating a deceleration consists first in using trial and error to find an x value that yields the desired duration after n

Example 2: Pitch series for section one



Example 3: Page one of *Tempo Study 2*. In order to facilitate alignments between parts at set temporal points, passages are diminished or augmented.



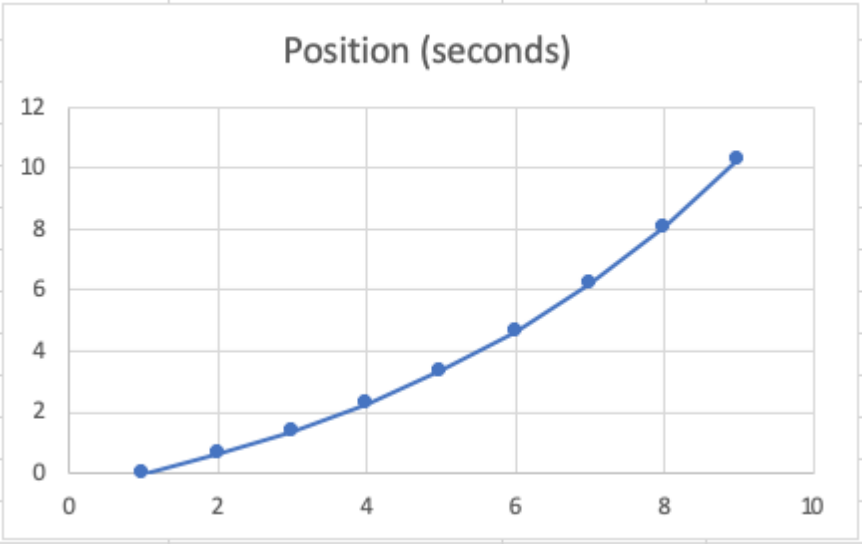
values, and then using the sheet shown in Example 4 to approximate the resulting note durations in a score.

My experiments at this stage showed that my methods produce two types of tempo change: ‘structural’, where an acceleration or deceleration determines structural aspects of the piece, and audible. The former are so-called because their effect is not immediately apparent to the listener. I found that tempo changes are most explicit when applied to a pulse on a single pitch, and therefore where my processes are applied to passages of my pitch series, for example, the implications are formal. This discovery informed the design of the piece. Having engaged with the metric designs of Carter’s quartets, I wondered how I might incorporate acceleration and deceleration into a long-range formal design, and found possible answers in that composer’s Fifth String Quartet. John Aylward describes a ‘long-range polyrhythm’ in the design of the quartet, in which synchronisations between pulses are used structurally to mark the beginnings of sections.[4] Further, the means by which increasing tempi are employed by Brian Ferneyhough in Song 2 of *Etudes Transcendantales* suggested to me a way in which I could use tempo to mark the sections of my pitch series.[5] Example 6 shows the result. By dividing the ensemble into four trios, I am able to begin the piece in four distinct tempi, each a ratio of a master tempo of 96bpm, chosen for its divisibility and for a total duration of 5:30 with each note of a pitch series played for a duration of one bar. Decelerations or accelerations are applied to each tempo such that each trio’s sixth section concludes at 5:30.

[4] John Aylward, “Metric Synchronization and Long-Range Polyrhythm in Elliott Carter’s Fifth String Quartet”, *Perspectives of New Music* 47, no. 2 (Summer 2009), pp. 90–91.
[5] Roger Redgate, “Brian Ferneyhough’s *Etudes Transcendantales*”, *Contemporary Music Review* 20, no. 1 (2001), p. 88.

Example 4: Deceleration calculator, showing eight notes beginning at 96bpm slowing at a rate of 1.2.

Beats in bar:	4		
BPM:	96		
x:	1.2		
y:	0.625		
Distance	**Position**	**Measure**	**Position in measure**
0	0	0	0
0.625	0.625	0.625	0.625
0.75	1.375	0.55	0.55
0.9	2.275	0.91	0.91
1.08	3.355	1.342	0.342
1.296	4.65100000000000	1.8604	0.8604
1.5552	6.206200000000	2.48248	0.48248
1.86624	8.0724400000	3.228976	0.228976
2.239488	10.31192800000000000	4.1247712	0.1247712



Example 5: Sheet that displays time values for various divisions of a bar in a given tempo

			Highlight												
	Starting tempo	96		1	2	3	4	5	6	7	8	9	10	11	12	13
			1/2	0	1.25											
	Crotchet duration	0.625	1/3	0	0.8333	1.6667										
			1/4	0	0.625	1.25	1.875									
			1/5	0	0.5	1	1.5	2								
			1/6	0	0.4167	0.8333	1.25	1.6667	2.0833							
			1/7	0	0.3571	0.7143	1.0714	1.4286	1.7857	2.1429						
			1/8	0	0.3125	0.625	0.9375	1.25	1.5625	1.875	2.1875					
			1/9	0	0.2778	0.5556	0.8333	1.1111	1.3889	1.6667	1.9444	2.2222				
			1/10	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25			
			1/11	0	0.2273	0.4545	0.6818	0.9091	1.1364	1.3636	1.5909	1.8182	2.0455	2.2727		
			1/12	0	0.2083	0.4167	0.625	0.8333	1.0417	1.25	1.4583	1.6667	1.875	2.0833	2.2917	
Base-tempo crotchet:	0.625		1/13	0	0.1923	0.3846	0.5769	0.7692	0.9615	1.1538	1.3462	1.5385	1.7308	1.9231	2.1154	2.3077
New tempo	64		1/14	0	0.1786	0.3571	0.5357	0.7143	0.8929	1.0714	1.25	1.4286	1.6071	1.7857	1.9643	2.1429
Crotchet to equal:	0.9375		1/15	0	0.1667	0.3333	0.5	0.6667	0.8333	1	1.1667	1.3333	1.5	1.6667	1.8333	2
			1/16	0	0.1563	0.3125	0.4688	0.625	0.7813	0.9375	1.0938	1.25	1.4063	1.5625	1.7188	1.875
			1/18	0	0.1389	0.2778	0.4167	0.5556	0.6944	0.8333	0.9722	1.1111	1.25	1.3889	1.5278	1.6667
			1/20	0	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1	1.125	1.25	1.375	1.5
			1/24	0	0.1042	0.2083	0.3125	0.4167	0.5208	0.625	0.7292	0.8333	0.9375	1.0417	1.1458	1.25
			1/30	0	0.0833	0.1667	0.25	0.3333	0.4167	0.5	0.5833	0.6667	0.75	0.8333	0.9167	1
			1/32	0	0.0781	0.1563	0.2344	0.3125	0.3906	0.4688	0.5469	0.625	0.7031	0.7813	0.8594	0.9375

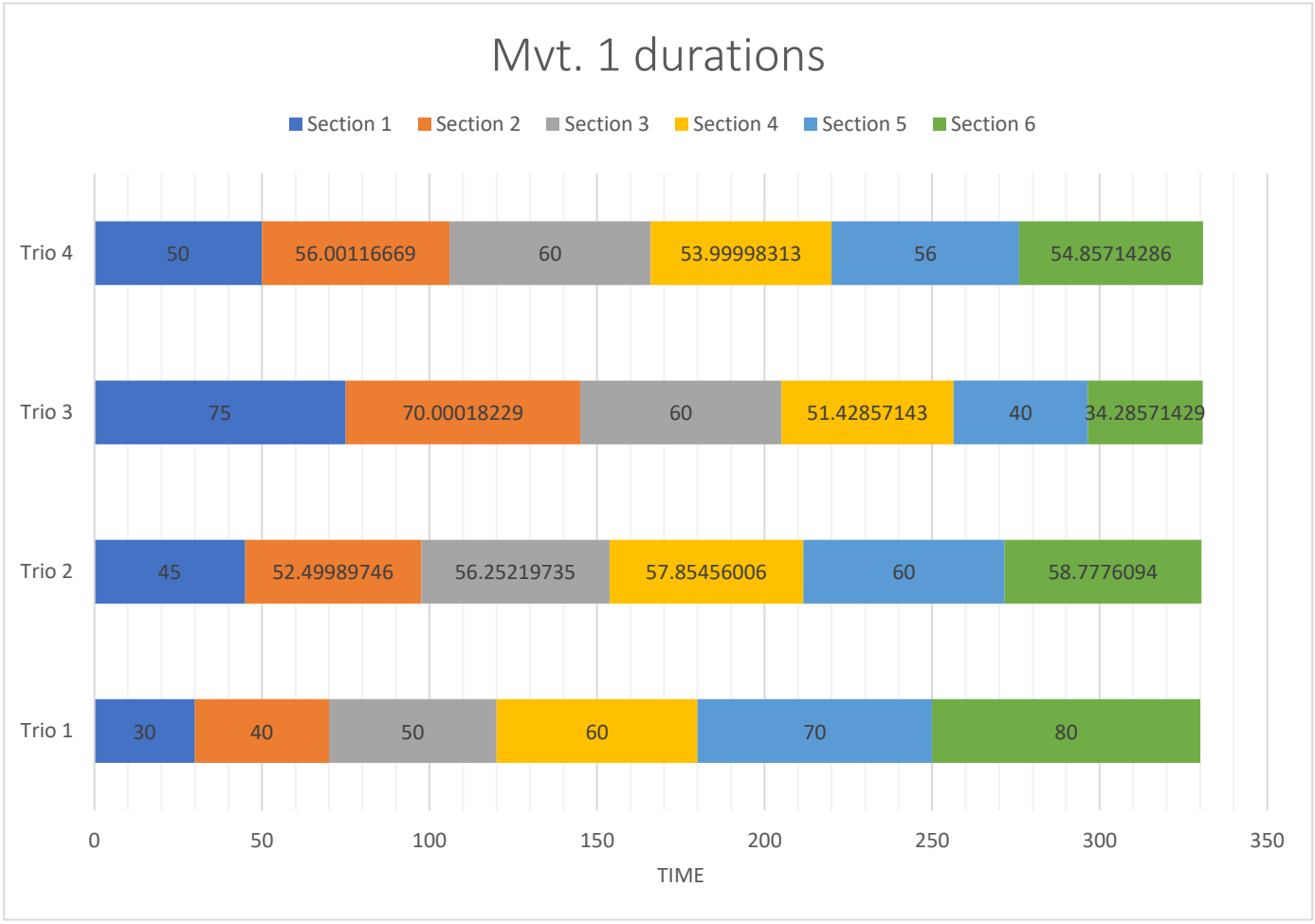
I had performability in mind at this stage in the compositional process. Though I investigated the performability of nested tuplets ('tuplets within tuplets'),[6] I decided that accurate reproducibility of my rhythms was of paramount importance for the musical aim of the piece. My solution was to employ a second layer of tempi, with secondary conductors in effect doing the work of the first layer of a nested tuplet by counting divisions of a master tempo. This gave me greater freedom in choosing pulse rates, and removed the need for any player to perform tuplets of more than one whole-number division of their tempi.

Example 7 shows the first stage in the score's production. Pulses and metric modulations are notated for the instrument determining the point of alignment in each repetition of the pitch series to best approximate the durations shown in Example 6.

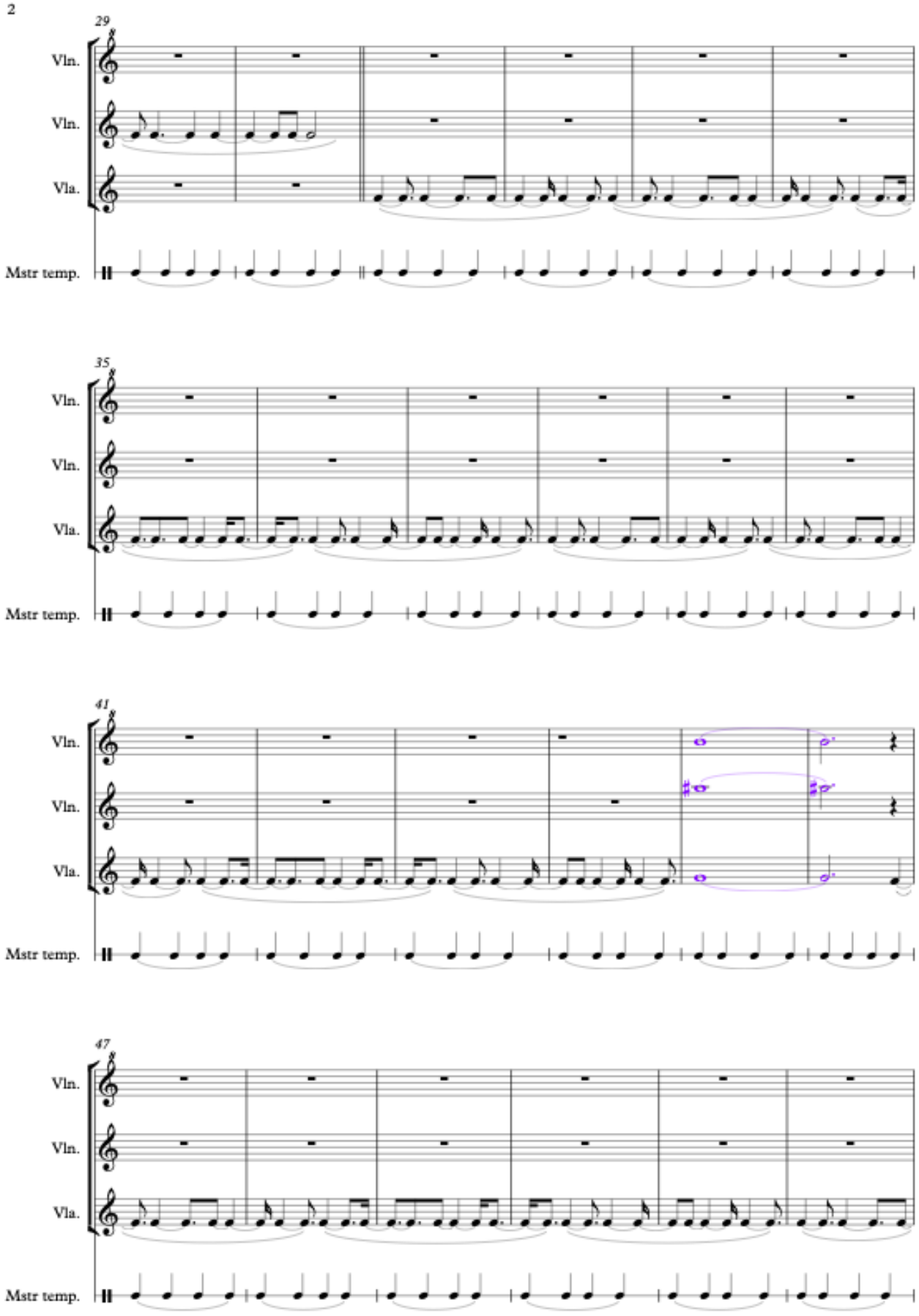
[6] Henry Cowell, *New Musical Resources* (Cambridge: Cambridge University Press, 1996), p. 64.

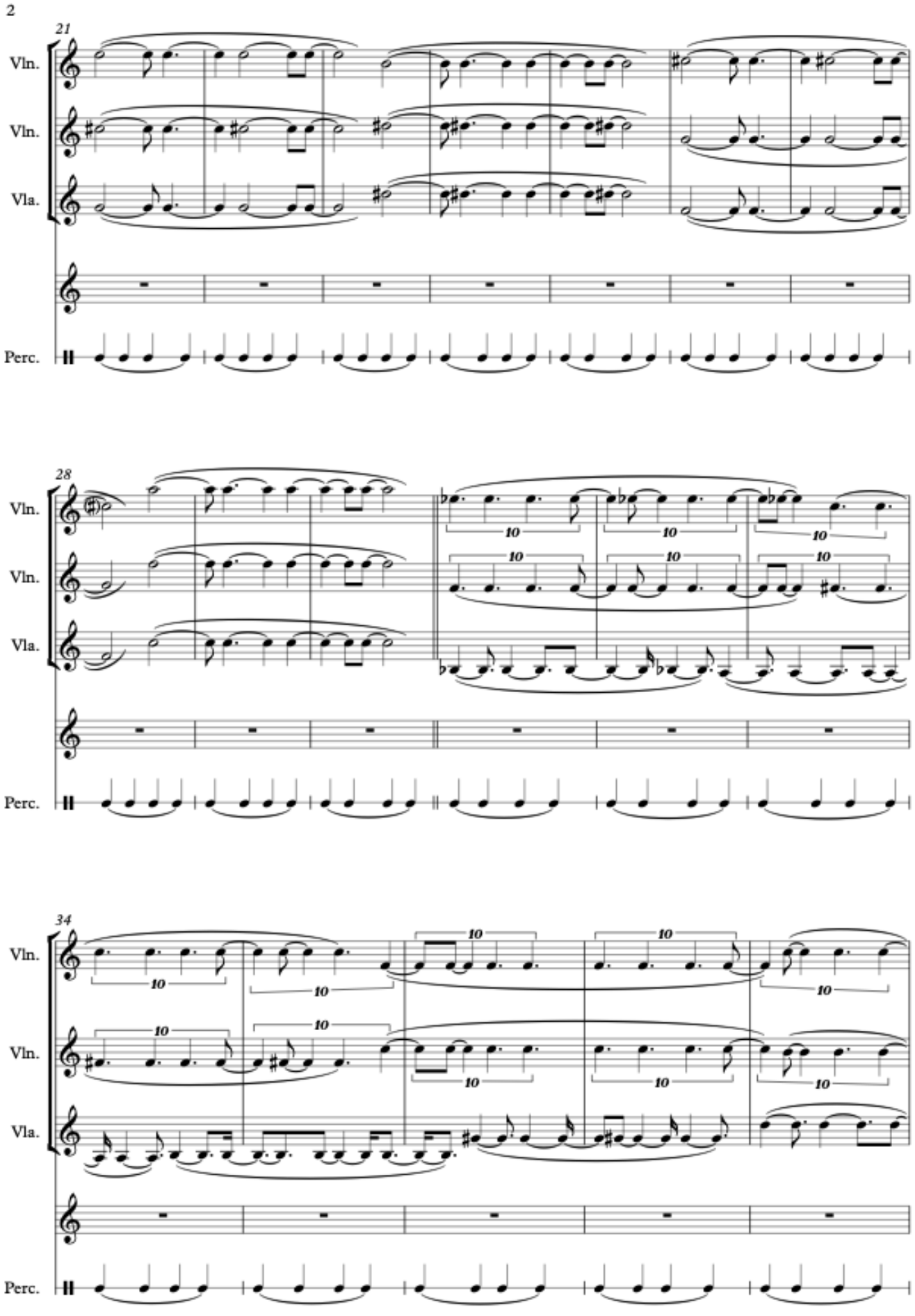
Example 6: Table showing starting-tempo ratios and section lengths in seconds when decelerations/accelerations are applied. Chart provides visual representation of how section lengths vary.

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6
Trio 4 (3:5)	50	56.0011667	60	53.9999831	56	54.8571429
Trio 3 (2:5)	75	70.0001823	60	51.4285714	40	34.2857143
Trio 2 (2:3)	45	52.4998975	56.2521974	57.8545601	60	58.7776094
Trio 1 (1:1)	30	40	50	60	70	80



Example 7: First and second stages in Trio 3's construction. Main tempo is outlined, as well as trio's point alignment for section (purple chord). Rhythms of remaining parts are determined by temporal space available between alignments/leading instrument switches.




2
21
Vln.
Vln.
Vla.
Perc.
28
Vln.
Vln.
Vla.
Perc.
10
34
Vln.
Vln.
Vla.
Perc.

The overall audible design of the piece can be described thus: instruments begin in unison, before *glissandoing* to their respective starting notes and tempi. At the conclusion of the introduction at b. 38, a formal process begins. Trios are, for the most part, disparate, playing to their own tempi, with occasional lapses into complete disparity between instruments where pulse rates diverge. The first events to emerge from the texture are rhythmic alignments within trios, which occur once for each trio. Next, six-note sustained chords occur between each possible combination of two instruments, followed by nine-note chords between all combinations of three trios. All six-note chords contain one minor-second interval, whilst nine-note chords contain two, and audible decelerations/accelerations become more prevalent as these alignment chords increase in size. The piece concludes with a full-orchestra alignment on a chord containing three minor seconds.

The introduction gives a reference to Ligeti's *Poème symphonique* through the use of instrumental body-tapping. Borrowing the cyclic organisation principle from *Tetradec*, each instrument moves to its starting pulse and the ensemble completes one full cycle of polyrhythm before proceeding to their starting notes (bb. 23–38).

Example 8: Table showing points of alignments between trios

Trios	**Time**	**Sonorities**	**Chords**
1,2	1:04	E1,Bb1,G2 Ab2,D#3,C#4	P8Rd
1,3	N/A- trio tempos too disparate	-	-
1,4	1:18	C1, A1, D#2 A5,F6,F#6	P9RI
2,3	Takes place in 1,2,3 alignment	-	-
2,4	2:34	D2,A2,Bb2 D#5,G5,G6	P1f
3,4	Occurs at same time as 1,2,3 alignment	-	-
1,2,3	4:14	E3,B3,G#5 D4,G6,A6 G5,E6,F6	P1Ib, P7Ij
1,3,4	4:35	Bb1,E2,C#3 E4,F4,D5 C#4,C#6,G#6	P7Ij, P5Rid, P1Ib,
1,2,4	5:00	C1,A1,G2 Ab2,F3,F#3 A5,D6,F#6	P2a, P10R
2,3,4/*Tutti*	To end	C#1,E1,E2 Bb2,C3,F3 Bb3,Ab4,A5 E5,C#6,G5	Various—adjustments made to ensure linking semitones between trios

Bibliography

Aylward, John. “Metric Synchronization and Long-Range Polyrhythm in Elliott Carter’s Fifth String Quartet”, *Perspectives of New Music* 47, no. 2 (Summer 2009).

Cage, John. *Silence* (London: Calder and Boyers, 1968).

Cowell, Henry, *New Musical Resources* (Cambridge: Cambridge University Press, 1996).

Gass, Glenn. “Elliott Carter’s Second String Quartet: Aspects of time and Rhythm,” *Indiana Theory Review* 4, no. 3 (Spring 1981).

Redgate, Roger. “Brian Ferneyhough’s *Etudes Transcendantales*”, *Contemporary Music Review* 20, no. 1 (2001).