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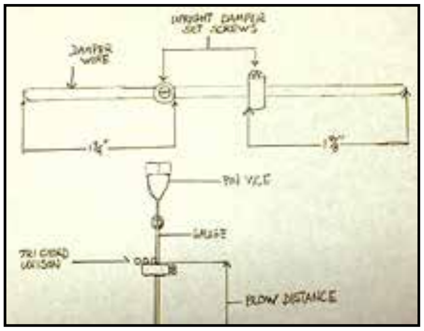


Unison Drift

By Mark Cerisano, RPT
Monteal QB Chapter

Preface

I have never found tuning to be easy. It took me two years to be able to hear the beating of a major third. Ever since starting to tune pianos, I have been fascinated by how difficult it is to tune equal temperament. I define it as progressively beating intervals within a beatless octave. (I defined a beatless octave in my June 2015 Journal article on equal temperament.)

In the June article I also defined a sequence that should produce accurate equal temperament; at least it does on paper. However, in trying to tune a temperament in one pass without refining at the end, I had been stumped. I would tune what my ears would tell me were beat speeds that bisected the beat speed windows that were being set up by the piano, and therefore should produce intervals that were progressive. However, when I finished, there were intervals that were not progressive.

This had me confused. I knew there was some drift due to adding unison strings together because of what I had read from Virgil Smith and Professor Gabriel Weinreich, and from what I had observed in my own tunings. But it appeared to me that something else must be going on.

That's when I started noticing that although I was tuning out Weinreich drift by judging the double-string unison before moving on, I was assuming there was no Weinreich drift between a double-string unison and a trichord.

I started measuring.

It turns out that the pitch of a trichord can change, up or down, when you add the third string to an already tuned double-string unison.

Since I have started judging the entire trichord in my open unison tuning *before* moving on, my tunings have become more accurate and more efficient. Now I have less refinement to do to my temperament, and because of the beat speed window method, my tunings are more accurate and precise than they used to be. I used to have the feeling I was fumbling around a bit, guessing at things. Now I am more confident with my tunings, and when something doesn't fit and I have to guess what the problem may be, I have fewer unknowns.

I hope you have the same experience.

Introduction

This article discusses the final pitch of a trichord unison compared to the initial pitch of the single-string and double-string unisons.

I have been searching for a more efficient aural tuning method, and understanding unison drift has helped me choose better techniques that reduce the amount of refinement needed in an aural tuning. The result has been more accurate, precise, and efficient tunings.

In the December 1977 edition of *The Journal of the Acoustical Society of America*, Volume 62, Issue 6, Professor Gabriel Weinreich wrote an article entitled "Coupled Piano Strings." In that article he mentions the resulting change in the frequency of a single piano string when coupled and sounded with another string of the same frequency.

Some piano technicians are aware of this and refer to this effect of drifting unison pitch as the "Weinreich Effect" in reference to this article and Professor Weinreich. However, some technicians erroneously explain this effect as resulting in a drop in pitch only.

According to the research contained in this paper, which conforms with Professor Weinreich's findings, the final pitch of a trichord can be higher, lower, or the same as the initial pitch of the single string, and there is no way to predict which direction it will change, if at all.

I have also found that the final pitch can be as much as two cents sharp or flat. For any technician striving for more accurate tunings, this effect cannot be ignored.

Definitions

Single-string unison – One string.

Double-string unison – Two strings tuned at or close to the same frequency.

Open-unison tuning – Tuning a complete note (trichord or bichord) for the purpose of using that as a reference to tune other notes, before moving on to tune other notes.

Shimming or *Cracking the Unison* – Muting one string of a trichord and detuning the resultant double-string unison in a method that results in a very fine tuning of the trichord.

Method

The trichord strings of various pianos were measured. Recordings were taken of the left string, the middle string, the right string, the two left strings, the two right strings, and the complete trichord. The iPhone app iStroboSoft was used to measure the pitches. The cents offset was recorded compared to an arbitrary datum (zero).

Pitches were plotted on a graph that showed the three strings of the trichord vertically. There were four trichords drawn on the graph, each representing the same trichord but repeated to show different measurements. The first trichord shows each string's independent pitch. The second trichord shows the pitch of the left double-string unison. The third trichord shows the pitch of the right double-string unison.

The fourth trichord shows the final pitch of all three strings sounding together.

Some strings measured a steady pitch while others varied. Steady pitches were plotted as dots. Varying pitches were plotted as vertical lines. Double-string unison pitches were plotted between the strings. The word "Muted" indicates which string was muted during the recordings. Trichord pitches were plotted on the center string.

The findings of six different pianos and specific trichords are shown in the graphs.

Results

Some pianos' trichord final pitches seemed to stay fairly close to the initial pitches of the individual strings. This group includes the Weber grand and the Willis upright. These findings and their steady readings help us to rule out any measurement or method error.

The Wurlitzer spinet's trichord produced steady measurements, but the final trichord measured a full 1.5 cents lower than the initial string pitches.

The Kawai console produced steady pitches for each string, but the pitches of the left double-string and the trichord varied quite a bit. The left double-string unison varied 4.3 cents. The trichord's measured pitch varied by 4.4 cents and averaged 2.2 cents lower than the initial string pitches.

The Mason & Risch spinet had two strings with pitches that were steady and one that varied within 0.6 cents. The double-string unisons were close to the initial single-string pitches, but the trichord varied 1.5 cents and averaged 1.3 cents higher than the initial string pitches.

The Baldwin spinet had good steady string pitches. The left double-string was steady at 0.3 cents higher. The right double-string unison varied 1.5 cents, and the trichord varied 3.0 cents!

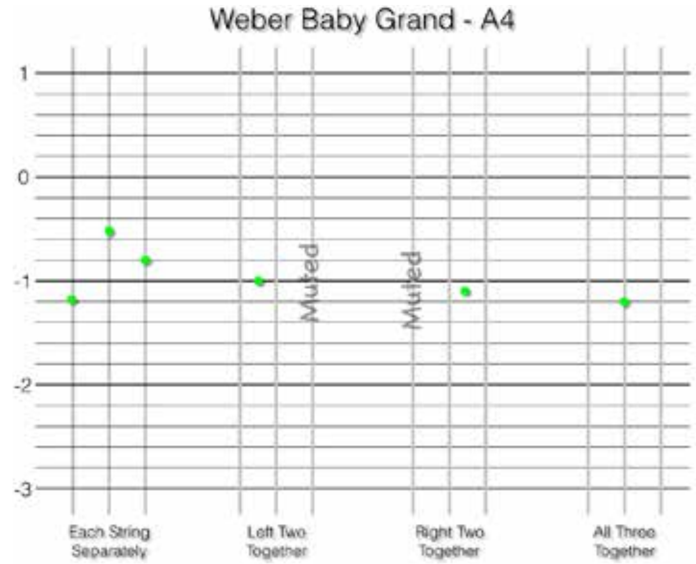
Conclusions

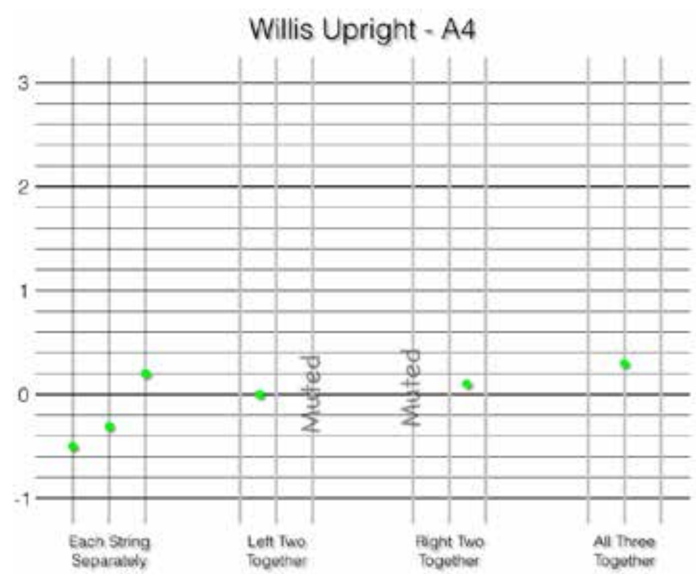
It is clear that the final pitch of a trichord or bichord cannot be assumed to be the same as the single string that we initially tuned. The final pitch may be the same, but may also be lower or higher, and there's no way to predict how it will change. Each note in a piano will drift in its own way.

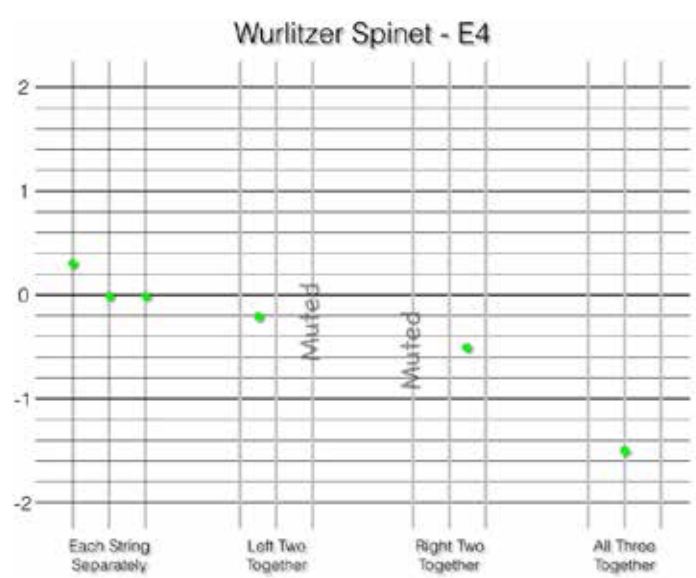
As well, the pitch spectrum of the final trichord may also be changed. The final trichord's pitch may vary up to 3.0 cents, even if the initial single-string pitches do not vary.

Recommendations

Tuning a piano is a difficult task. This research has shown that if we want to make it less difficult by being more efficient when we tune and by focusing our efforts on producing frequencies that are stable, we cannot trust the frequency of a single string. If we want to be as precise and efficient as possible and not have to retune every note that drifts due to Weinreich drift after we remove our mute strips, then we need to make our judgment of the acceptability of the pitch of a note based on the way it sounds as a fully tuned,







complete and pure bichord or trichord unison.

We may also need to choose a particular section of the note's sustain as a reference if the pitch appears to vary over time, which it may, even if the individual strings have steady pitches

Open-unison tuning techniques, where the entire unison is tuned completely before moving on, and where the fully tuned bichord or trichord unison is used as a reference to tune other notes, has the benefit of having had any Weinrich drift occur already; so, whether it occurs or not is a moot point. The pitch of the tuned open bichord or trichord unison will not change due to Weinreich drift because, if it occurs, it has already occurred and you will not have to retune that note later for that reason (Weinreich phenomenon).

Whether or not a tuner uses a mute strip, and even if an electronic tuning device is used, the pitch of the final open unison must be reassessed before moving on. This would seem to indicate that using a mute strip, even just for the temperament, may not be efficient if one is tuning only single strings first, then removing the mute strip, tuning all the strings, and expecting the pitches not to drift. A better, more efficient method may to be to tune each unison as an open unison, using wedge mutes, and then assessing the pitch of the fully tuned bichord or trichord unison before going on.

Also, if the pitch of the fully tuned bichord or trichord unison is found to be off, then the tuner must change the pitch without listening to how the single or double-string unison sounds, or without looking at the ETD screen. There is a method of changing the pitch of a pure trichord or bichord called shimming, or cracking the unison. This is my recommended technique for changing the pitch of a trichord or bichord. You do not check the sound of the incomplete bichord or trichord as you are tuning—you simply want it to change from where it was to a new slightly higher or lower pitch, as a complete bichord or trichord.

For ETD users, it may be more accurate to tune all the strings of a note first, and then try to get the lights to stop by moving the trichord or bichord using the shimming method discussed below.

Shimming Unison Method

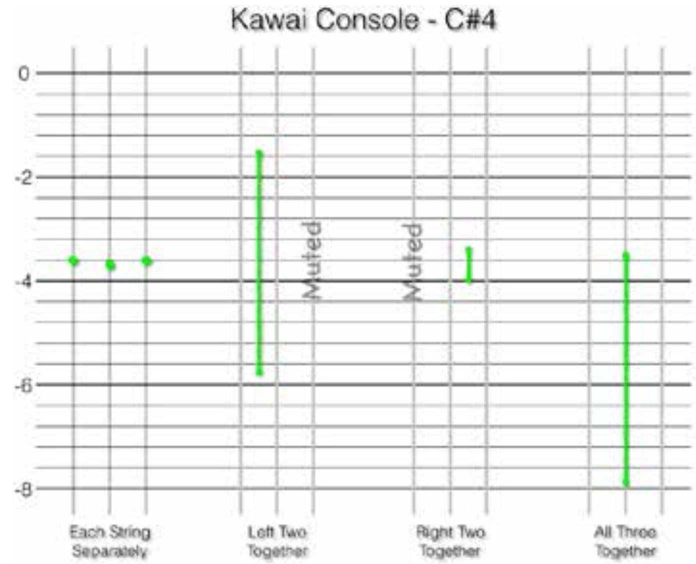
Use this method if you have a fully tuned bichord or trichord unison, and you need to raise it or lower it by the smallest amount. The resolution of this method can be as little as 0.3 cents.

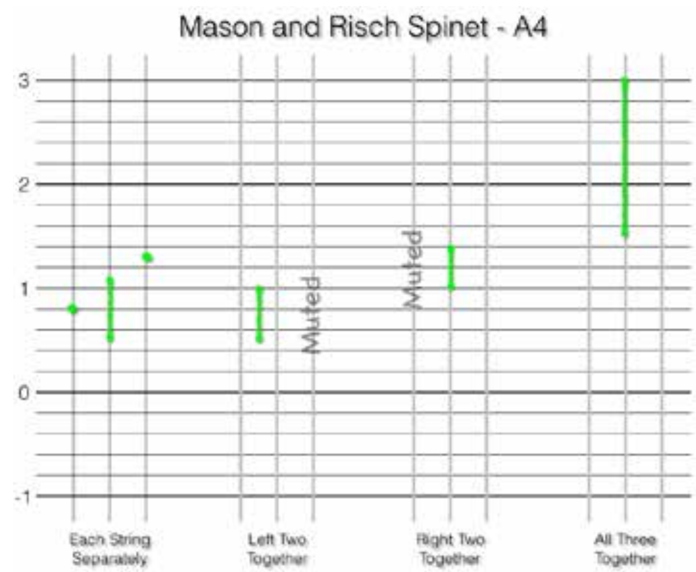
Let's assume we want to lower the pitch of a pure trichord.

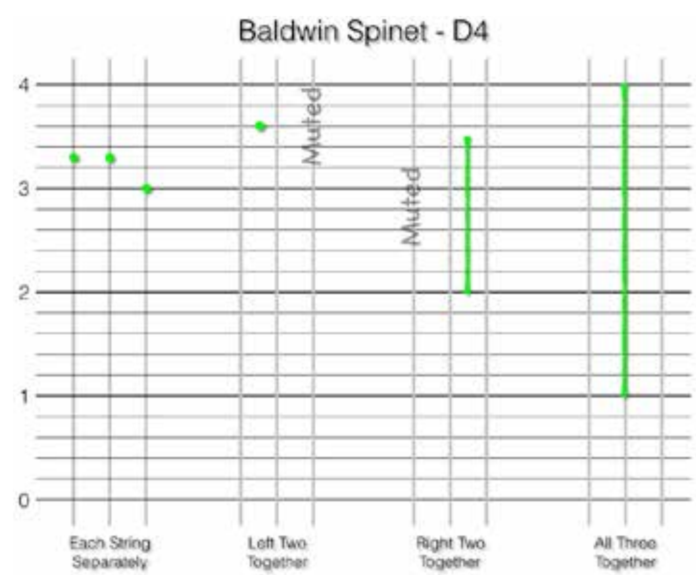
The result will be that the effective final pitch of the trichord has dropped by as little as 0.3 cents.

You may find that after moving the double-string unison, if you check it, it may sound wrong. Do not be fooled. Add the third string before making any judgment.

After adopting this style of tuning, you hopefully will find that you have less refining to do at the end of the temperament sequence or even the entire tuning. This should be expected, since you have eliminated the effect of Weinreich drift.







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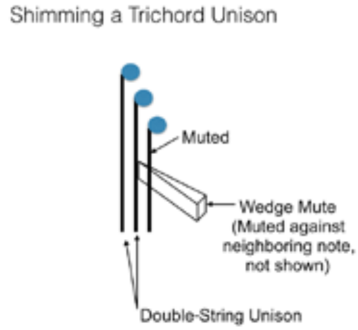


Unison shimming, step 1 – Mute off one string.

1. Mute one string. This produces a double-string unison composed of the other two strings that are still free to vibrate.

Step 2 – Detune the double-string unison in the direction you want it to go.

2. Detune the resultant double string unison by applying as little force as possible to one pin. Listen for the unison to change color. We do *not* want to create a beat in the unison, just change its color, or tone.

Step 3 – Retune the double-string unison pure by turning the other pin.

3. Apply a similar force to the other pin of the double string unison and make the double string unison pure again.

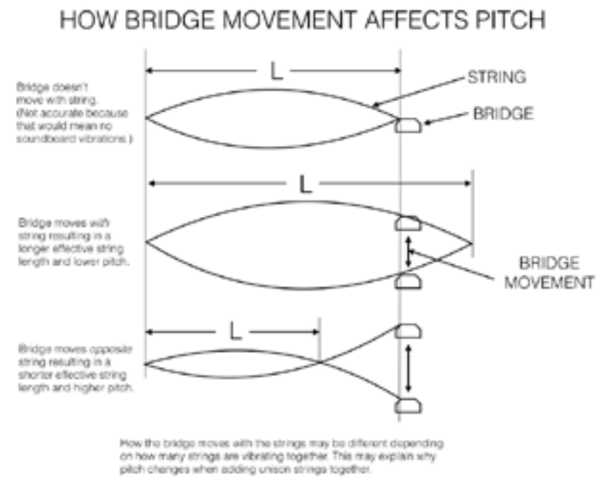
Step 4 – Remove the mute and tune the trichord pure.

4. Remove the mute. Apply a similar force to the third pin so that the fully tuned trichord is pure again.

Final Thoughts

The biggest problem in learning to tune pianos better is not the piano, not Weinrich drift, not tuning lever deformation, not stability or inharmonicity. I think it is our own arrogance. After careful and painful self-examination, I have seen too many periods in my career where I thought I had arrived because of something I had discovered. The problem with that attitude is that we stop looking and stop thinking about how to improve our tunings. And who wants to waste time trying to find a better way to do something when we believe our way is the best? How can one justify the time and energy to look for and learn new methods when there doesn't seem to be a need?

Possible Explanation of What is Happening



The answer is humility. My challenge is that you start looking at your own tunings as I did with mine. Measure them. Try to identify what assumptions you are making, then prove them wrong, and find better ways to tune. The result of this kind of self-learning process is that your tunings become more accurate, more precise, and more efficient.

A comment I've heard many times is, "But my tunings are good enough!" Maybe they are—most of the time. But what about when you have a time restraint, or noise in the environment? What about when you get "that" call? You know the one: "We have a piano that needs to be tuned. So-and-so (your mouth drops) is coming to town, and we got your name from someone. We've never used you before, but we're in a bit of a bind."

Do you want to use your "good enough" tuning on that one?

I don't tune many concert venues. I don't work for many high-level international artists. But whenever one calls, I am always confident that I can deliver a solid tuning. Part of that has come from unlearning old techniques and learning new ones. I invite you to join me in that practice of ongoing learning and improvement. ■

Mark Cerisano, RPT, *lives in Montreal. He has taught piano tuning and repair to hundreds of students since 2005. His experience as a mechanical engineer, public school teacher and professional musician has helped him create unique tools to help people learn about piano tuning and repair. More information is available at howtotunepianos.com.*