

Andrián Pertout

Exposiciones

for Sampled Microtonal Schoenhut Toy Piano

No. 392

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Composed between February and July, 2005

Composed for the Extensible Toy Piano Project (Clark University, Department of Visual and Performing Arts, 4-5 November, 2005, Worcester, MA, USA)

Hommage à Frank Zappa (1940-1993)

World Premier: 5 November, 2005 (Razzo Recital Hall, Traina Center for the Arts, Clark University, Worcester, MA, USA)

Latin American Premier: 10 March, 2006 (Museo de Ron, International Electroacoustic Music Festival 'Spring in Havana' 2006, 6-12 March, 2006, Havana, Cuba)

European Premier: 24 October, 2006, Logos Tetrahedron, Ghent, Belgium

Australian Premier: 11 July, 2006 (Scott Theatre, Elder Conservatorium of Music, University of Adelaide, Medi(t)ations: Computers, Music and Intermedia, Australasian Computer Music Association Conference 2006, 11-13 July, 2006, Adelaide, Australia)

Duration: 7'00"

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PROGRAMME NOTES

“It has a deceptively simple mechanism – plastic hammers hitting steel rods. Yet, the toy piano produces a rich and quirky sound palette. John Cage brought the instrument from a treasured plaything to a bona fide musical instrument with his *Suite for Toy Piano* (1948). Our aim is to bring the instrument into the 21st Century.”

The Extensible Toy Piano Project, Clark University, Department of Visual and Performing Arts, Worcester, MA, USA

The history of the toy piano (Fr. *piano jouet*; Ger. *Spielzeugklavier*; It. *pianino-giocattolo*) begins as Troiger’s ‘Stahlklavier’ (Dessau, 1792) and Franz Schuster’s ‘Adiaphonon’ (Vienna, c. 1818), to be later developed in Philadelphia, USA, in 1872, where German immigrant Albert Schoenhut ultimately conceives the child’s toy that in time will also capture the imagination of the contemporary composer. The instrument is usually made out of wood or plastic, and is dimensionally less than fifty centimetres in width, with a range between two diatonic and three chromatic octaves. It has a simple sounding mechanism (similar to that of the full-sized keyboard glockenspiel) consisting of plastic hammers operated via a keyboard, which strike fixed metal plates or steel rods. Traditionally, toy pianos were modelled on uprights, but following the 1950s grand piano varieties were commonplace.

Contemporary works that have incorporated the toy piano include John Cage’s *Suite for Toy Piano* (1948) and George Crumb’s *Ancient Voices of Children* (1970), as well as other works by Renaud Gagneux, Mauricio Kagel, Louis Roquin, Zygmunt Krauze, and Leonid Aleksandrovich, among many. Internationally acclaimed concert pianist Margaret Leng Tan made her debut on the toy piano in 1993 at New York’s Lincoln Centre, and went on to introduce the model 6625, 25-key Schoenhut Traditional Spinnet to Carnegie Hall in 1997; also releasing ‘The Art of the Toy Piano’ in that same year – a collection of works by Stephen Montague, John Lennon and Paul McCartney, Toby Twining, Jed Distler, Philip Glass, David Lang, Julia Wolfe, Ludwig van Beethoven, Guy Klucevsek, Raphael Mostel, and Erik Satie.

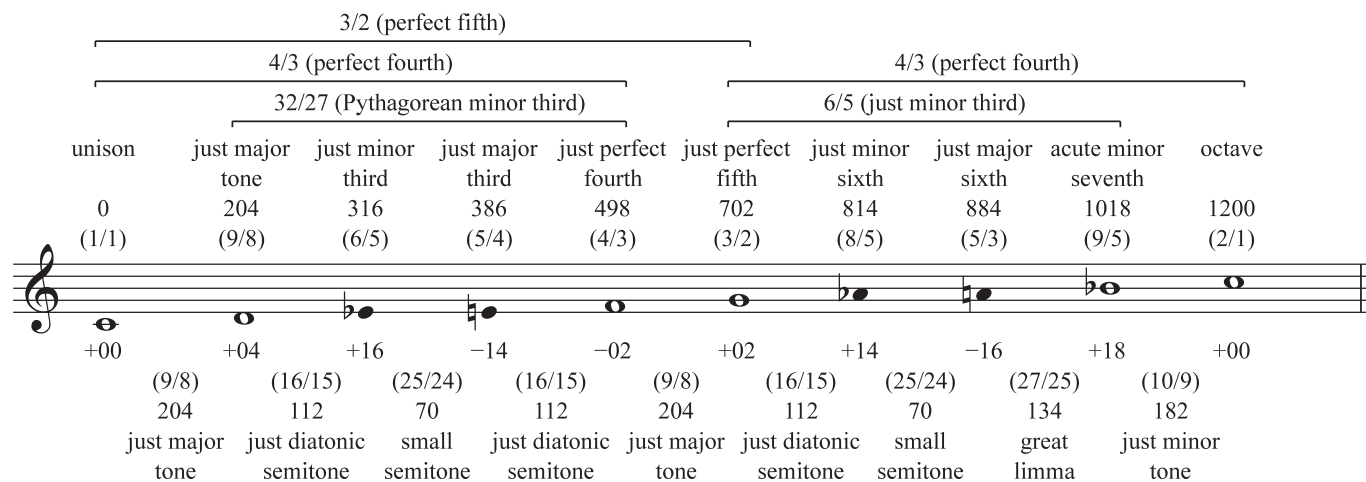
‘Exposiciones’ for Sampled Microtonal Schoenhut Toy Piano is an ‘acousmatic’ work that attempts to explore the equally-tempered sound world within the context of a sampled microtonal Schoenhut model 6625, 25-key toy piano and a complex polyrhythmic scheme. All equal temperaments between 1 and 24 – essentially functioning as tuning modulations – as well as all polyrhythms (divisible only by 1 and including their inversions) between the ranges of 2 and 15 are presented. In other words, polyrhythmic ratios 3:2 (2:3), 5:2 (2:5), 4:3 (3:4), 5:3 (3:5), and so on – 57 polyrhythmic sets in total, with the last set represented by 15:14 (14:15) – alongside two complementary scales (Indonesian *Pélog* and *Sléndro* forms with primary and secondary scale tones, as well as primary and secondary auxiliary tones) shaped via microtonal inflections produced by sequential tuning modulations featuring the first 24 equally-tempered divisions of the octave.

The intervallic structure of the pentatonic scales defined by the ratios of just intonation, or the ‘Scale of Proportions’ (The Harmonic Division of the Octave) as presented by Alain Daniélou in *Music and the Power of Sound: The Influence of Tuning and Interval on Consciousness* (1995) – the current edition of his 1943 monumental work *Introduction to the Study of Musical Scales*. The ‘Scale of Proportions’ is based on the harmonic series. It is a division of the octave into fifty-three distinct intervals, and is a scale of just intonation, where the intervals are called pure (or just), because there are no beats between the notes or their harmonics. The quarter-tone (three-quarter-tone), a result of the further division of the disjunctions of this scale (major half-tone, or just diatonic semitone), giving a total of sixty-six unique intervals (the octave included). In Indian musical theory this system referred to as ‘The Sixty-Six *Śrutis*’. The notation (inspired by Alain Daniélou’s work and highly illustrative of the effect of each equal temperament on the two scales and their consequential intervallic deviation from just intonation), based on approximate syntonic comma (81/80, or 21.506 cents) subdivisions of the just major tone (9/8, or 203.91 cents) and resulting in the following scheme:

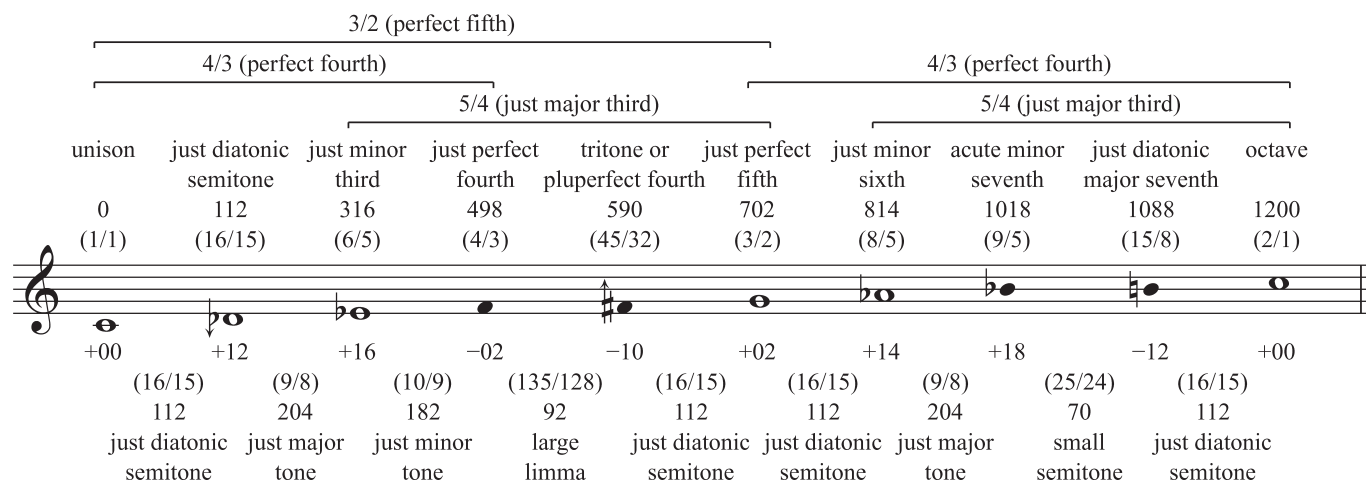
<u>Note</u>	<u>Interval</u>	<u>Ratio</u>	<u>Cents</u>
C	unison	1/1	0.000
C↑	syntonic comma	81/80	21.506
C↑↑	great diesis	128/125	41.059
C‡ / D♭	Greek enharmonic or septimal quarter-tone	31/30	56.767
C♯	small just chromatic semitone	25/24	70.672
D↓♭	Pythagorean limma	256/243	90.225
D♭	just diatonic semitone	16/15	111.731
D♭	great limma	27/25	133.238
C♯ / D♭	three-quarter-tone	135/124	147.143
D↓↓	small tone	800/729	160.897
D↓	just minor tone	10/9	182.404
D	just major tone (9th harmonic)	9/8	203.91

The Schoenhut model 6625, 25-key toy piano samples (recorded in dead studio space [96kHz/24bit] by engineer John Shirley at Clark University, Department of Visual and Performing Arts, Worcester, MA, USA, utilizing two Neumann TLM 103s [positioned front-L and back-R] and a Nuendo recorder) include three sets of twenty-five (two-octave chromatic span) forte (***f***), mezzo forte (***mf***), and piano (***p***) samples, as well as one corresponding set of keyboard release clicks. All these sounds multi-sampled on an Akai S3000XL Midi Stereo Digital Sampler – tuned firstly to standard A=440 Hz twelve-tone equal temperament, modified within thirty velocity cross-faded patches, and then operated via a midi sequencer; a gong-like detuned middle C (octave down) sounding the tonal centre, as well as marking the downbeat, while another severely gated alternative providing the rhythmic pulse (downbeats and upbeats).

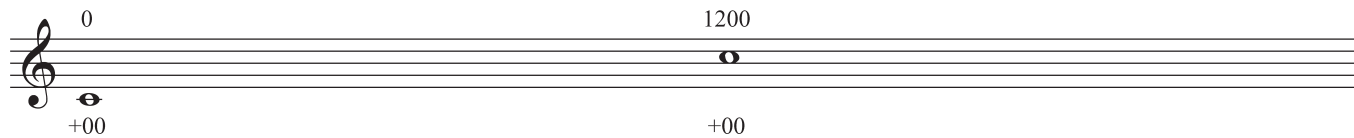
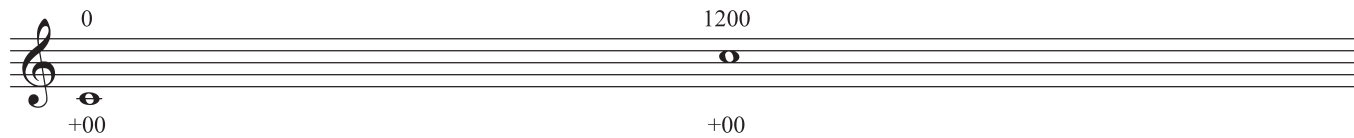
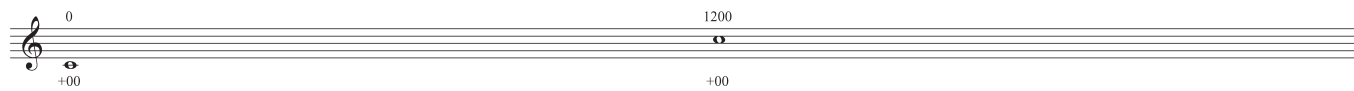
Sléndro Scale



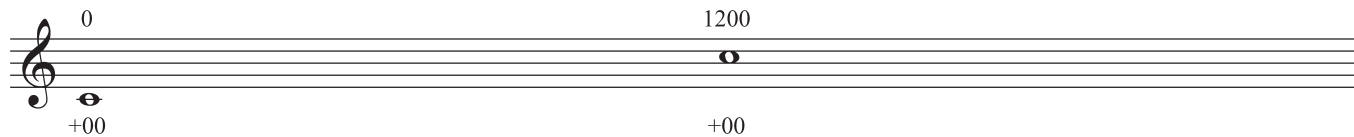
Pélog Scale



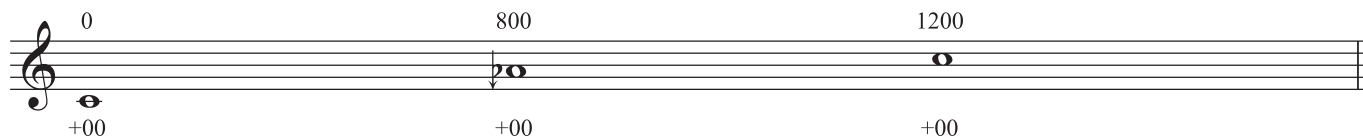
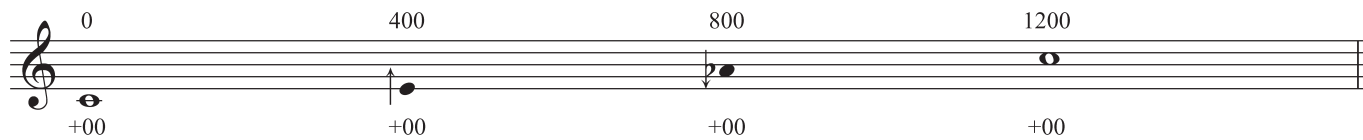
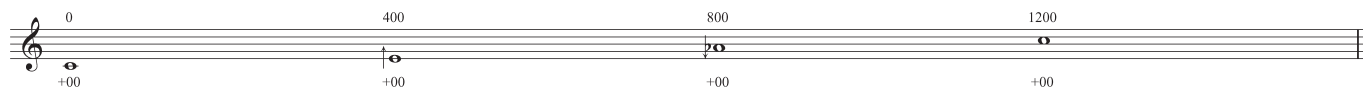
1-tone equal temperament



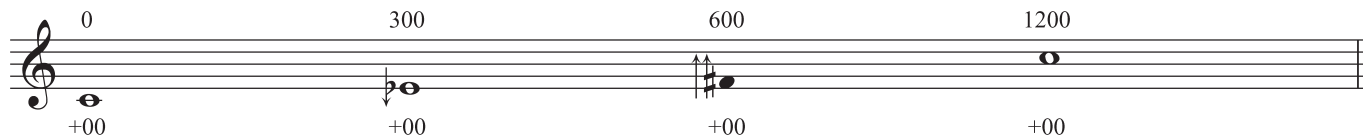
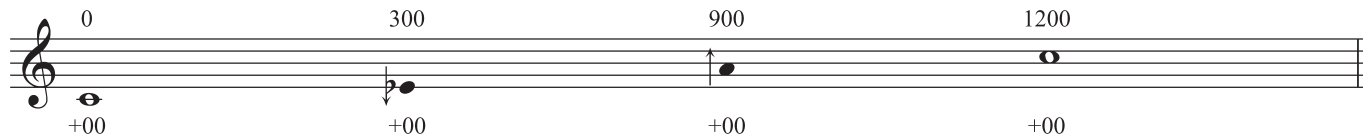
2-tone equal temperament



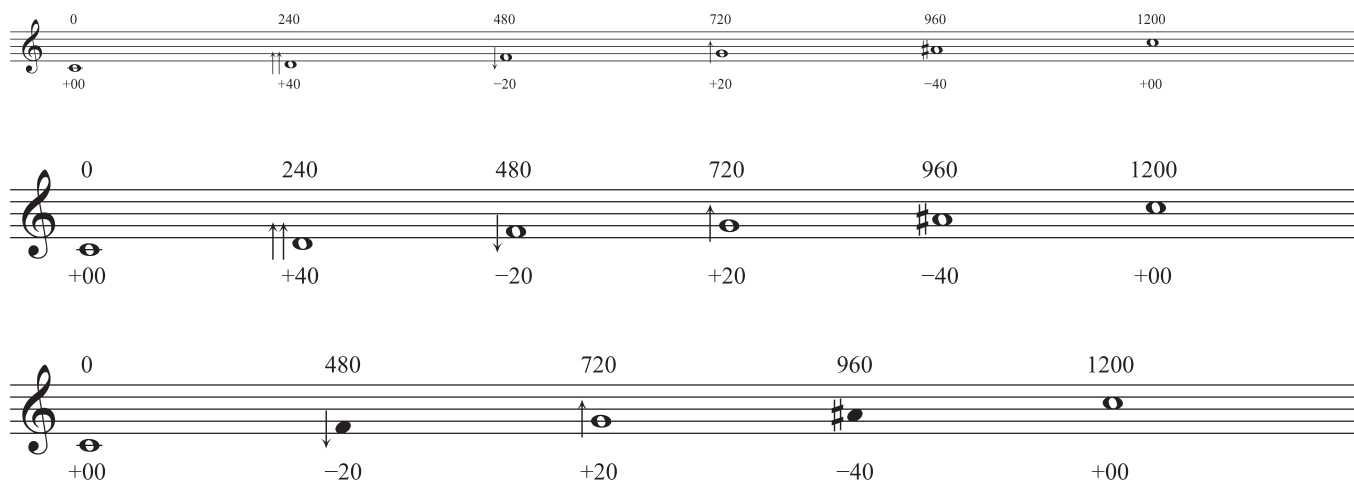
3-tone equal temperament



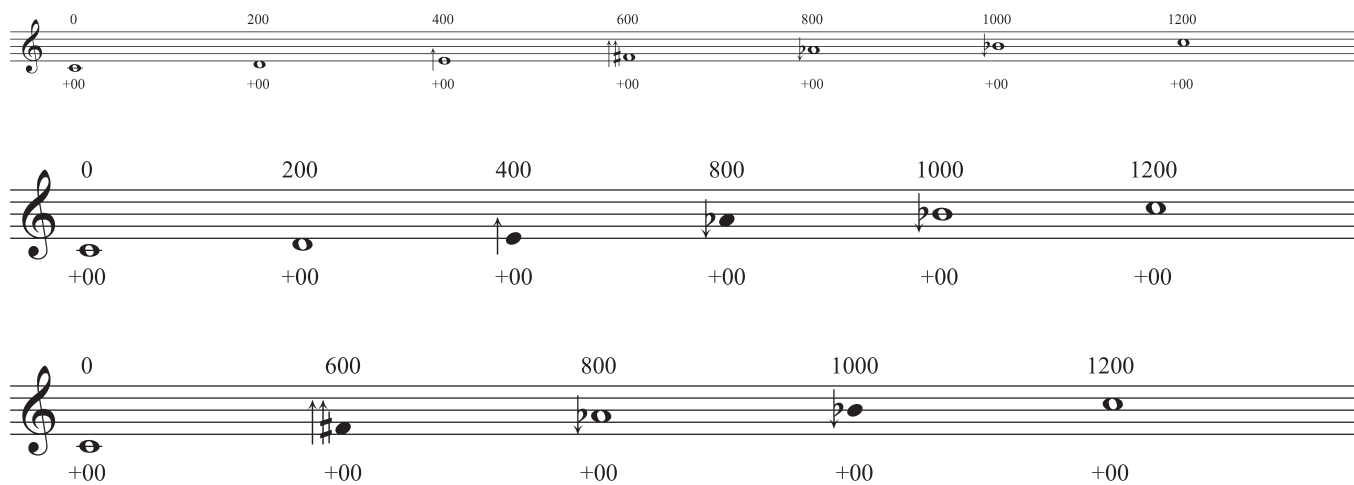
4-tone equal temperament



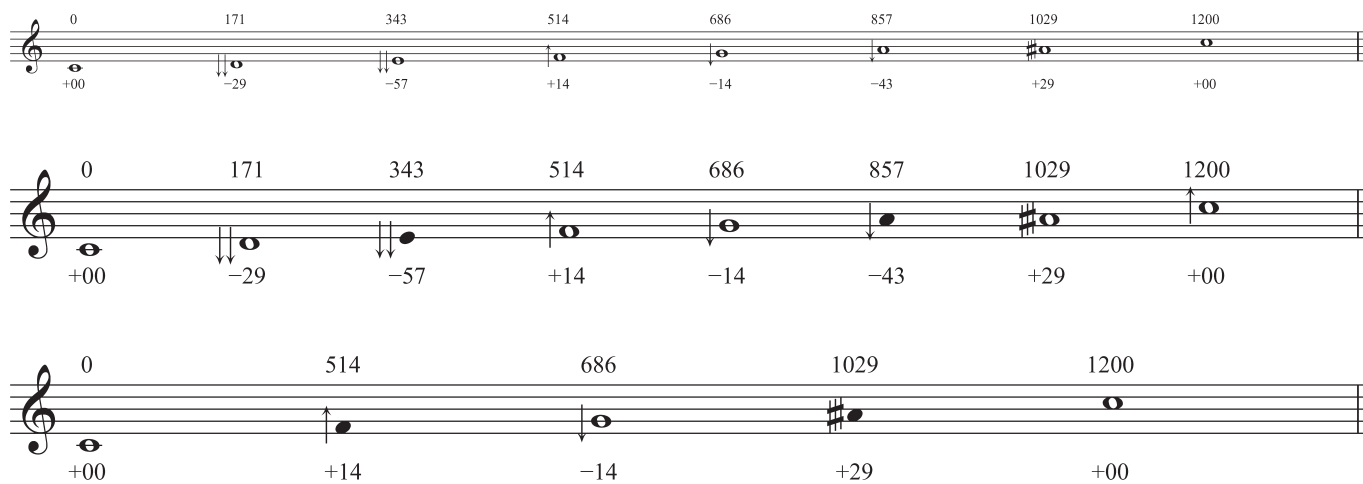
5-tone equal temperament



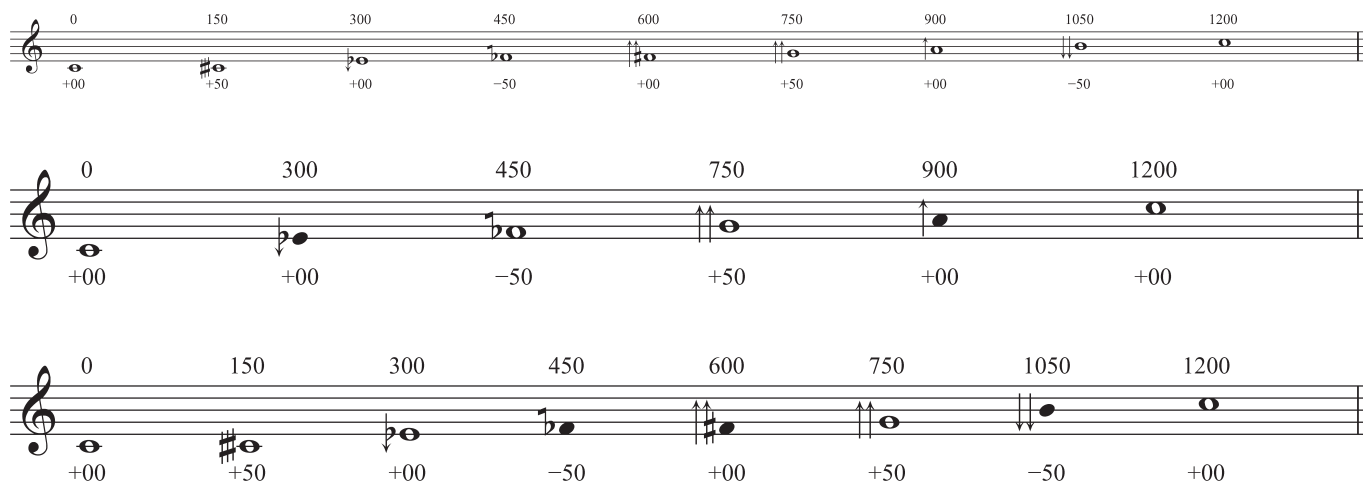
6-tone equal temperament



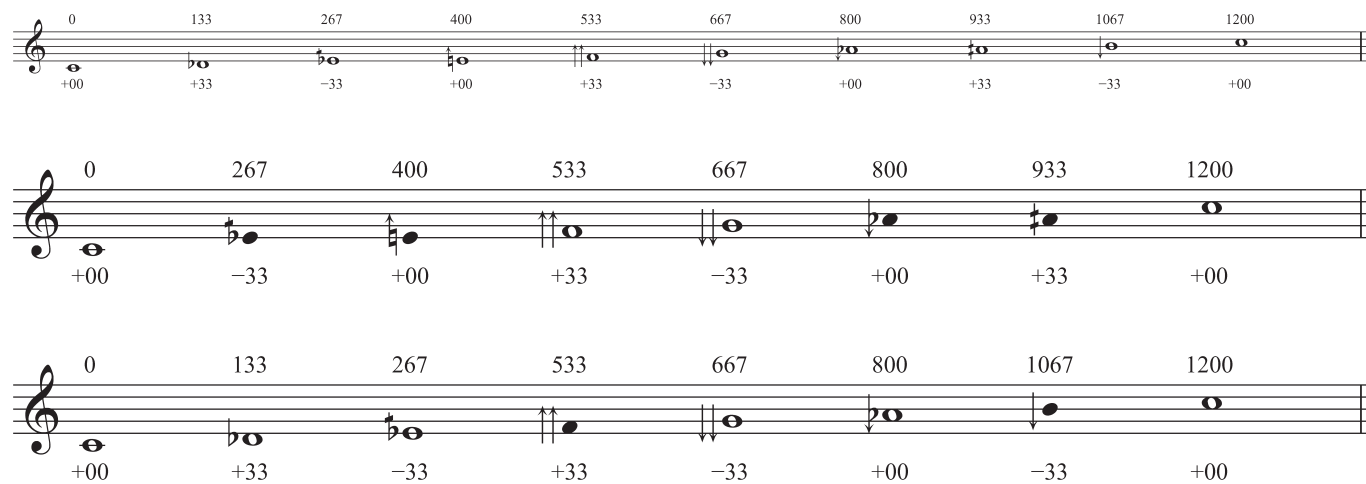
7-tone equal temperament



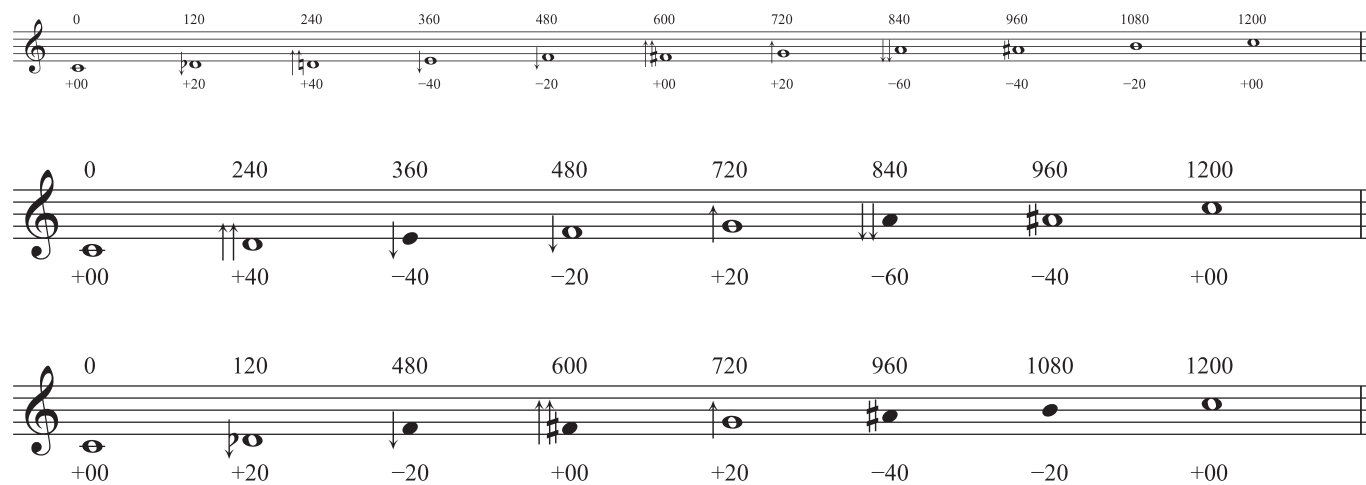
8-tone equal temperament



9-tone equal temperament



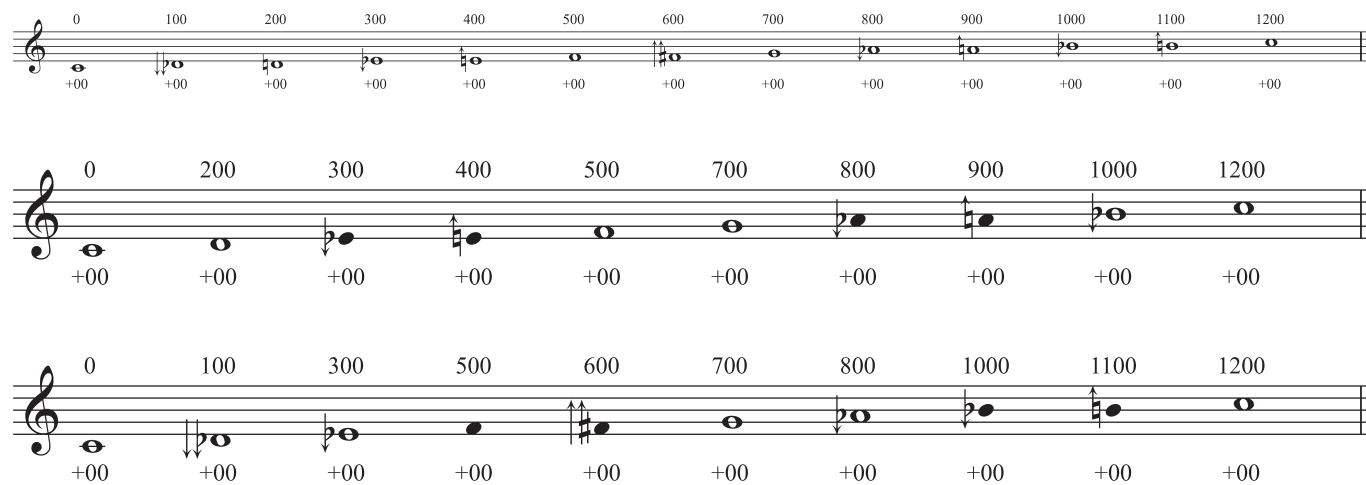
10-tone equal temperament



11-tone equal temperament



12-tone equal temperament



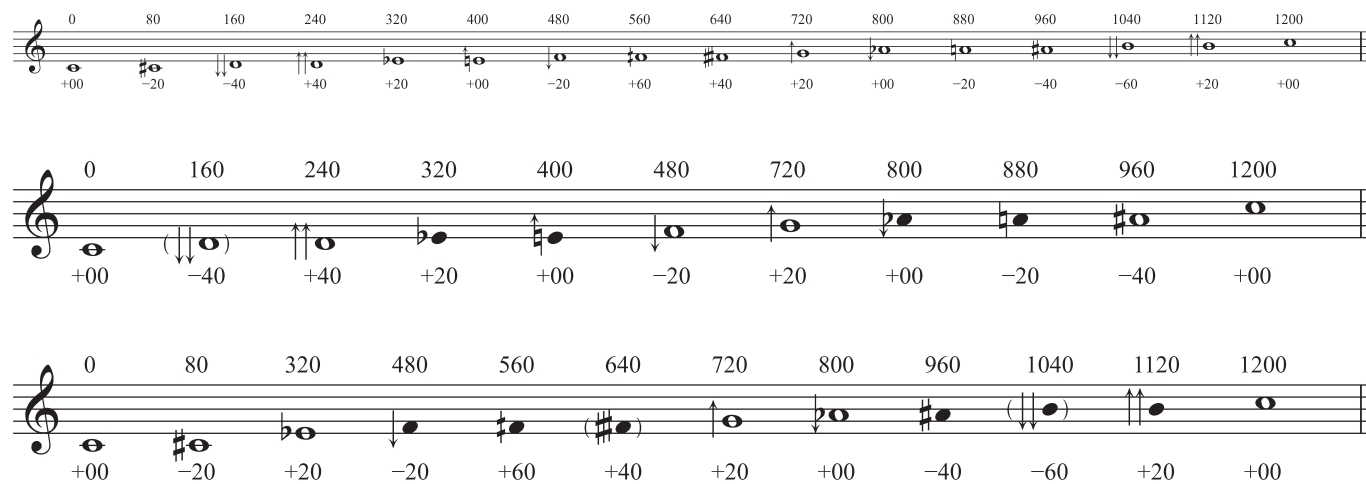
13-tone equal temperament



14-tone equal temperament



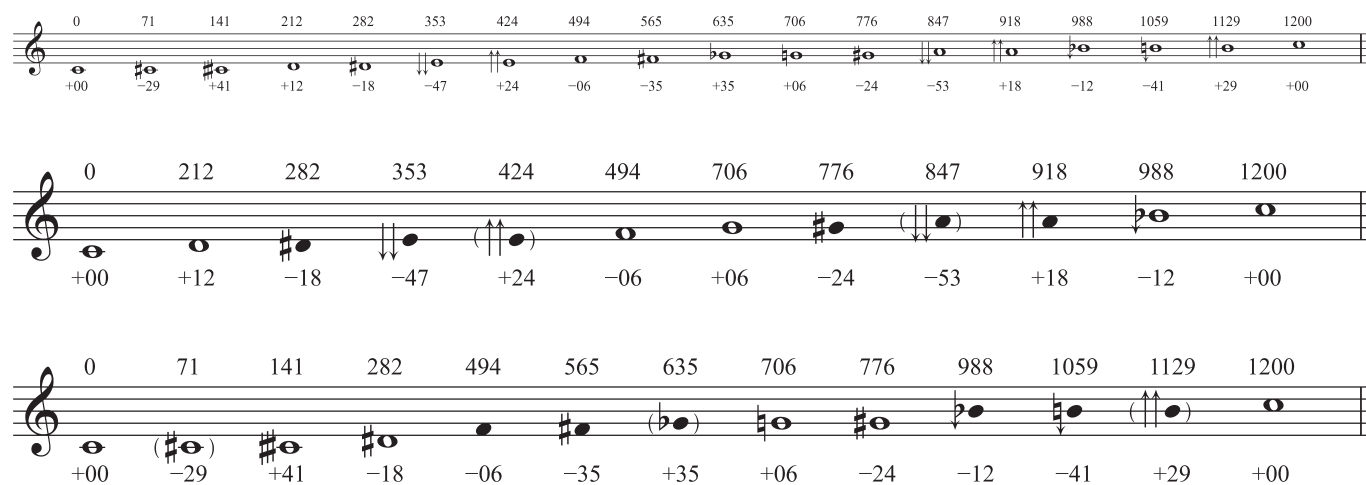
15-tone equal temperament



16-tone equal temperament



17-tone equal temperament



18-tone equal temperament



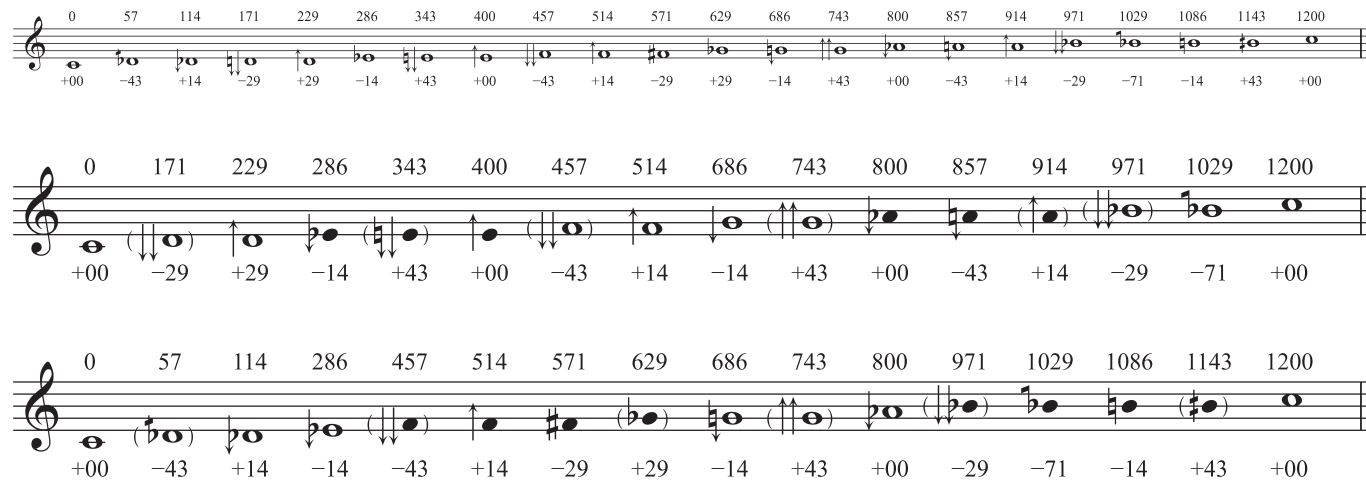
19-tone equal temperament



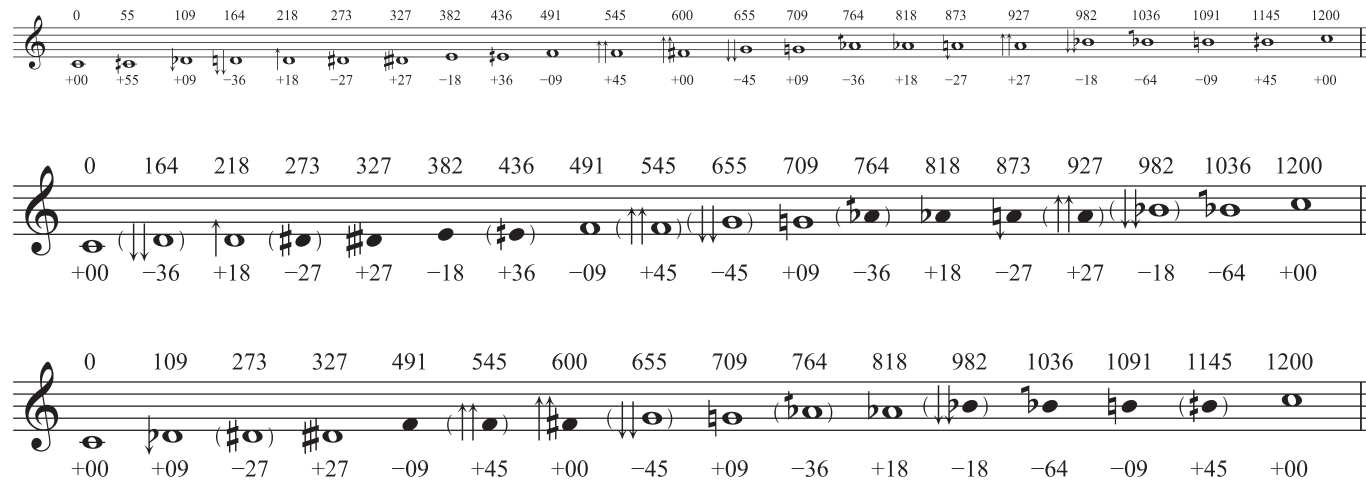
20-tone equal temperament



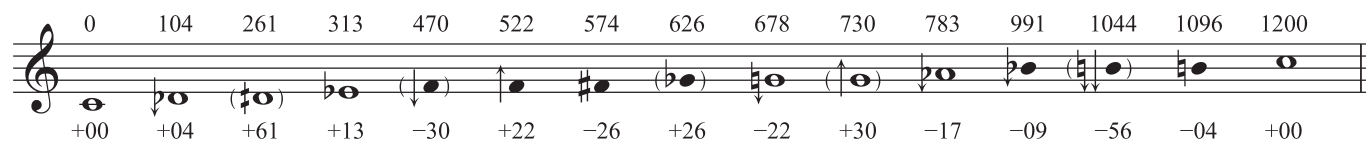
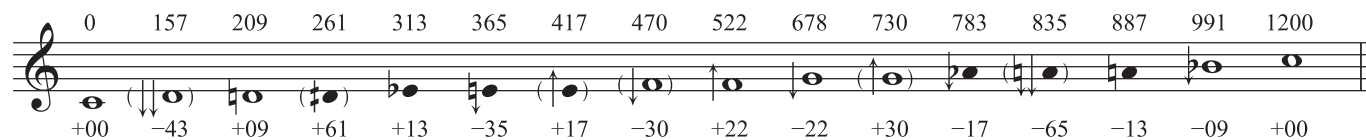
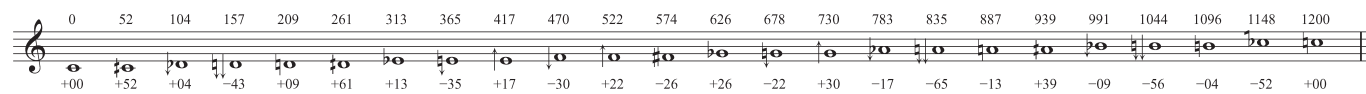
21-tone equal temperament



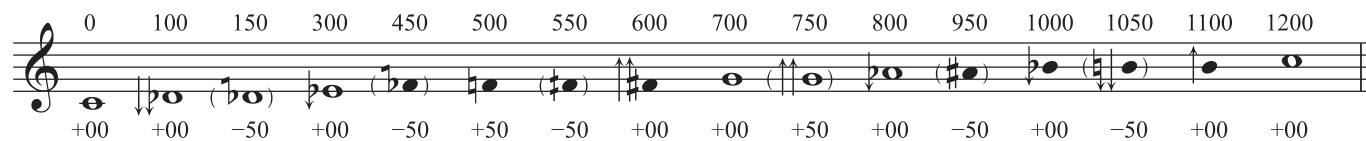
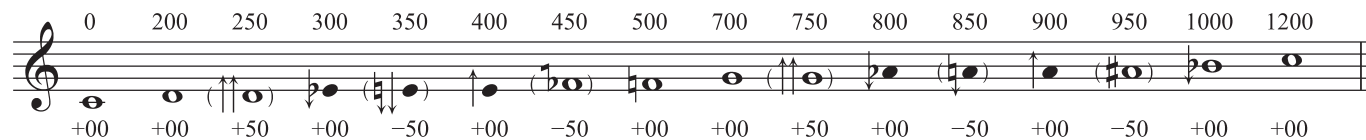
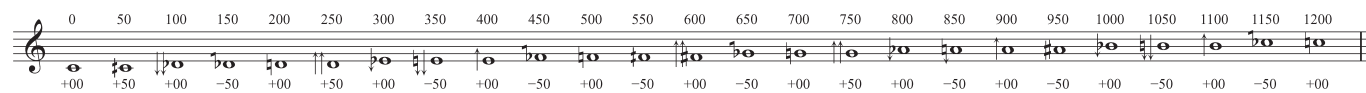
22-tone equal temperament



23-tone equal temperament



24-tone equal temperament



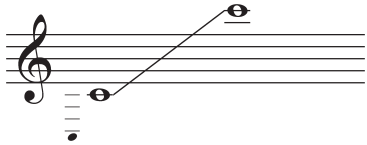
Polyrhythm 1-16 Set

1-et	3:2	(2:3)						
2-et	5:2	(2:5)						
3-et	4:3	(3:4)						
4-et	5:3	(3:5)						
5-et	7:2	(2:7)	5:4	(4:5)				
6-et	7:3	(3:7)	9:2	(2:9)				
7-et	8:3	(3:8)	7:4	(4:7)				
8-et	6:5	(5:6)	7:5	(5:7)				
9-et	11:2	(2:11)	10:3	(3:10)	9:4	(4:9)		
10-et	8:5	(5:8)	7:6	(6:7)	11:3	(3:11)		
11-et	9:5	(5:9)	13:2	(2:13)	11:4	(4:11)		
12-et	8:7	(7:8)	13:3	(3:13)	11:5	(5:11)		
13-et	9:7	(7:9)	15:2	(2:15)	14:3	(3:14)	13:4	(4:13)
14-et	12:5	(5:12)	11:6	(6:11)	10:7	(7:10)	9:8	(8:9)
15-et	13:5	(5:13)	11:7	(7:11)	15:4	(4:15)	14:5	(5:14)
16-et	13:6	(6:13)	12:7	(7:12)	11:8	(8:11)	10:9	(9:10)
17-et	13:7	(7:13)	11:9	(9:11)	13:8	(8:13)		
18-et	11:10	(10:11)	15:7	(7:15)	13:9	(9:13)		
19-et	15:8	(8:15)	14:9	(9:14)	13:10	(10:13)		
20-et	12:11	(11:12)	13:11	(11:13)				
21-et	14:11	(11:14)	13:12	(12:13)				
22-et	15:11	(11:15)	14:13	(13:14)				
23-et	15:13	(13:15)						
24-et	15:14	(14:15)						

INSTRUMENTATION

PLAYER 1

Sampled Microtonal Schoenhut Toy Piano (Akai S3000XL Midi Stereo Digital Sampler)



Schoenhut Traditional Spinet (Model 6625, 25-key)



Piano features:

25-key two-octave designer spinet

Age range: 3 and up

Chromatically tuned with lovely chime like notes produced by little hammers striking precision ground, German steel music rods

Play-by-colour teaching method makes playing simple and fun

Removable colour strip fits behind the keys to guide small fingers from chord to chord

Helps to build your child's confidence and develop basic playing skills

Comes with a songbook which contains a collection of familiar tunes

Available in mahogany, white, or red finish

Dimensions: 19 $\frac{3}{4}$ " high $\times$ 10 $\frac{1}{4}$ " deep $\times$ 17" wide

Matching bench: 9 $\frac{1}{4}$ " high $\times$ 6" deep $\times$ 10" wide

Weights 17 lbs

PERFORMANCE NOTES

In this score, accidentals apply throughout the bar.

The notation utilized in the score is based on Alain Daniélou's 'Scale of Proportions' (The Harmonic Division of the Octave). It contains 23 unique symbols – 3 identical to conventional sharp (#), flat (b), and natural (♮) accidentals (raising, lowering or neutralizing a tone by 25/24, or 70.672 cents), with an additional 4 derived from standard quarter-tone notation in twentieth century contemporary music practice; the latter representative of the division of the 'unequal' major half-tone, or just diatonic semitone (16/15), and not of the 'equal' quarter-tone (1:1.029302237, or 50.000 cents) derived from twenty-four-tone equal temperament ($\sqrt[24]{2}$). The quarter-tone symbols include (♯) and (♭), raising or lowering a tone by 31/30 (Greek enharmonic or septimal quarter-tone), or 56.767 cents; and (♯) and (♭), raising or lowering a tone by 135/124 (three-quarter-tone), or 147.143 cents. Additional symbols include (↑, ♮, ♯, ♭) and (↓, ♮, ♯, ♭), raising or lowering an unaltered, naturalized, sharpened, or flattened tone by 81/80 (one syntonic comma), or 21.506 cents; and (↑↑, ↑♮, ↑♯, ↑♭) and (↓↓, ↓♮, ↓♯, ↓♭), raising or lowering an unaltered, naturalized, sharpened, or flattened tone by 128/125 (approximately two syntonic commas, or one great diesis), or 41.059 cents.

↑	raised by one comma (81/80, or 21.506 cents)
↑↑	raised by approximately two commas, or one great diesis (128/125, or 41.059 cents)
♮↑	natural raised by one comma (81/80, or 21.506 cents)
♮↑↑	natural raised by approximately two commas, or one great diesis (128/125, or 41.059 cents)
♯	raised by one Greek enharmonic or septimal quarter-tone (31/30, or 56.767 cents)
♯	raised by one small just chromatic semitone, or sharp (25/24, or 70.672 cents)
♯↑	sharp raised by one comma (81/80, or 21.506 cents)



sharp raised by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



sharp lowered by one comma ($81/80$, or 21.506 cents)



sharp lowered by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



raised by one three-quarter-tone ($135/124$, or 147.143 cents)



raised or lowered to natural tone



lowered by one comma ($81/80$, or 21.506 cents)



lowered by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



natural lowered by one comma ($81/80$, or 21.506 cents)



natural lowered by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



lowered by one Greek enharmonic or septimal quarter-tone ($31/30$, or 56.767 cents)



lowered by one small just chromatic semitone, or flat ($25/24$, or 70.672 cents)



flat lowered by one comma ($81/80$, or 21.506 cents)



flat lowered by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



flat raised by one comma ($81/80$, or 21.506 cents)



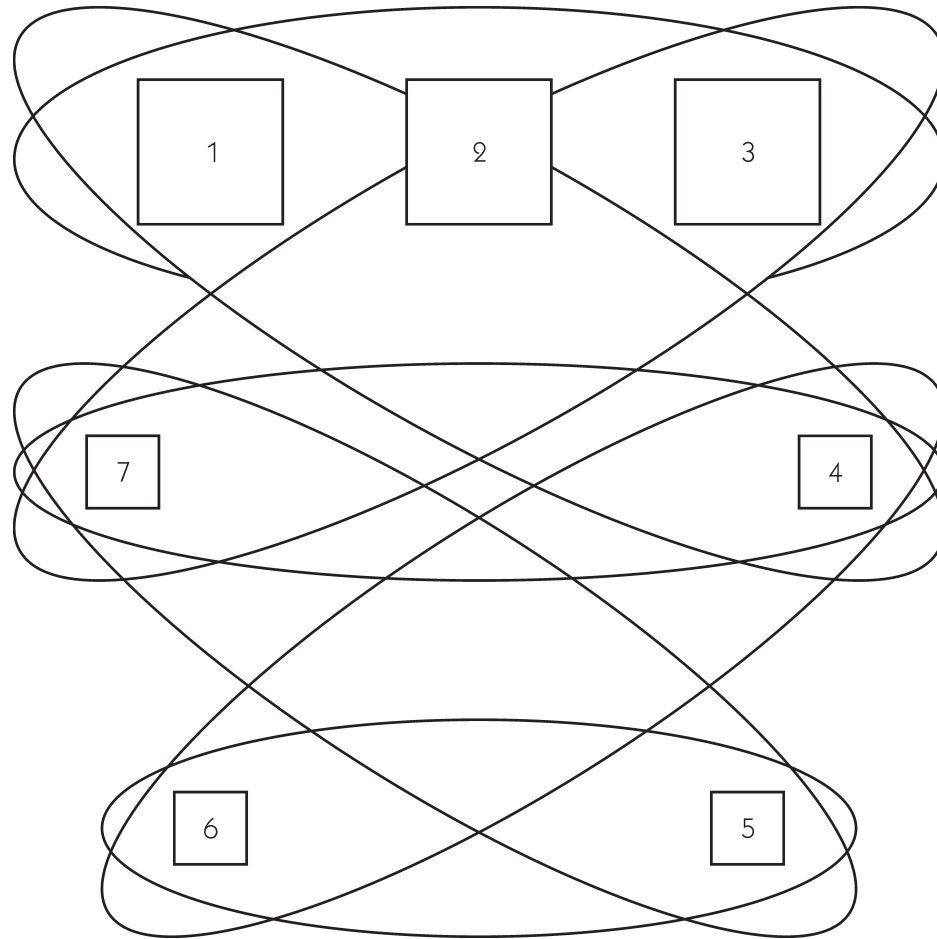
flat raised by approximately two commas, or one great diesis ($128/125$, or 41.059 cents)



lowered by one three-quarter-tone ($135/124$, or 147.143 cents)

Sound Diffusion Matrix

Razzo Recital Hall, Clark University, Department of Visual and Performing Arts
Worcester, MA, USA



The optimum method of performance for 'Exposiciones' for Sampled Microtonal Schoenhut Toy Piano is 7-channel sound diffusion, with a scheme designed around the speaker system available in the performance space of the Razzo Recital Hall at Clark University, Department of Visual and Performing Arts, in Worcester, MA, USA, although the work may be performed utilizing a simple two-channel system (CD player).

The system incorporates seven EAW speakers in various dimensions: three on-stage large soffit-mounted speakers (left front = 1, centre front = 2, right front = 3); plus four other smaller 'left and right side sets' soffit-mounted speakers (right side = 4, left side = 7); as well as left and right rear sets (left rear = 6, right rear = 5).

Sound diffusion organized in such a manner as to sonically delineate the various elements of the toy piano samples: toy piano (1 = 75.0%, 3 = 100.0%, 4 = 12.5%, 7 = 50.0%); key clicks (1 = 100.0%, 3 = 75.0%, 4 = 50.0%, 7 = 12.5%); gong (2 = 100.0%); downbeat counter (4 = 50.0%, 5 = 100.0%, 6 = 100.0%, 7 = 50.0%); and upbeat counter (1 = 50.0%, 3 = 50.0%, 4 = 100.0%, 5 = 50.0%, 6 = 50.0%, 7 = 100.0%).

Alain Daniélou's Scale of Proportions (The Harmonic Division of the Octave)

Relative Pitch: A₄ = 440Hz / C₄ (middle C) = 261.6255654Hz

DEGREE NUMBER	NOTE	INTERVAL	RATIO (FRACTION)	RATIO (DECIMAL)	FREQUENCY (HERTZ)	CENTS	TUNING
01	C	unison	1/1	1.000000	261.626	0.000	+00
02	C↑	syntonic comma	81/80	1.012500	264.896	21.506	+22
03	C↑↑	great diesis	128/125	1.024000	267.905	41.059	+41
	C♯ / D♭	Greek enharmonic or septimal quarter-tone	31/30	1.033333	270.346	56.767	+57
04	C♯	grave or small just chromatic semitone, or minor half-tone	25/24	1.041667	272.527	70.672	−29
05	D↓♭	Pythagorean limma	256/243	1.053498	275.622	90.225	−10
06	D♭	just diatonic semitone, or major half-tone	16/15	1.066667	279.067	111.731	+12
07	D♭	great limma, acute or large half-tone	27/25	1.080000	282.556	133.238	+33
	C♯♯ / D♭♭	three-quarter-tone	135/124	1.088710	284.834	147.143	+47
08	D↓↓	grave or small tone	800/729	1.097394	287.106	160.897	−39
09	D↓	just minor tone	10/9	1.111111	290.695	182.404	−18
10	D	just major tone (9th harmonic)	9/8	1.125000	294.329	203.910	+04
11	D↑	acute or large tone	256/225	1.137778	297.672	223.463	+23
12	D↑↑	supermajor second	59049/51300	1.151053	301.145	243.545	+44
	D♯ / E♭	five quarter-tones	93/80	1.162500	304.140	260.677	+61
13	D♯	augmented second (75th harmonic)	75/64	1.171875	306.592	274.582	−25
14	E♭	Pythagorean minor third, or trihemitone	32/27	1.185185	310.075	294.135	−06
15	E♭	just minor third	6/5	1.200000	313.951	315.641	+16
	D♯♯ / E♭♭	seven quarter-tones	75/62	1.209677	316.483	329.547	+30
16	E↓↓	neutral third	8000/6561	1.219326	319.007	343.301	−57
17	E↓	grave or small major third	100/81	1.234568	322.995	364.807	−35
18	E	just major third (5th harmonic)	5/4	1.250000	327.032	386.314	−14
19	E↑	Pythagorean major third, or ditone (81st harmonic)	81/64	1.265625	331.120	407.820	+08
20	E↑↑	acute or large major third	32/25	1.280000	334.881	427.373	+27
	E♯ / F♭	nine quarter-tones	31/24	1.291667	337.933	443.081	+43
21	F↓↓	subfourth	125/96	1.302083	340.658	456.986	−43
22	F↓	grave or small fourth	320/243	1.316872	344.527	476.539	−23
23	F	just and Pythagorean perfect fourth	4/3	1.333333	348.834	498.045	−02
24	F↑	acute or large fourth	27/20	1.350000	353.195	519.551	+20
25	F↑↑	superfourth	512/375	1.365333	357.206	539.104	+39
	F♯ / G♭	eleven quarter-tones	62/45	1.377778	360.462	554.812	+55
26	F♯	grave or small augmented fourth	25/18	1.388889	363.369	568.717	−31

DEGREE NUMBER	NOTE	INTERVAL	RATIO (FRACTION)	RATIO (DECIMAL)	FREQUENCY (HERTZ)	CENTS	TUNING
27	F $\sharp$	just tritone, or augmented fourth (45th harmonic)	45/32	1.406250	367.911	590.224	−10
28	F $\sharp$	acute or large tritone, or augmented fourth	64/45	1.422222	372.090	609.776	+10
29	G $\flat$	acute or large diminished fifth	36/25	1.440000	376.741	631.283	+31
	F $\sharp$ / G $\flat$	thirteen quarter-tones	90/62	1.451613	379.779	645.188	+45
30	G $\downarrow$	subfifth	375/256	1.464844	383.241	660.896	−39
31	G $\downarrow$	grave or small fifth	40/27	1.481481	387.593	680.449	−20
32	G	just and Pythagorean perfect fifth (3rd harmonic)	3/2	1.500000	392.438	701.955	+02
33	G $\uparrow$	acute or large fifth	243/160	1.518750	397.344	723.014	+23
34	G $\uparrow$	superfifth	192/125	1.536000	401.857	743.014	+43
	G $\sharp$ / A $\flat$	fifteen quarter-tones	31/20	1.550000	405.520	758.722	+59
35	G $\sharp$	augmented fifth (25th harmonic)	25/16	1.562500	408.790	772.627	−27
36	A $\flat$	Pythagorean minor sixth	128/81	1.580247	413.433	792.180	−08
37	A $\flat$	just minor sixth	8/5	1.600000	418.601	813.686	+14
	G $\sharp$ / A $\flat$	seventeen quarter-tones	50/31	1.612903	421.977	827.592	+28
38	A $\downarrow$	neutral sixth	81/50	1.620000	423.833	835.193	−75
39	A $\downarrow$	grave or small major sixth	400/243	1.646091	430.659	862.852	−37
40	A	just major sixth	5/3	1.666667	436.043	884.359	−16
41	A $\uparrow$	Pythagorean major sixth (27th harmonic)	27/16	1.687500	441.493	905.865	+06
42	A $\uparrow$	acute or large major sixth	128/75	1.706667	446.508	925.418	+25
	A $\sharp$ / B $\flat$	nineteen quarter-tones	31/18	1.722222	450.577	941.126	+41
43	A $\sharp$	augmented sixth	125/72	1.736111	454.211	955.031	−45
44	B $\downarrow$	grave or small minor seventh	225/128	1.757813	459.889	976.537	−23
45	B $\downarrow$	Pythagorean minor seventh	16/9	1.777778	465.112	996.090	−04
46	B $\downarrow$	acute or large minor seventh	9/5	1.800000	470.926	1017.596	+18
	A $\sharp$ / B $\flat$	twenty-one quarter-tones (29th harmonic)	29/16	1.812500	474.196	1029.577	+30
47	B $\downarrow$	neutral seventh	4000/2187	1.828989	478.510	1045.256	−55
48	B $\downarrow$	grave or small major seventh	50/27	1.851852	484.492	1066.762	−33
49	B	just diatonic major seventh (15th harmonic)	15/8	1.875000	490.548	1088.269	−12
50	B $\uparrow$	Pythagorean major seventh	243/128	1.898438	496.680	1109.775	+10
51	B $\uparrow$	acute or large major seventh	48/25	1.920000	502.321	1129.328	+29
	B $\sharp$ / C $\flat$	twenty-three quarter-tones	60/31	1.935484	506.372	1143.233	+43
52	C $\downarrow$	suboctave (125th harmonic)	125/64	1.953125	510.987	1158.941	−41
53	C $\downarrow$	grave or small octave	160/81	1.975309	516.791	1178.494	−22
01	C	octave	2/1	2.000000	523.251	1200.000	+00

Hommage à Frank Zappa (1940-1993)

Exposiciones

for Sampled Microtonal Schoenhut Toy Piano

Andrián Pertout, No. 392

2005

Moderato ♩ = 60

I 1-tone equal temperament

II 2-tone equal temperament

III 3-tone equal temperament

IV 4-tone equal temperament

V 5-tone equal temperament

Toy Piano

p *espressivo*

p *sempre*

mf

pp

p

mp

p

f

p (sub)

11

2+3+2 2♩:7♩ ♩ = ♩

3:2♩ 7♩:2♩ *f*

5:4♩ 3+2 4:5♩ ♩ = ♩

p *f* *p*

VI 6-tone equal temperament

14

7♩:3♩ ♩ = ♩

2+3+2 3♩:7♩

sostenuto

16

9♩:2♩ 2♩:9♩ VII 7-tone equal temperament

8♩:3♩ ♩ = ♩

cresc. *f* *p (sub)*

19

3:8

7:4

2+3+2

4:7

f

p (sub)

22

VIII 8-tone equal temperament

6:5

5:6

3+2

7:5

4:3

25

IX 9-tone equal temperament

3+4

5:7

11:2

6+5

2:11

3:2

5:3

2:7

3:4

4:3

4:3

28 $10\flat:3\flat$ sfz *sostenuto* p (sub) mf

31 $4\flat:9\flat$ f p (sub) *sostenuto* mf

33 $5:8\flat$ mp (sub) $7:6\flat$ $4:3\flat$ $6:4\flat$ $6:4\flat$ $3+4$ $6:7\flat$ mf

X 10-tone equal temperament

5+5 $3\flat:10\flat$ $9\flat:4\flat$ $3:2\flat$ $8:5\flat$ $9:7\flat$

28 10 8 4 9 16

31 9 16 8 16

33 8 16 7 16 8 16

36 $11\text{:}3$ $6+5$ $3\text{:}11$ $3+2$ **XI** 11-tone equal temperament $9\text{:}5$

f *mp* *pp* *mf* *p* (sub)

39 $5\text{:}9$ $3\text{:}5$ $5\text{:}4$ $5\text{:}4$ $5\text{:}4$ $5\text{:}4$ $13\text{:}2$ $5+8$ $2\text{:}13$

mf *mp* *mf* *mp* (sub)

42 $11\text{:}4$ $6+5$ $4\text{:}11$

mf *mp*

2+3+2
XII 12-tone equal temperament

44 $8:7$ $7:8$

mf $3:2$ *mp* (sub) $6:4$

46 $13:3$ $8+5$ $3:13$ $3+2$ $11:5$

p $3:2$ $3:2$ $3:2$

49 $6+5$ $5:11$ $5:4$ $6:4$ $7:4$ $2+3+2$
XIII 13-tone equal temperament

mf $9:7$ *f* *p* (sub)

51

7:9

5:6

3:2

15:2

5+5+5

2:15

5:4

pp

p

54

14:3

3:14

13:4

cresc.

57

8+5

4:13

12:5

5:12

mf

p

mp

XIV 14-tone equal temperament

60

11:6

6+5

6:11

2+3+2

10:7

mf

63

5+5

7:10

9:8

8:9

p

66

3+2

XV 15-tone equal temperament

13:5

8+5

5:13

2+3+2

11:7

mf

p (sub)

mp

p

69

6+5 7:11♩ mp p (sub) 15♩:4♩ mp 5+5+5 4♩:15♩

72

3+2 14♩:5♩ p 7+7 5♩:14♩ mp XVI 16-tone equal temperament 13♩:6♩

75

8+5 6♩:13♩ p (sub) 4+3 12:7♩ mp sostenuto mf 7:12♩ p

78 $11:8$ $6+5$ $8:11$ $10:9$

mp

81 $5+5$ $9:10$ $3:2$ $6:4$ $6:4$ $6:4$ $6:4$ $6:4$ $6:4$ $6:4$

p

2+3+2

XVII 17-tone equal temperament

82 $13:7$

mf *p* (sub)

83

8+5

7:13

mp

cresc.

84

11:9

mf

85

6+5

9:11

13:8

8+5

8:13

mp (sub)

mf mp (sub) mf

XVIII 18-tone equal temperament

5+5

11:10

4:3

6+5

10:11

2+3+2

15:7

5+5+5

7:15

13:9

8+5

9:13

XIX 19-tone equal temperament

15:8

8:5

5+5+5

8:15

14:9

p

This musical score consists of three systems, each with a treble and bass staff. The notation is highly complex, featuring numerous accidentals, ties, and dynamic markings.

System 1 (Measures 97-100):

- Measure 97: Treble staff has a $7+7$ and $9:14$ bracket. Bass staff has a mp marking.
- Measure 98: Treble staff has a $5+5$ and $13:10$ bracket.
- Measure 99: Treble staff has an $8+5$ and $10:13$ bracket.
- Measure 100: Treble staff has a $6+5$ and $12:11$ bracket. A box labeled **XX** contains the text "20-tone equal temperament".

System 2 (Measures 101-104):

- Measure 101: Treble staff has an $11:12$ bracket. Bass staff has a *cresc.* marking.
- Measure 102: Treble staff has a $6+5$ and $13:11$ bracket. Bass staff has a *mf* marking.
- Measure 103: Treble staff has an $8+5$ and $11:13$ bracket. Bass staff has a *mp (sub)* marking.
- Measure 104: Treble staff has a $12:11$ bracket.

The score includes various other markings such as *mp*, *mf*, *mp (sub)*, and *cresc.* throughout the systems.

6+5

XXI 21-tone equal temperament

104

14:11

mf

14

105

7+7

11:14

13:12

4:5

6:5

mp (sub)

12

13

18

107

8+5

12:13

11

6+5
XXII 22-tone equal temperament

108

15:11

15

109

5+5+5

11:15

13

mf

110

8+5

14:13

14

mp (sub)

The musical score consists of three measures, each with a piano and a right-hand part. Measure 108 is in 11/16 time, featuring a 6+5 ratio and a 15:11 interval. The piano part has a series of eighth notes, while the right hand has a series of chords. Measure 109 is in 13/16 time, featuring a 5+5+5 ratio and an 11:15 interval. The piano part has a series of eighth notes, while the right hand has a series of chords. Measure 110 is in 14/16 time, featuring an 8+5 ratio and a 14:13 interval. The piano part has a series of eighth notes, while the right hand has a series of chords. The score includes dynamics such as p, mf, and mp (sub), as well as articulation marks like accents and slurs.

111 $7+7$ $13:14$

112 $8+5$ XXIII 23-tone equal temperament $15:13$

113 $5+5+5$ $13:15$

(7+7) **XXIV** 24-tone equal temperament

114 mf mp (sub) $15:14$

115 p *cresc.* $15:14$ $15:14$

116 $5+5+5$ $14:15$ f

The musical score is for a piece titled 'XXIV 24-tone equal temperament' in a 7+7 meter. It consists of three systems of music, measures 114, 115, and 116. Measure 114 is in 7/8 time, marked mf and mp (sub), with a $15:14$ ratio indicated. Measure 115 is in 7/8 time, marked p and *cresc.*, with a $15:14$ ratio indicated. Measure 116 is in 15/32 time, marked f , with a $5+5+5$ meter and a $14:15$ ratio indicated. The score features complex rhythmic patterns, including triplets and sixteenth notes, and a variety of dynamic markings.

