Johanna Catriona Devaney

REALIZING TEMPERAMENTS:

THE RECREATION OF HISTORICAL TUNING SYSTEMS WITH COMMERCIAL SOFTWARE

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Johanna Devaney
Department of Music, York University, Toronto Canada

ABSTRACT

This paper explores the research and pedagogical value of digital recreations of historic temperaments using software samplers and sequencers.

INTRODUCTION

So entrenched is equal temperament in our musical culture that many people, musicians and otherwise, are ignorant of the vast number of historic temperaments – not to mention unique contemporary microtonal systems.[i] In particular, the Renaissance and early Baroque periods offer a rich array of temperaments. The dominance of equal temperament subsequent to these periods has all but obliterated the understanding of these systems in contemporary musical culture. The popularity of the piano in the past few hundred years has been perhaps the major factor in cultivating this situation. The success of equal temperament can be attributed to the fact that it is a compromise that allows modulation to all keys while also allowing the piano to play "in tune" in all keys. The irony here is that vocalist and instrumentalists on non-fixed intonation instruments spend as much of their time, at least when not playing with fixed intonation instruments, playing in some form of pure intonation as they did hundreds of years ago. In this age of computer music musicians are finally able to work with non-fixed temperament comfortably and effectively.[ii] Computers allow us not only to explore the aural world of historical tuning but also to educate listeners. This can be achieved through commercially available software.

My experience in this area is two fold. My own research has centered on Nicola

Vicentino and his 31-tone modified mean-tone system. Pedagogically I explored the potential of digital recreations while planning and teaching the *Introduction to Temperament, Alternate Tunings and Microtonal Tuning Systems Using Computers and Synthesizers* course at York University's music department.

OVERVIEW OF RENAISSANCE TUNING SYSTEMS

For ease of classification I have focused on renaissance tuning systems that can be defined as a version or a modification of Just Intonation or Meantone. The equal-tempered system with which we are all familiar was a development of the late Baroque era and comma tuning systems. Just Intonation systems are essentially pure systems with a prime-number limit on which ratios can be used. Thus five limit Just uses only those ratios found in the harmonic series which contain primes of five or less, seven-limit consists of ratios using only primes of seven or less, and so on. Meantone intonation is a precursor to comma tunings, it utilises the first two major seconds which occur in the harmonic series (9/8 and 10/9) and works with the difference between the two to generate a cohesive twelve tone temperament. More comprehensive definitions of these systems are widely available online and in print.

The issue with both Just and Meantone is that traditional keyboard applications are impossible if one wishes to be able to play in all of the keys – these systems are only feasible for instruments with flexible intonation or keyboards playing in a limited number of keys. Thus these systems provided a partial solution for the intonation issues that arose when vocalists, string and wind/brass players, who gravitate towards pure intonation, performed with fixed-intonation keyboards.

Nicola Vicentino was a sixteenth century northern Italian theorist and composer. His treatise *Antica musica ridotta alla moderna prattica* (*Ancient music adapted to modern practice*) described his 31-tone tuning system and 36-tone keyboard, the *archicembalo*.[iii] A bit of a black sheep, despite studying with Adrian Willaert in Venice, he was unable to secure a position there and moved to Ferrara and later to Rome. Vicentino was concerned with observing the natural tendencies of singers to adjust their intonation depending on the function of the note. From these studies and his knowledge of ancient Greek genera he developed a 31-tone system based on a modified mean-tone. His theoretical work provides an interesting

counterpoint to another student of Willaert, Gioseffe Zarlino who was a key figure in the development of Just Intonation. Vicentino's *archicembalo* was a physical realization of this system plus five additional pitches offset by a comma from the original pitches. This keyboard was designed as a pedagogical tool for improving singers' intonation.

PROBLEMATIQUE

A physical recreation of an instrument like the *archicembalo* would be prohibitively expensive for research purposes; naturally a digital recreation is an appealing cost-efficient alternative. The ease of intonation adjustments in a digital system provides a second motivating factor. Initially there were numerous routes for a digital recreation but closer examination of a number of the alternatives quickly ruled them out. The pitch bend available through MIDI though an option, would be unnecessarily cumbersome. Likewise the mapping of pre-tuned samples to a single keyboard map, while theoretically possible, was far too unintuitive to work with as single octave would have to be stretched over three octaves on the keyboard. The fine-tuning features on some synthesizers, particularly Roland's JV-2080, were viable options but not practicable for use with a keyboard controller, nor feasible for a classroom. The most elegant solution for a non-real-time realization, though admittedly still time consuming and impractical for use with a keyboard controller, was the use of a software sequencer and sampler.

METHODOLOGY

My initials realizations were done using Steinberg's *Cubase* and Digidesign's *SampleCell*, for classroom use I imported the *SampleCell* patches into Bitzhead's *Unity DS-1*. The process of creation was quite simple – first discrete samples for each pitch were created and four copies of each were made, then they were assigned to four separate keyboard mappings and individually detuned according to Vicentino's system with each mapping assigned to its own channel.

0 F	100 F#	200 G	300 G#	400 A	500 A#	600 B	700 C	800 C#	900 D	1000 D#	1100 E	1200 F
		232							929			
		213	348	426	542	619		813	910	1045	1123	
39	116	194	310	407	503	600	697	774	890	1006	1103	
0	78	155	271	387	464	581	658	735	852	968	1084	1161

Figure 1: First Tuning of System of Nicola Vicentino's *Archicembalo*[iv]

The four-part madrigal was sequenced with Cubase, each note was assigning the channel appropriate. Vicentino's notation was very clear in terms of which version of the pitches be used through the use of periods and commas.

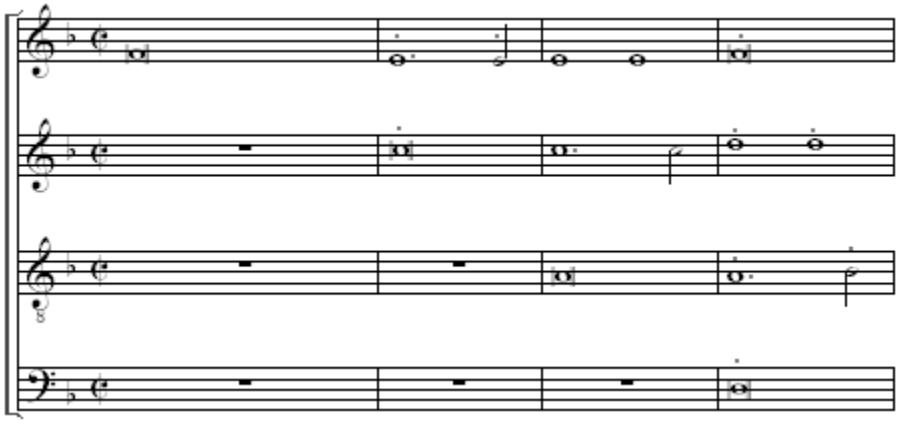

Figure 2: Enharmonic Madrigal for Four Voices[v]

For the purposes of comparison I also created an equal tempered mapping with the sample set.

The system was also used in the classroom to recreate altered twelve-tone scales. This was achieved quite simply with a single keyboard mapping of discrete samples and the same process of detuning the samples. The students were required to first calculate the cent deviations for each pitch and detune the samples accordingly. Ultimately this process provided greater pedagogical value than using synths with pre-programmed altered scales.

RESULTS

The aural results of the Vicentino recreations were quite remarkable. Although they initially seemed a little "out of tune" to ears accustomed to equal temperament, the logic and beauty of the system became apparent after a few repetitions. Objectively the system provided a valuable pedagogical resource as, in addition to allowing the recreation of complex systems, it enabled the students to explore the details of altered twelve-tone systems.

CONCLUSIONS

The primary issue surrounding this approach was the amount of time it took to create and map the discrete samples, and to assign each note a separate channel. A secondary issue is its limitations for recreating systems beyond twelve tones – while it is feasible it is no longer an intuitive interface. It is also not practical for systems that are not based on the seven diatonic pitches, such as equal divisions of the octave other than twelve. What this approach does offer is both ease of expandability and use, and., because it used around a scale based interface, it facilitates a more intuitive interaction than is working directly with frequency.

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[i] See Barbour, J. Murray *Tuning and Temperament: A Historical Survey*. East Lansing: Michgan State College Press, 1953 and Lloyd, L.S. and H. Boyle. *Intervals, Scales and Temperaments*. New York: St. Martins Press. 1979 for a more detailed discussion.

[ii] For a detailed survey of recreations with synthesizers see Wilkinson, Scott R. *Tuning In: Microtonality in Electronic Music.* Hal Leonard Books, 1988.

[iii] Vicentino, Nicola, 1576. *Antica musica ridotta alla moderna prattica.* English *Ancient music adapted to modern practice* translated with introduction and notes by Maria Rike Maniates; edited by Claude V. Palisica. New Haven: Yale University Press, 1996

[iv] Data obtained from "Appendix VII: Table of Cents Values for the First Tuning System of the Archichembalo" Vicentino, 452-3.

[v] Vicentino, 209